

Outcomes of patients with cancer receiving early feeding following gastric, small intestinal or colorectal surgery

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Abstract. Early enteral nutrition (EEN) has been shown to improve clinical outcomes of patients undergoing gastrointestinal surgery worldwide. However, its implementation remains inconsistent in certain countries, particularly among patients with gastrointestinal cancer. The present study aimed to provide further evidence of the outcomes of patients receiving EEN. The present prospective descriptive study included 256 patients with cancer indicated for gastric, small intestine and colorectal surgery. EEN was initiated within 72 h post-operatively, and dietary intake was monitored over the subsequent 7 days. The key outcomes assessed were post-operative weight change, digestive symptoms, time to initiate enteral nutrition, early postoperative complications, the length of hospitalization and the daily dietary intake of energy and protein. The average time to initiate digestion was 34.7±16.1 h. The mean post-operative weight loss was 0.6 kg at day 7 compared to the pre-operative weight. The incidence of abdominal distension and diarrhea was 7.4 and 4.7%, respectively. Patients with abdominal distension had a 5-fold higher risk of experiencing weight loss than those without ($P<0.05$). The complication rate was 0.4%. The mean length of hospitalization was 7.12 days. Peak nutritional intake was recorded on post-operative day 4, reaching 1370.8±310.8 kcal/day (26.5±7.3 kcal/kg/day). In particular, the total energy intake in the diabetic group was consistently lower than in the non-diabetic group, with statistically significant differences on the majority of post-operative days ($P<0.05$). These findings demonstrate the feasibility and clinical benefits of early enteral nutrition following surgery for

gastrointestinal cancer, particularly when evaluating outcomes such as weight loss, complication rate, length of hospitalization and dietary intake. Moreover, these results further emphasize the importance of nutritional interventions for patients with cancer with diabetes specifically.

Introduction

Cancer remains one of the leading causes of mortality worldwide. Malnutrition is highly prevalent among patients with cancer, primarily due to tumor burden, major surgical stress, metabolic disorders, immunodeficiency and reduced dietary intake (1). Malnutrition has been identified as a critical factor associated with post-operative complications and clinical outcomes in oncology patients (2).

Enhanced recovery after surgery (ERAS) is a multidisciplinary surgical care protocol designed to improve recovery, minimize post-operative complications, and reduce the period of hospitalization. A key element of ERAS is the initiation of early oral or enteral nutrition post-operatively (3-5). Early enteral nutrition (EEN), defined as initiating feeding within 24 h following surgery, or 48 h in critically ill patients, is recommended over delayed initiation (6). EEN has been shown to reduce post-operative catabolism, promote the recovery of gastrointestinal function, and lower the risk of developing post-operative complications (7,8).

Currently, EEN provided within 24-48 h post-operatively has been widely implemented in colorectal surgery, with strong evidence of safety and efficacy from high-quality clinical trials (9,10). Several studies have confirmed that EEN is both feasible and safe, even when initiated on the 1st day post-operatively. In Vietnam, some studies have reported positive outcomes of EEN following gastrointestinal surgery (11,12). Nonetheless, concerns about anastomotic leak and post-operative ileus continue to lead a number of institutions to delay feeding until the passage of flatus.

The Vietnam National Cancer Hospital (Hanoi, Vietnam) is the leading oncology hospital in the country. However, the implementation of EEN in patients with gastrointestinal cancer post-operatively has not been standardized across surgical departments. Moreover, large-scale data evaluating the outcomes of EEN in this population in Vietnam remain limited. Therefore, the present study was conducted to provide further evidence to support clinical decision-making

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Abbreviations: EEN, early enteral nutrition; PG-SGA, Patient Generated Subjective Global Assessment; PNI, prognostic nutritional index

Key words: early feeding, gastrointestinal cancer surgery, dietary intake, time to initiate enteral feeding, cancer patients with diabetes

regarding the optimal timing of EEN initiation in patients with gastrointestinal cancer post-operatively.

Patients and methods

The present prospective descriptive study was conducted from May to August, 2024 at the Department of Gastrointestinal Surgery, Vietnam National Cancer Hospital. Eligible participants were patients with gastrointestinal cancer scheduled for surgery and indicated for EEN within 72 h post-operatively. Initial ethics approval was obtained in April 2024. The study was officially approved by the Ethics Committee of the Vietnam National Cancer Hospital (Decision no. 3458/QĐ-BVK, dated November 22, 2024). This is a clinical research study that has been approved by the hospital's ethics committee. All participants were fully informed and provided with a thorough explanation.

Sample size and selection of participants. The inclusion criteria comprised adult patients (aged ≥ 20 years) with a confirmed diagnoses of gastric, small intestine, colon, or rectal cancer who were eligible for surgery and for initiating EEN within 24-72 h post-operatively (as determined by a consensus among the surgeon, attending physician, and clinical nutritionist). The exclusion criteria were those with severe hepatic, renal, or cardiac failure; emergency surgery; lack of informed consent; non-compliance with nutritional protocols; and an altered mental status.

Study protocol. The study protocol included the following steps: i) Pre-operative phase: Eligible patients were interviewed, and anthropometric measurements and laboratory tests were recorded. ii) Post-operative phase: Patients were clinically assessed to determine readiness for gastrointestinal function initiation based on consensus among the surgical team. Daily follow-up monitoring was performed. iii) Follow-up: Digestive symptoms, post-operative complications and 24-h dietary intake were recorded for 7 consecutive days. iv) Day 7 assessment: Anthropometric indices were reassessed, and nutritional status was evaluated using the Patient-Generated Subjective Global Assessment (PG-SGA). v) Outcome recording: The length of hospitalization was documented. During the 4-month study period, 469 patients underwent surgery. Of these, 190 patients were excluded due to discontinuous monitoring or non-compliance with the nutritional protocol, and 23 patients were excluded for commencing EEN >72 h post-operatively. A total of 256 patients were included in the final analysis.

Outcome measures and analytical tools

Body mass index (BMI). BMI was calculated as weight (kg) divided by height squared (m^2), as follows: Overweight/obese, BMI ≥ 25 ; normal, BMI ≥ 18.5 and < 25 ; malnutrition, BMI < 18.5 . When the BMI is < 18.5 , this indicates chronic energy deficiency (CED) and was classified as follows: CED grade 1 (mild), BMI 17-18.49; CED grade 2 (moderate), BMI 16.0-16.99; CED grade 3 (severe), BMI < 16 .

PG-SGA. The PG-SGA (13) is a comprehensive tool widely used to assess nutritional status in oncology. It incorporates multiple factors, including the following: Unintentional weight loss, reduced dietary intake, declined physical activity,

elevated metabolic demand (e.g., fever, corticosteroid use), and physical examination findings such as muscle atrophy, subcutaneous fat loss, edema and ascites. A higher PG-SGA score indicates a greater degree of nutritional risk. The categories are as follows: Category A, well-nourished; category B, suspected or moderate malnutrition; category C, severe malnutrition.

Prognostic nutritional index (PNI). The PNI was first proposed as an immune nutritional index to assess nutritional status prior to surgery (14-16). The PNI reflects the serum albumin levels and the total number of lymphocytes in the blood. It is calculated as follows: $PNI = 10 \times \text{albumin (g/dl)} + 0.05 \times \text{lymphocyte count (G/L)}$. Nutritional status classification was as follows: PNI ≥ 50 , normal; PNI > 45 and < 50 , mild malnutrition; PNI ≥ 40 and ≤ 45 , moderate-to-severe malnutrition; and PNI < 40 , severe malnutrition.

24-h dietary intake assessment. The principles of postoperative nutritional support were as follows: As per the ESPEN practical guideline on clinical nutrition in surgery, patients with cancer undergoing surgery should receive nutrition within an ERAS framework (3,6,17). The energy requirements are 30-35 kcal/kg/day, the protein requirements are 1.2-2 g/kg/day, which can be increased up to 2 g/kg/day, and vitamin and mineral are provided according to the daily recommended intake. High-dose supplementation is discouraged unless deficiency is confirmed.

Enteral nutrition protocol (applied in the present study). For the initiation of enteral nutrition, on the day gastrointestinal feeding was initiated, patients received a clear liquid diet consisting of thin rice porridge (finely ground rice with added sodium chloride) or a 10% glucose solution, administered at 100 ml per meal, three to six times daily, in combination with parenteral nutrition to meet baseline energy requirements. On day 2 of enteral feeding, patients progressed to a transitional liquid diet consisting of blended rice porridge (prepared with rice, lean pork and salt), provided at 150-200 ml per meal, three times daily, supplemented with milk (200 ml), twice daily, alongside continued parenteral nutrition. On post-operative days 3 to 7, patients advanced to a full liquid or soft diet, including porridge made with rice, a protein source (pork, beef, or chicken), vegetable oil, salt and cooked vegetables, administered at volumes ranging from 250-500 ml per meal, three times daily. This was supplemented with milk (200 ml), twice daily, with parenteral nutrition continued as needed, based on individual nutritional status and tolerance. The dietary regimen was individualized and maintained through post-operative day 7.

Statistical analysis. The data were cleaned before and during the data entry process. Statistical analyses were performed using SPSS v20.0 software (Dotmatics). Proportions were compared using the Chi-squared test (χ^2 test); Fisher's exact test was used when expected values were < 5 . Continuous variables were compared using the t-test (if normally distributed) or the Mann-Whitney U test (if not normally distributed). For comparisons across ≥ 3 groups, otherwise, the Kruskal-Wallis test was applied followed by the Bonferroni correction. Associations were evaluated using odds ratios (ORs) and 95% confidence intervals (CIs). A value of $P < 0.05$ was considered to indicate a statistically significant difference.

Table I. Baseline demographic and clinical characteristics of the patients (n=256).

Characteristic	All participants (%)	BMI <18.5 (%)	BMI ≥18.5 (%)	P-value	OR (95% CI)
Cancer site, n (%)				0.083 ^a	
Stomach	81 (31.6)	29 (43.9)	52 (27.4)		
Small intestine	7 (2.7)	2 (3.0)	5 (2.6)		
Colon	82 (32.0)	18 (27.3)	64 (33.7)		
Rectum	86 (33.7)	17 (25.8)	69 (36.3)		
Stage disease, n (%)				0.464 ^b	
I	33 (12.9)	6 (9.1)	27 (14.2)		
II	48 (18.8)	10 (15.2)	38 (20.0)		
III	134 (52.3)	37 (56.1)	97 (51.1)		
IV	41 (16.0)	13 (19.6)	28 (14.7)		
Neoadjuvant chemo-radiotherapy, n (%)				0.003 ^{b,c}	
No	173(67.6)	35 (53.0)	138 (72.6)		2.4 (1.3-4.2)
Yes	83 (32.4)	31 (47.0)	52 (27.4)		
Surgical approach, n (%)				0.009 ^{b,c}	
Laparotomy	172 (67.2)	53 (80.3)	119 (62.6)		
Laparoscopy	84 (32.8)	13 (19.7)	71 (37.4)		
History of diabetes, n (%)				0.135 ^b	
No	228 (89.1)	72 (31.6)	156 (68.)		
Yes	28 (10.9)	5 (17.9)	23 (82.1)		
Age group, n (%)				0.021 ^{b,c}	
>70 years	42 (16.4)	17 (25.8)	25 (13.2)		2.3 (1.1-4.6)
≤70 years	214 (83.6)	49 (74.2)	165 (86.8)		
Mean age, years	60.9±10.4				
Time to initiation of enteral nutrition (h), n (%)				0.061 ^b	
<24	130 (50.8)	27 (40.9)	103 (54.2)		
24-48	91 (35.5)	25 (37.9)	66 (34.7)		
48-72	35 (13.7)	14 (21.2)	21 (11.1)		
All participants	256 (100)	66 (100)	190 (100)		

Data were analyzed using ^aFisher's exact test or ^bthe Chi-squared test. ^cIndicates a statistically significant difference (P<0.05).

Results

Data were collected from 256 hospitalized older patients with a mean age of 60.9±10.4 years. The baseline demographic and clinical characteristics of the patients are presented in Table I. Among the types of cancer, colorectal cancer accounted for the highest proportion (65.7%), with rectal and colon cancer comprising 33.7 and 32.0%, respectively, gastric cancer at 31.6%, and small intestine cancer at the lowest value, with 2.7%. In terms of cancer stage, stage III was the most common, comprising 52.3% of cases. 0. Regarding treatment methods, 32.4% of patients received neoadjuvant chemo-radiotherapy prior to surgery. Malnutrition was 2.4-fold more prevalent among patients receiving neoadjuvant chemo-radiotherapy (P<0.05). As regards surgical approaches, laparotomy accounted for 67.2% while laparoscopic surgery accounted for 32.8%. Among the patients with a BMI <18.5, the proportion

undergoing laparotomy was particularly high (80.3%), with a statistically significant difference (P<0.05). Malnutrition was significantly more common in patients aged >70 years (OR, 2.3; 95% CI, 1.1-4.6; P<0.05). In terms of timing for the initiation of enteral nutrition, 50.8% of patients began oral feeding within 24 h following surgery, 35.5% within 24-48 h and only 13.7% between 48-72 h.

As presented in Table II, the average pre-operative weight of the patients was 53.2±9.7 kg, which decreased to 52.7±9.5 kg at 7 days post-surgery, with a statistically significant reduction of 0.6 kg (P<0.05). The prevalence of malnutrition, classified by a BMI <18.5, increased from 25.8 to 30.1%. Nutritional status evaluated using the PG-SGA, which indicated that pre-operatively, 83.2% of the patients were at a nutritional risk, with 60.9% in category B (moderate risk) and 22.3% in category C (severe risk). These proportions increased to 67.1 and 26.6%, respectively, indicating a progressive deterioration

Table II. Comparison of weight, BMI classification, PG-SGA and PNI before and 7 days following surgery.

Parameter	Pre-operative	Post-operative	P-value
Weight, kg (n=256)			
Mean value	53.2±9.7	52.7±9.5	0.001 ^c
Mean change in weight		0.6±3.3	
BMI (n=256)			
BMI <18.5	66 (25.8%)	77 (30.1%)	0.001 ^b
BMI ≥18.5	190 (74.2%)	197 (69.9%)	
PG-SGA (n=256)			
A	43 (16.8%)	16 (6.3%)	0.001 ^a
B	156 (60.9%)	172 (67.1%)	
C	57 (22.3%)	68 (26.6%)	
PNI (n=189)			
≥50	0 (0.0%)		
>45 and <50	6 (3.2%)		
≥40 and ≤45	101 (53.4%)		
<40	82 (43.4%)		
Mean value	39.8±3.8		

Data were analyzed using ^aFisher's exact test, ^bthe Chi-squared test, or ^cthe Mann-Whitney U test. PG-SGA, Patient Generated Subjective Global Assessment; PNI, prognostic nutritional index.

in nutritional status over the 7-day post-operative period. Among the 189 patients with complete pre-operative albumin data, the average PNI was 39.8±3.8. All patients had a PNI <50, and 43.4% had a PNI <40, indicating severe malnutrition.

As demonstrated by the data presented in Table III, the average time to the initiation of enteral nutrition was 34.7±16.1 h (1.4 days). By cancer location, the earliest initiation was observed in patients with small intestine cancer (29.1 h), followed by colorectal cancer (31.9 h), and the longest delay was in gastric cancer cases (40.8 h), with statistically significant differences between groups ($P<0.05$). The initiation time in the group receiving neoadjuvant chemo-radiotherapy was longer than in group not receiving this treatment (37.2 vs. 33.5 h). However, the difference was not statistically significant ($P>0.05$).

The results of a comparison of several characteristics between the weight loss group and the weight gain group on post-operative day 7 are presented in Table IV. Among the 256 patients who underwent gastrointestinal surgery included in the study, the time to the initiation of enteral nutrition was earlier in the weight gain group than in the weight loss group (33.3±14.3 vs. 35.4±16.9 h), with no statistically significant difference ($P>0.05$). Additionally, the incidence of abdominal distension was 7.4%, and the incidence of diarrhea was 4.7%. In terms of gastrointestinal symptoms, abdominal distension was observed in 7.4% of patients. Abdominal distension was associated with a markedly higher incidence of weight loss (89.5 vs. 62.9%, $P<0.05$). The odds of weight loss were 5-fold higher in patients with abdominal distension (OR, 5.0; 95% CI, 1.1-22.2). Diarrhea occurred in 4.7% of patients, with 83.3% experiencing weight loss, compared to 63.9% in those without diarrhea. However, this difference was not statistically significant ($P>0.05$). As regards post-operative complications,

only 1 case (0.4%) of post-operative bowel obstruction due to ileus was recorded. This patient underwent gastric surgery and received enteral nutrition after 48 h post-operatively. Ileus was diagnosed on post-operative day 4. The average length of hospitalization was 7.0±1.3 days, with no significant differences between the two groups. As regards post-operative dietary intake, overall energy intake did not meet the recommended nutritional requirements. The dietary intake was lowest on post-operative day 1 (682.9±220.7 kcal/day), peaking on day 4 (1,370.8±310.8 kcal/day) and then slightly decreasing by day 7 (1,172.5±283.0 kcal/day). From day 3 onward, both energy and protein intake were consistently higher in the weight gain group compared to the weight loss group, with significant differences from post-operative days 3 to 7 ($P<0.05$).

The present study then compared some of the outcomes between diabetic and non-diabetic patients with EEN following gastrointestinal surgery. The results are presented in Table V. The time to the initiation of digestion was 34.9±15.3 h, with no significant difference between the groups. The weight change following surgery was 0.8±1.9 kg in the diabetic group, which was higher than that in the non-diabetic group; however, this difference was not statistically significant. Among the diabetic patients, the incidence of abdominal distension was 3.6%, and diarrhea was reported in 7.1% of patients. No significant differences were observed between the diabetic and non-diabetic patients. Protein intake was comparable between the two groups throughout the 7-day post-operative period. However, the total energy intake in the diabetic group was consistently lower than that in the non-diabetic group, with statistically significant differences observed on post-operative days 1, 2, 5 and 6 ($P<0.05$). The proportion of energy derived from enteral nutrition was also lower in the diabetic patients, highlighting the need for individualized nutritional counseling and monitoring.

Table III. Digestion initiation time according to cancer location, surgical type and surgical method (n=256).

Parameter	Time to initiate enteral nutrition (days)	P-value
Cancer site		
Stomach	40.8±18.0 (1.7)	0.001 ^{a,b}
Small intestine	29.1±12.2 (1.2)	
Colon and rectum	31.9±14.3 (1.3)	
Surgical type		
Total gastrectomy	40.1±18.5 (1.7)	0.009 ^{a,b}
Near-total gastrectomy	44.3±16.7 (1.8)	
Gastrojejunostomy	40.0±15.9 (1.7)	
Small intestine resection	21.1±12.2 (1.2)	
Colon/rectum resection	32.0±14.7 (1.3)	
Colostomy creation	31.5±13.3 (1.3)	
Pre-operative chemotherapy and/or radiation therapy		
Surgery		
Yes	37.2±16.7 (1.5)	0.119 ^a
No	33.5±15.7 (1.4)	
Procedure		
Laparotomy	35.4±16.5 (1.5)	0.772 ^a
p Laparoscopy	34.0±15.9 (1.4)	
Overall mean	34.7±16.1 (1.4)	

Data were analyzed using ^athe Mann-Whitney U test, or ^bthe Kruskal-Wallis test with the Bonferroni correction. ^cIndicates a statistically significant difference (P<0.05).

Table IV. Comparison of several criteria between the weight loss group and weight gain group 7 days following gastrointestinal surgery.

Parameter	All participants	Weight loss group (n=166)	Weight gain group (n=90)	P-value	OR (95% CI)
Time to initiation of enteral nutrition (h)	34.7±16.1	35.4±16.9	33.3±14.3	0.628 ^c	
Digestive symptoms					
Abdominal distension				0.019 ^{a,d}	5.0 (1.1-22.2)
No	237 (92.6%)	149 (62.9%)	88 (37.1%)		
Yes	19 (7.4%)	17 (89.5%)	2 (10.5%)		
Diarrhea				0.224 ^a	2.8 (0.6-13.1)
No	244 (95.3%)	156 (63.9%)	88 (36.1%)		
Yes	12 (4.7%)	10 (83.3%)	2 (16.7%)		
Complications				0.999 ^a	
No	255 (99.6%)	165 (64.7%)	90 (35.3%)		
Yes	1 (0.4%)	1 (100.0%)	0 (0%)		
Length of hospitalization (days)	7.0±1.3	7.1±1.5	6.9±1.1	0.204 ^b	
Post-operative daily dietary intake					
Day 1					
Protein (g/kg/day)	0.4±0.1	0.4±0.0	0.4±0.1	0.087 ^c	
Energy (kcal/kg/day)	13.2±4.8	13.1±4.6	13.3±5.1	0.712 ^c	
Energy total (kcal/day)	682.9±220.7				

Table IV. Continued.

Parameter	All participants	Weight loss group (n=166)	Weight gain group (n=90)	P-value	OR (95% CI)
Day 2					
Protein (g/kg/day)	0.6±0.3	0.6±0.3	0.7±0.3	0.021 ^{a,d}	
Energy (kcal/kg/day)	18.6±7.5	17.9±7.2	19.7±7.9	0.059 ^c	
Energy total (kcal/day)	962.7±357.5				
Day 3					
Protein (g/kg/day)	0.9±0.3	0.9±0.3	1.0±0.3	0.008 ^{a,d}	
Energy (kcal/kg/day)	24.2±7.6	23.4±7.4	25.7±7.7	0.026 ^{a,d}	
Energy total (kcal/day)	1,256.5±344.8				
Day 4					
Protein (g/kg/day)	1.1±0.3	1.0±0.2	1.1±0.3	0.001 ^{b,d}	
Energy (kcal/kg/day)	26.5±7.3	25.3±6.6	27.8±7.1	0.001 ^{b,d}	
Energy total (kcal/day)	1,370.8±310.8				
Day 5					
Protein (g/kg/day)	1.1±0.3	1.0±0.2	1.1±0.3	0.003 ^{b,d}	
Energy (kcal/kg/day)	26.0±6.9	25.1±6.6	26.1±6.9	0.003 ^{b,d}	
Energy total (kcal/day)	1,346.4±285.3				
Day 6					
Protein (g/kg/day)	1.0±0.3	1.0±0.2	1.1±0.3	0.026 ^{b,d}	
Energy (kcal/kg/day)	24.9±6.6	24.2±6.3	26.1±6.9	0.025 ^{b,d}	
Energy total (kcal/day)	1,288.8±271.6				
Day 7					
Protein (g/kg/day)	1.0±0.3	0.9±0.3	1.0±0.3	0.032 ^{b,d}	
Energy (kcal/kg/day)	22.6±6.6	21.9±6.1	24.0±7.2	0.011 ^{b,d}	
Energy total (kcal/day)	1172.5±283.0				

Data were analyzed using ^aFisher's exact test, ^bthe Mann-Whitney U test, or ^cthe t-test. ^dIndicates a statistically significant difference (P<0.05).

Discussion

The present study evaluated 256 gastrointestinal cancer patients who were indicated for surgery, with an average age of 61 years of age (60.9±10.4 years).

Postoperative weight loss. The research results indicate that the average weight loss within 7 days following surgery was 0.6 kg (Table II) (from 53.2 to 52.7 kg). This result is lower than what was reported in previous studies, which observed weight loss ranging from 1.5 to 3 kg (12,18-21). Another international study on surgical patients, primarily gastrointestinal surgeries, demonstrated that patients experienced an average weight loss of 4.21 kg after 2 weeks post-operatively (22). The differences in these results may be due to the fact that the subjects in the present study received effective nutritional interventions and care, which contributed to less weight loss compared to previous studies.

Nutritional status assessment according to BMI and PG-SGA. Based on BMI, the pre-operative malnutrition rate was 25.8%. This finding is consistent with the findings in the studies by Thanh and Duyen, which reported rates of 26.0 and 24.5%, respectively (18,20). This finding is also in line with the findings

in the study by Chu (12) in patients undergoing gastrointestinal surgery, where the malnutrition rate was 33.87%. These results underscore the importance of nutritional interventions for surgical patients, particularly those with gastrointestinal cancer (23). In patients undergoing surgery for abdominal cancers, Mullen *et al* (24) reported that the mortality rate among those with a malnourished preoperative BMI was 5-fold higher than among patients with a normal weight or those who were overweight or obese. Similarly, Hede *et al* (25) found that patients with colorectal cancer with a BMI <18.5 kg/m² had a higher 30-day post-operative mortality rate compared to those with a BMI ≥18.5 kg/m². In the present study, patients who underwent neoadjuvant chemoradiotherapy had a 2.4-fold higher malnutrition rate compared to those who did not receive pre-operative treatment. This difference was statistically significant (P<0.05). This may be attributed to the adverse effects of chemotherapy on the gastrointestinal system, which can lead to anorexia and malabsorption, thereby contributing to a decline in nutritional status. Moreover, patients requiring neoadjuvant treatment often present with more advanced disease, further compromising their nutritional condition (26). In addition, the malnutrition rate (BMI <18.5) in patients aged >70 years was 2.3-fold higher than in those aged ≤70 years, consistent with physiological changes associated with aging.

Table V. Comparison of some characteristics between the group of patients with diabetes and the group without diabetes.

Parameter	Non-diabetes, n=228 (89.1%)	Diabetes, n=28 (10.9%)	P-value
Time to initiation of enteral nutrition (h)	34.6±16.2	34.9±15.3	0.927 ^c
Change in weight (kg)	0.6±3.4	0.8±1.9	0.589 ^d
Digestive symptoms			
Abdominal distension			
No	215 (94.3%)	27 (96.4%)	0.999 ^a
Yes	13 (5.7%)	1 (3.6%)	
Diarrhea			
No	218 (95.6%)	26 (92.9%)	0.627 ^a
Yes	110 (4.4%)	2 (7.1%)	
Complications			
No	227 (99.6%)	28 (100.0%)	0.999 ^a
Yes	1 (0.4%)	0 (0%)	
Length of hospitalization (days)	7.1±1.5	6.9±0.8	0.693 ^c
Day 1			
Protein (g/kg/day)	0.4±0.1	0.3±0.1	0.163 ^b
Energy (kcal/kg/day)	13.5±4.7	10.8±4.5	
% from enteral nutrition	2.0%	1.5%	
Day 2			
Protein (g/kg/day)	0.6±0.3	0.6±0.2	0.246 ^b
Energy (kcal/kg/day)	19.0±7.5	14.8±6.4	
% from enteral nutrition	30.8%	22.5%	
Day 3			
Protein (g/kg/day)	0.9±0.3	0.9±0.3	0.635 ^b
Energy (kcal/kg/day)	24.5±7.5	21.8±8.1	
% from enteral nutrition	59.4%	53.3%	
Day 4			
Protein (g/kg/day)	1.1±0.3	1.0±0.2	0.198 ^b
Energy (kcal/kg/day)	26.8±7.3	23.8±6.1	
% from enteral nutrition	76.7%	72.4%	
Day 5			
Protein (g/kg/day)	1.1±0.2	1.0±0.3	0.037 ^{b,d}
Energy (kcal/kg/day)	26.4±6.8	23.6±7.2	
% from enteral nutrition	81.5%	77.0%	
Day 6			
Protein (g/kg/day)	1.1±0.3	1.0±0.3	0.055 ^b
Energy (kcal/kg/day)	25.2±6.6	22.8±6.5	
% from enteral nutrition	82.1%	77.0%	
Day 7			
Protein (g/kg/day)	1.0±0.3	0.9±0.3	0.112 ^b
Energy (kcal/kg/day)	22.8±6.7	21.0±5.8	
% from enteral nutrition	82.0%	77.0%	

Data were analyzed using ^aFisher's exact test, ^bthe Mann-Whitney U test, or ^cthe t-test. ^dIndicates a statistically significant difference (P<0.05).

This result is also supported by the study by Nguyen *et al* (27), which demonstrated that individuals aged >70 years had a higher malnutrition rate compared to younger age groups. At 7 days post-operatively, the malnutrition rate in the present

study increased to 30.1%, although still lower than the 39.4% reported in the study by Nguyen (18). This difference highlights the significance of early feeding interventions for patients in post-surgery.

Pre-operative assessment using the PG-SGA indicated that 83.2% of the patients were classified as mildly/moderately or severely malnourished, with 60.9% falling into mild/moderate malnutrition (PG-SGA category B) and 22.3% into severe malnutrition (PG-SGA category C). These rates were higher than those reported in the 2022 study by Le *et al* (28) on patients with colorectal cancer, which demonstrated that 60.9% of patients were categorized as PG-SGA B and 8.6% as PG-SGA C. Similarly, they exceeded the findings of the study by Diệp *et al* (29), which reported 55.0% in PG-SGA B and 25.7% in PG-SGA C, and those of the study by Linh *et al* (30), where the overall malnutrition rate was 56.8%. Compared to international studies, there were also notable differences in malnutrition risk across countries and regions. The malnutrition rate in the present study was higher than that reported in the study by Maurício *et al* (31), where 52.4% of 84 patients undergoing rectal cancer surgery were classified as having mild/moderate or severe malnutrition. In the present study, following surgery, the nutritional status remained poor, with 67.1% of patients classified as PG-SGA B and 26.6% as PG-SGA C. This increase in malnutrition is consistent with the majority of studies, which show a deterioration in nutritional status based on PG-SGA following surgery (30). Contributing factors include post-operative weight loss, a marked decrease in dietary intake compared to pre-operative levels, limited functional activity (e.g., difficulty walking, some patients unable to stand), muscle atrophy and an elevated metabolic rate. Pain at the surgical site further aggravates the condition. These factors significantly affect PG-SGA scores following surgery, resulting in higher proportions of patients being classified as PG-SGA B or C. Although weight status appears improved compared to earlier studies, other critical factors, such as anorexia, abdominal distension and pain continue to negatively affect post-operative nutritional status. These findings highlight the need for ongoing nutritional intervention and monitoring, as the nutritional status of patients may deteriorate substantially after discharge without appropriate support (32).

Time to initiate enteral nutrition. According to the data presented in Table III, the mean time to initiate enteral nutrition in our study was 34.7 h (~1.4 days), notably earlier than reported in previous domestic studies over the past decade, where the average initiation time typically ranged from 3 to 6 days in patients receiving traditional feeding protocols. The study by Đào *et al* (33) reported a mean time to initiate enteral nutrition of 23.5 h in the early enteral nutrition group and 60 h in the traditional feeding group. By contrast, other studies reported a mean time to initiate enteral nutrition of 3 to 6 days post-operatively (12,18,19,34,35). These discrepancies may be attributed to evolving clinical perspectives among surgeons regarding the optimal timing for nutritional initiation, as well as the growing involvement of clinical nutrition teams who now actively advocate for EEN. The decision to implement early feeding, informed by updated postoperative care guidelines, has been increasingly supported by recent studies. International literature and recommendations suggest that enteral nutrition can be initiated within 24-48 h following gastrointestinal surgery without increasing the risk of post-operative complications (6,9,36). Furthermore, the study by Yang *et al* (37) confirmed that the timing of early enteral

nutrition was an independent factor that does not increase the risk of post-operative bowel obstruction.

Some gastrointestinal symptoms encountered following surgery. Among the 256 patients included in the present study, 19 patients (7.4%) developed abdominal distension following the initiation of enteral nutrition, and 12 patients (4.7%) experienced diarrhea. These rates are considerably lower than those reported in the study by Agrawal *et al* (38), in which 28.57% of 35 patients undergoing gastrointestinal surgery receiving early enteral feeding within 24 h developed abdominal distension. The rate of weight loss in patients with abdominal distension was 5-fold higher than in those without (95% CI, 1.1-22.2). Abdominal distension, considered a marker of poor gastrointestinal tolerance, markedly influences decisions regarding nutritional support and energy provision. This symptom warrants close clinical monitoring to identify underlying etiologies and guide appropriate nutritional and medical interventions. In the present study, the incidence of diarrhea was 4.7%. This condition may contribute to an increased risk of malnutrition and predispose patients to additional postoperative complications. The study by Xu and Kong (39) indicated that post-operative diarrhea in patients with colorectal cancer was associated with a higher risk of anorectal fistula formation.

Early post-operative complications within 7 days. In the present study, among the 256 patients receiving early enteral nutrition, only 1 patient (0.4%) experienced a post-operative complication within the first 7 days. This individual developed bowel obstruction on post-operative day 4, having commenced enteral feeding on postoperative day 2. The complication rate in the present study is markedly lower than the rates reported in previous studies (11,12,28,30). This difference may be attributable to the initial effectiveness of nutritional intervention. However, the relatively short follow-up period of 7 days in the present study may not fully capture both early and delayed post-operative complications, thereby underestimating the true complication rate. Accordingly, future studies with extended follow-up durations are warranted to comprehensively assess postoperative outcomes in gastrointestinal cancer patients.

Dietary intake following surgery. In the present study, dietary intake during the 7-day post-operative period was assessed and found to be below the recommended levels according to the ESPEN guidelines. Specifically, energy intake was lowest on post-operative day 1, with an average of 682.9±220.7 kcal/day (equivalent to 13.2±4.8 kcal/kg/day), it peaked on day 4 at 1,370.8±310.8 kcal/day (26.5±7.3 kcal/kg/day) and then decreased to 1,172.5±283.0 kcal/day (22.6±6.6 kcal/kg/day) by day 7. Compared to a previous study, the nutrition intervention group in that study achieved ~400 kcal on post-operative day 1, nearly 1,300 kcal on day 4, and >1,600 kcal/day by day 6. Moreover, the control group (receiving traditional feeding) had an intake ranging from only 200 to 600 kcal over the first 6 post-operative days (11). The study by Ho *et al* (40) further supports this view, demonstrating that early enteral nutrition significantly increased both energy and protein intake compared to delayed initiation. When comparing the weight gain and weight loss subgroups, the results of the present study revealed significantly higher per-kg nutritional intake

in the weight gain group. This aligns with the physiological understanding that adequate nutrition plays a critical role in preventing postoperative weight loss. As regards patients with diabetes, no statistically significant difference in protein intake was observed between the diabetic and non-diabetic groups during the 7-day post-operative period. However, total energy intake was consistently lower in the diabetic group, with statistically significant differences observed on post-operative days 1, 2, 5 and 6 ($P < 0.05$). This difference may be attributed to a reduced appetite or lower food intake due to elevated blood glucose levels in the diabetic group. In the present study, the percentage of energy from enteral nutrition (patients on a porridge or blended porridge diet) was lower in the diabetic group compared to the non-diabetic group. This can be explained by the fact that cancer patients with diabetes tend to reduce their starch intake (such as reducing their porridge portions) without increasing other nutritional components, leading to a lower total energy intake in the diabetic patient group compared to the other group. A study on knowledge and dietary practices has also indicated inadequate nutrient intake in patients with diabetes (41). A study in Vietnam evaluating 169 diabetic patients found that their nutritional energy intake was lower than the recommended requirement ($1,341.6 \pm 158.0$ vs. $1,652.6 \pm 171.0$ kcal/day) (41). In addition, the diabetic group tends to experience more pain after surgery, and the level of pain may affect their food intake. Another study conducted on 80 patients found that the diabetic group had a higher level of pain (assessed using the visual analogue scale) compared to the non-diabetic group (42). This suggests that further attention should be paid to counseling and care for diabetic patients, ensuring they follow the nutritional care plan provided by healthcare professionals.

Duration of hospitalization. The average duration of hospitalization in the present study was 7.0 ± 1.3 days. This result is lower than that in the study by Chu (12), where the average hospitalization duration for the intervention group was 8.3 days. The results of the present study are higher than those in the study by Dao *et al* (11), where the average hospitalization duration for the intervention group was 6.2 days. However, the differences in hospitalization time across studies on early enteral nutrition are relatively small. These results are consistent with international findings suggesting that early initiation of enteral nutrition following gastrointestinal surgery may contribute to a shortened length of hospitalization, particularly when compared to conventional delayed feeding approaches (43,44). These findings further support the positive impact of early enteral nutrition on clinical recovery in patients undergoing gastrointestinal cancer surgery.

Despite the valuable insight provided by the present study, several limitations should be acknowledged. First, the sample size was limited to a single hospital, which may restrict the generalizability of the findings to other populations or clinical settings. Second, due to the short follow-up period, long-term post-operative nutritional outcomes could not be evaluated. Third, although the authors considered potential confounding factors, such as cancer stage and surgical approach during the study, the data collection did not ensure a balanced distribution of patients across subgroups, such as cancer stages (I-IV)

or the six different surgical techniques included in the study. Consequently, the authors intend to conduct a larger-scale, more comprehensive investigation in the future to better control for these confounding variables, as recommended. In the future, the authors also plan to implement multicenter randomized controlled trials with extended intervention and follow-up periods to comprehensively assess early and late post-operative complications.

Despite these limitations, the findings presented herein support the implementation of early gastrointestinal nutrition protocols for patients undergoing surgery for gastric, small intestinal, or colorectal cancer in particular, and for gastrointestinal cancers in general. This practice should be applied systematically and proactively to improve the outcomes of patients. Moreover, the combination of enteral and parenteral nutrition should be carefully tailored to meet recommended nutritional requirements. Special attention should be paid to patients with a history of diabetes, those aged >70 years, or those who have received neoadjuvant chemo-radiotherapy.

In conclusion, the average gastrointestinal initiation time has met the recommended early feeding timeframe according to the ERAS program. Patients who received neoadjuvant chemoradiotherapy and those aged >70 years exhibited a higher risk of malnutrition. Abdominal distension was associated with a significantly greater risk of weight loss. Patients who have undergone gastrointestinal surgery and also have diabetes have lower nutritional levels compared to those without diabetes. The average nutritional intake for patients receiving early feeding in Vietnam still does not meet the recommended requirements according to ESPEN. This further emphasizes the importance of early feeding and nutritional interventions for general cancer patients and cancer patients with diabetes specifically.

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Availability of data and materials

The data generated in the present study may be requested from the corresponding author.

Authors' contributions

TTT, BVH and HTL were involved in the conceptualization of the study. TTT was involved in data curation and in project administration. TTT and THTN were involved in formal analysis and in data analysis. TTT, BVH and HTL were involved in the study methodology, in data validation and supervised the study. TTT, THTN and BVH were involved in the writing and preparation of the original draft of the manuscript. TTT, BVH, HTL and THTN were involved in the writing, review and editing of the manuscript. TTT and BVH confirmed the authenticity of the raw data. All authors have read and agreed to the published version of the manuscript.

Ethics approval and consent to participate

Initial ethics approval was obtained in April 2024. The study was officially approved by the Ethics Committee of the Vietnam National Cancer Hospital (Decision no. 3458/QĐ-BVK, dated November 22, 2024). This is a clinical research study that has been approved by the hospital's ethics committee. All participants were fully informed and provided with a thorough explanation.

Patient consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Use of artificial intelligence tools

During the preparation of this work, AI tools were used to improve the readability and language of the manuscript or to generate images, and subsequently, the authors revised and edited the content produced by the AI tools as necessary, taking full responsibility for the ultimate content of the present manuscript.

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