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**Application and evaluation of a nurse-directed prehabilitation intervention program in patients with gastrointestinal cancer: A randomized intervention study**

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**Abstract****Aim:** To demonstrate that nurse-directed prehabilitation intervention may effectively accelerate postoperative rehabilitation.**Design:** A single-blinded randomized intervention study.**Methods:** Based on the pathway management of enhanced recovery after surgery, a nurse-directed prehabilitation intervention program was formulated in combination with the clinical experience of gastrointestinal surgery. A total of 189 participants with gastrointestinal cancer were enrolled in this study, which was conducted between June 2021 and February 2022. Participants were randomly divided into an intervention group (n = 94) and a reference group (n = 95). The reference group received routine care, while the intervention group was given systematic nurse-directed prehabilitation intervention on nutrition, activity, and psychology. The postoperative recovery of the two groups was compared.**Results:** The time from the end of surgery to first ambulation, flatus, and defaecation in the intervention group was significantly shorter than that in the reference group, and the postoperative hospital stay, overall hospital stay, and hospital costs were significantly less than those in the reference group.**Conclusion:** Preoperative nurse-directed prehabilitation intervention in patients with gastrointestinal cancer improves the quality of postoperative recovery.**Keywords:** Gastrointestinal cancer; Cancer prehabilitation; Nursing intervention.**Introduction**

Gastrointestinal cancer is the most common malignant cancer encountered clinically, it not only reduces the quality of life of patients and increases the burden of caregivers, but also harms patients' mental health and increases patients' suffering and a serious threat to human health [1,2]. Surgery is the most effective method for treating gastrointestinal cancer [3]. However, to patients, surgery implies inevitable trauma, a decline in

physical function, and psychological problems such as anxiety or depression [4-7]. Additionally, gastrointestinal cancer affects preoperative patients with poor nutritional status, metabolic level, immune function, and mental health [8,9]. Hence, an increasing amount of research on accelerating recovery and reducing adverse outcomes after surgery is underway. In the previous studies, patient rehabilitation was generally considered to take place in the postoperative phase; however, patients are in better physical condition and more willing to cooperate actively

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in the preoperative preparation than in the postoperative period when they are waiting for surgery and have a higher psychological tolerance than in the postoperative period when they are undergoing rehabilitation exercises. Therefore, for such patients, a series of preoperative interventions can reduce the risk of postoperative related complications and promote rapid physical recovery.

## Background

Cancer rehabilitation involves performing physical and psychological assessments on patients and making judgements about their condition during the diagnosis and implementation of certain treatments (such as surgery or chemoradiotherapy). This is done to carry out specific interventions to improve their health and physical function and decrease treatment-related morbidity while simultaneously reducing the number of hospitalisation days and costs [10]. As postoperative adverse events in patients are closely related to preoperative physical function [11], it is necessary to prioritise preoperative nursing to accelerate recovery and reduce postoperative complications [12,13]. Preoperative pre-rehabilitation is a series of planned and systematic interventions through nutritional support therapy, physical exercise, alleviation of anxiety and depression before surgery, and improving physical function to cope with the body's stress response and accelerate the patient's recovery process after surgery [14,15]. Prehabilitation, as a further manifestation of the concept of accelerated surgical rehabilitation, assumes an important task in the overall treatment plan of surgical patients, especially in the perioperative period. The strategy emphasizes early intervention in the preoperative stage, making full use of the precious time of the patient before surgery and applying reasonable nursing measures to provide therapeutic care for the patient in three aspects: nutrition, exercise and psychology. It helps patients face the surgery in the best physical and mental condition, improves the physical condition of gastrointestinal cancer surgery patients after surgery, accelerates their post-operative recovery, thus improving their immunity and improving their post-operative quality of life.

Pre-rehabilitation is based on the theory of accelerated rehabilitation surgery and is a distinctive concept of perioperative care, which means that a series of rehabilitation measures are taken before elective surgery to enhance the patient's physical functional reserve and regulate the patient's psychology, so that he or she is in the best condition to cope with the stress of surgery [16]. The concept of prehabilitation emphasizes a complete and continuous care package from the diagnosis of the disease to the start of surgery, including motor function exercises, nutritional status improvement and psychological guidance and education, including moderate amounts of aerobic and strength exercises to enhance the functional reserve of the body during the waiting period for surgery [17]. Positive psychological counseling was conducted to eliminate fear and anxiety about disease and surgery and to reduce physical and mental damage; reasonable nutrition was conducted to provide sufficient raw materials for the recovery of operated organs in order to shorten the total length of hospitalization, reduce complications, alleviate the economic burden and improve the quality of life of patients. Theoretically, the features of prehabilitation measures exactly fill the current gap in perioperative care for

patients with gastrointestinal cancer and have a positive effect on their postoperative recovery.

Based on the management of perioperative Enhanced Recovery After Surgery (ERAS), our study aimed to organise relevant psychology, nutrition, and rehabilitation experts in a preoperative intervention program for patients with gastrointestinal cancer and provide pre-rehabilitation to those who reach the surgical indications. In this study, the nurse-directed prehabilitation intervention program for patients with gastrointestinal cancer was expected to relieve pain and promote the postoperative rehabilitation process. Our study also enables medical practitioners to realise the clinical value of preoperative pre-rehabilitation interventions and provides evidence for their promotion.

## The study

### Aim

To demonstrate that nurse-directed prehabilitation intervention may effectively accelerate postoperative rehabilitation. The primary outcome was the laboratory indicators. The secondary outcomes included the postoperative evaluation, patients' QOR.

### Study setting

This study was performed in a Grade-A general hospital in Wuxi, Jiangsu, China. This hospital has a total bed capacity of 2,000 and more than 3,000 employees. Among them, gastrointestinal surgery is a provincial clinical key specialty with 138 beds and about 1500 cases of gastrointestinal surgery per year.

### Participants

This prospective study was conducted at XXX between June 2021 and February 2022. Patients diagnosed with gastrointestinal cancer were selected as the participants, who were randomly divided into the intervention and reference groups by randomizing digital table. The inclusion criteria were: (1) age  $\geq$  18 years; (2) the first diagnosis performed by digestive endoscopy or pathology was gastric cancer or colorectal cancer, and laparoscopic radical resection was scheduled; and (3) cognitive impairment, or severe cardiopulmonary disease. The exclusion criteria were: (1) mobility, cognitive impairment, or severe organ dysfunction and (2) patients who were transferred, discharged, or withdrawn during the diagnosis and treatment process. Finally, 189 patients with gastrointestinal cancer were included: 94 in the intervention group and 95 in the reference group.

### Research team

The research team consisted of healthcare workers in Gastrointestinal Cancer, Nutrition, Rehabilitation, and Oncology departments, including one chief physician, two associate chief physicians, two attending physicians, one associate chief nurse, four nurses-in-charge, two nurse practitioners, and two nursing graduate students. As team leaders, the chief physicians and associate chief nurses were responsible for the dynamic modification and overall control of the study plan to ensure feasibility. The attending physicians were responsible for observing the condition of the participants and implementing the treatment plan; nutritionists were responsible for formulating nutritional

programs for study participants; rehabilitation physicians were responsible for guiding patients' activities during the pre and postoperative periods; nurses-in-charge were responsible for implementation and quality control during the intervention process, and nursing graduate students were responsible for literature review, data collection, and data processing.

### Interventions

The interventions implemented in the reference group were as follows: patients were instructed on a routine diet, nutrition, and daily activities, and intravenous or oral nutritional therapy was administered to emaciated patients or with very recent weight loss. Simultaneously, targeted routine treatment measures were taken, such as timely blood transfusion or human serum albumin for patients with haemoglobin < 80 g/L or albumin  $\leq$  30 g/L, respectively, according to the patient's body mass index (BMI), haemoglobin, serum albumin, serum total protein, and other indicators on admission. It is necessary to persuade patients to quit smoking and drinking, exercise properly, maintain healthy sleep, evaluate the patient's psychological status and provide intervention to relieve the patient's negative emotions early.

Based on the reference group, the intervention group was given a systematic nurse-directed prehabilitation intervention in nutrition, activity, and psychology as follows:

**Nutrition:** Based on routine dietary guidance and nutritional support, patients underwent preoperative Nutritional Risk Screening according to the Nutritional Risk Screening 2002 (NRS 2002) when admitted to the hospital. A score of <3 indicated that the patient was not at risk of malnutrition, and nutritional and dietary education should be provided, such as instructing them to have a high-protein and high-vitamin digestible diet and encouraging enteral nutrition (Intacted Protein Enteral Nutrition Powder or ENSURE). Conversely, a score  $\geq$ 3 indicated that the patient was at a certain risk of malnutrition; thus, the Patient-Generated Subjective Global Assessment (PG-SGA) needed reevaluation. According to the reassessment results, patients with a score of 2-3 needed dietary modification and oral enteral nutrition by a dietitian. Otherwise, for patients with a score of  $\geq$ 4, we invited multidisciplinary experts to discuss the case. After the experts' discussion, dietitians formulated corresponding diet adjustments and enteral and parenteral nutrition programs (such as intravenous infusion of amino acids, medium and long chain fat emulsions, trace elements, vitamins, etc.) to ensure that the daily intake of protein was 1.5 g/(kg/d). Simultaneously, poultry, fish, dairy products, eggs, and vegetable protein were preferred in the diet, and the non-protein calories were maintained at 125 kJ/(kg/d) to ensure that the ratio of starch, protein, and vegetables was 2:1:2. In addition, the nutritional status of patients was dynamically assessed according to various examination indicators, such as BMI, haemoglobin, and serum albumin, to take corresponding treatment measures. Patients with serum haemoglobin or albumin levels less than 80 g/L or  $\leq$ 30 g/L were treated with blood transfusion or human albumin, respectively, in a timely manner. The frequency of NRS 2002 was once a week for a score of 0-2, once a day for a score  $\geq$ 3, and the nutritional intervention plan was dynamically adjusted according to the evaluation results. In addition, patients were instructed to take oral glucose for energy support at night before and on the morning of surgery.

**Exercise:** When the patients were admitted to the hospital, the Barthel Index and Braden Scales were used to comprehen-

sively evaluate their cardiopulmonary function and formulate an exercise program, including respiratory function exercise, limb and joint activities, and resistance training. Respiratory function exercises included balloon blowing, pursed-lip breathing, effective coughing, expectoration and breathing exercises, and many more. The above exercises were performed 10 times per group, 3-5 times daily. Limb and joint activities involved brisk indoor walking (at least 6000 steps per day), stair climbing (three times a day, 3-4 stairs each time), first training, straight leg raising training, quadriceps endurance training, etc. Resistance training included ankle-pump exercises, hip lifts, and air cycling. The above exercises were performed when the patient's condition was acceptable, and it was advisable for the patient not to feel tired. The six-minute walk test (6 MWT) was used as an evaluation index to assess the patient's exercise and cardiopulmonary function. Exercise training to improve the preoperative level was beneficial for improving the postoperative clinical outcome of the patient.

**Psychology:** At the time of admission, the General Anxiety Disorder-7 (GAD-7) and Patient Health Questionnaire (PHQ-9) were used for scoring the patients, and the corresponding psychological counselling and intervention were selected according to the results. Special psychological patients, difficult cases, or crisis events required multidisciplinary expert consultations to revise the intervention strategy. Effective psychological interventions for patients with gastrointestinal cancer could alleviate the distress caused by negative emotions to their psychological state, help patients smoothly pass through the psychological crisis stage, and reduce the negative impact of preoperative anxiety or depression on postoperative cardiopulmonary function, wound healing, and disease rehabilitation.

### Data collection

General sociodemographic characteristics and evaluation indicators were collected. General sociodemographic characteristics included age, sex, education level, smoking, drinking, chronic disease, diagnosis, tumour TNM stage, and degree of differentiation. Evaluation indicators included laboratory tests, clinical recovery indicators, and a self-evaluation index. Laboratory tests included haemoglobin, serum albumin, and serum total protein levels for patients at admission, after the intervention, and at discharge. Additionally, clinical recovery indicators included the time from the end of surgery to the time of first ambulation, flatus and defaecation, postoperative hospital stay, overall hospital stay and costs, and postoperative complications (such as anastomotic leakage, bleeding, lung infection, and deep vein thrombosis). The 15-item Quality of Recovery (QOR-15) scale was used to evaluate the self-evaluation index [15], which assesses the quality of early postoperative recovery from the patient's perspective, covering five dimensions (physical comfort, psychological support, independence, emotion, and pain), with each item scored from 0 to 10, with a higher overall score indicating a better recovery quality of patients' self-evaluation.

### Statistical analysis

All statistical analyses were performed using SPSS 22.0 (IBM Corp., Armonk, NY, USA). Continuous variable data were based on the results of normality and homogeneity of variance tests. The mean and standard deviation were calculated for the distribution characteristics of the quantitative data. The mean values among groups were compared using a t-test or rank sum test, while comparisons at different time levels were described using repeated-measures analysis of variance. Qualitative data are



presented as frequencies and percentages, and comparisons between groups were performed using the chi-square or Fisher's exact tests. A *P* value less than 0.05 was considered statistically significant.

## Results

### Comparison of general data for patients in different groups

A total of 189 patients with gastrointestinal cancer were included in this study. Among them, 94 (49.7%) were in the intervention group, with an average age and standard deviation (SD) of  $65.27 \pm 9.96$  years. The intervention group included 73 (77.7%) males and 21 (22.3%) women. The number of patients with gastric, colon, and rectal cancer was 49 (52.1%), 18 (19.2%), and 27 (28.7%), respectively. The reference group consisted of 95 (50.3%) patients, with an average age and SD of  $64.77 \pm 10.19$  years. There were 71 (74.7%) males and 24 (25.3%) females in the reference group, and 44 (46.3%), 21 (22.1%), and 30 (31.6%) patients with gastric, colon, and rectal cancers, respectively. There was no significant difference between the intervention and reference groups regarding general demographic characteristics or laboratory test results (*P* > 0.05). Detailed sample characteristics are presented in Table 1.

### Comparison of data from repeated measurements in different groups

Repeated measurements of haemoglobin, serum albumin, serum total protein, 6 MWT, GAD-7, and PHQ-9 were significantly different at the three different time points: at admission, the day before surgery, and at discharge (*P* < 0.001). Meanwhile, there were significant differences in the QOR-15 scores at the four different time points, on the day before surgery, postoperative day 1, postoperative day 3, and postoperative day 7 (*P* < 0.001). However, there was no interaction between the three different time points of haemoglobin, serum albumin, and PHQ-9 in the repeated measurement data among the different groups (*P* > 0.05), indicating that the effect of the time factor did not vary between the groups. Nevertheless, different time points of serum total protein, 6 MWT, QOR-15, and GAD-7 showed interactions among the different groups (*P* < 0.05). There was no significant difference in the effect of the different groups on serum albumin levels (Table 2).

### Comparison of postoperative recovery indicators in different groups

As shown in Table 3, the first time leaving bed after surgery, first anal exhaust time, and first defecation time in the intervention group were  $22.65 \pm 8.63$  h,  $49.71 \pm 23.73$  h, and  $87.61 \pm 43.64$  h, respectively. The postoperative hospitalization duration was  $12.16 \pm 3.77$  days, total hospitalization days was  $19.10 \pm 4.22$ , and the hospitalization cost was  $57971.14 \pm 13465.29$  yuan. In the reference group, the first time getting out of bed after surgery, first exhaust time, and first defaecation time were  $25.64 \pm 8.35$  h,  $68.47 \pm 27.61$  h, and  $127.41 \pm 57.04$  h, respectively. The postoperative hospitalization duration was  $15.22 \pm 5.27$  days, the total hospitalization days was  $23.31 \pm 6.60$ , and the hospitalization cost was  $66526.07 \pm 18019.05$  yuan. In the intervention group, the first time leaving the bed after surgery, the first anal exhaust, and defaecation time were significantly earlier than those in the reference group (*P* < 0.05). In contrast, the number of postoperative and total hospitalisation days and hospitalisation costs in the intervention group were significantly lower than in the reference group (*P* < 0.05). Nevertheless, there was no significant difference in postoperative complica-

tions between the intervention and reference groups (*P* > 0.05).

## Discussion

Prehabilitation is a new type of preoperative care model based on ERAS. Targeted interventions are implemented to improve the patient's physical function, optimise the individual's response to the stress of surgical trauma, and speed up the process of postoperative recovery before evaluating the patient's physical and psychological state [18,10]. With the developing social economy in recent years, residents' lifestyles have undergone tremendous changes, and the incidence of gastrointestinal cancer induced by unhealthy diets and habits has increased annually. Most patients have suffered from cancer with different degrees of malnutrition and decreased body function before receiving medical treatment [13,11]. In patients with gastrointestinal cancer who are ready for surgery, early and effective nutritional support and adjustment of body functions are important measures to improve the success rate of surgery and speed up the process of postoperative recovery [19,8]. Many other scholars have also concluded that such measures, which are diversified pre-rehabilitation nursing interventions, are beneficial for helping patients with rehabilitation and reducing the incidence of postoperative complications [12,15,20].

In this study, the time from the end of surgery to first ambulation, flatus, and defaecation in the intervention group was shorter than that in the reference group, indicating that prehabilitation nursing interventions in nutrition, exercise, and psychology, can effectively promote earlier postoperative recovery in patients with gastrointestinal cancer, similar to the findings of Levett et al. [21,22]. Due to the different degrees of trauma in patients following surgeries, exercise load, tolerance, and psychological states are often affected to various degrees, requiring a month or more to recover [23,24]. Nutritional support increases the reserve of patients and can help the body adjust to a better state and promote the recovery of postoperative physical functions. At the same time, psychological intervention reduces anxiety and depression to improve the patient's confidence in overcoming the disease and is conducive to shortening the patient's recovery time [25-27]. Many patients undergo surgery immediately after preoperative examinations in the clinic, resulting in limited time for performing prehabilitation nursing interventions [28-30]. More time is needed to help patients adjust their physical state before surgery to cope with the stress response caused by surgery, help patients go through the perioperative period smoothly, and improve the quality of their postoperative recovery [31]. The follow-up plan of this study will advance the pre-rehabilitation intervention time before admission to obtain more time to help patients adjust their physical state before surgery and cope with the stress response caused by surgery. This will benefit patients who pass the perioperative period smoothly and improve the quality of postoperative recovery.

This study had several limitations. First, the number of patients enrolled in our analyses was relatively limited, which may have led to some bias in the results. Second, patients scheduled for elective surgery had a short time between admission and surgery; therefore, the effects of nutrition, psychology, and exercise interventions may be limited. Finally, our findings might not apply to other countries because of differences in culture, and further in-depth studies with longitudinal follow-up data are needed to explore the effect of the intervention.

**Table 1:** Characteristics of the study participants (n=189).

Variables	Intervention group (n=94)	Reference group (n=95)	t/ $\chi^2$ /Z	P
Age (years)	65.27 ± 9.96	64.77 ± 10.19	0.340	0.735
Gender (n, %)			0.222	0.637
Male	73(77.7)	71(74.7)		
Female	21(22.3)	24(25.3)		
Education level (n, %)			3.090	0.378
Primary school or lower	28(29.8)	20(21.1)		
Junior high school	39(41.5)	48(50.5)		
Senior high school	18(19.2)	31(22.1)		
Junior college or above	9(9.6)	6(6.3)		
Smoke (n, %)			0.143	0.705
No	55(58.5)	53(55.8)		
Yes	39(41.5)	42(44.2)		
Drinking (n, %)			2.308	0.129
No	64(68.1)	74(77.9)		
Yes	30(31.9)	21(22.1)		
Chronic disease (n, %)			2.236	0.327
0	45(47.9)	40(42.1)		
1	36(38.3)	46(48.4)		
≥2	13(13.8)	9(9.5)		
Diagnosis (n, %)			0.652	0.722
Gastric carcinoma	49(52.1)	44(46.3)		
Colorectal carcinoma	18(19.2)	21(22.1)		
Carcinoma of the rectum	27(28.7)	30(31.6)		
Tumor TNM stage (n, %)			7.157	0.067
I	24(25.5)	15(15.8)		
II	22(23.4)	35(36.8)		
III	36(38.3)	39(41.1)		
IV	12(12.8)	6(6.3)		
Degree of differentiation (n, %)			1.693	0.429
Poorly differentiated	24(25.5)	30(31.6)		
Moderately differentiated	64(68.1)	62(65.3)		
Well- differentiated	6(6.4)	3(3.2)		
SBP (mmHg)	127.65 ± 13.55	128.63 ± 14.39	-0.483	0.629
DBP (mmHg)	74.15 ± 8.97	73.60 ± 11.69	0.362	0.718
BMI (kg/m <sup>2</sup> )	22.73 ± 2.85	22.42 ± 3.82	0.638	0.524
TBIL (μmol/L)	13.50 ± 5.99	13.18 ± 5.46	0.378	0.706
DBIL (μmol/L)	2.62 ± 1.13	2.46 ± 1.02	1.076	0.283
IBIL (μmol/L)	10.87 ± 5.06	10.72 ± 4.60	0.208	0.836
ALT (u/L)	14.57 ± 7.52	15.77 ± 11.72	-0.832	0.406
AST (u/L)	18.56 ± 6.11	18.80 ± 11.00	-0.182	0.856
GGT (u/L)	25.71 ± 21.66	24.43 ± 20.15	0.422	0.673
Hb (g/L)	120.07 ± 23.05	114.18 ± 23.97	1.723	0.086
ALB (g/L)	38.27 ± 7.03	36.75 ± 4.26	1.806	0.073
TP (g/L)	61.10 ± 6.17	61.10 ± 9.82	-0.002	0.999

SBP: Systolic Pressure; DBP: Diastolic Pressure; BMI: Body Mass Index; TBIL: Total Bilirubin; DBIL: Direct Bilirubin; IBIL: Indirect Bilirubin; ALT: Alanine Transaminase; AST: Aspartate Aminotransferase; GGT: Glutamyltransferase; Hb: Hemoglobin; ALB: Albumin; TP: Total Protein.

**Table 2:** Comparison of repeated measurement indexes in different groups (n=189).

Variables	Intervention group (n=94)	Reference group (n=95)	F <sub>time</sub>	F <sub>group</sub>	F <sub>interaction</sub>
Hb (g/L)			182.566**	6.038*	0.322
Time 1	120.07 ± 23.05	114.18 ± 23.97			
Time 2	128.07 ± 18.41	121.52 ± 17.92			
Time 3	111.60 ± 17.78	104.28 ± 15.86			
ALB (g/L)			68.836**	1.329	1.409
Time 1	38.27 ± 7.03	36.75 ± 4.26			
Time 2	39.96 ± 4.04	39.65 ± 5.36			
Time 3	34.37 ± 6.85	34.31 ± 2.81			
TP (g/L)			117.027**	1.558	8.678**
Time 1	61.10 ± 6.17	61.10 ± 9.82			
Time 2	64.88 ± 5.82	65.67 ± 6.27			
Time 3	58.37 ± 6.85	54.70 ± 5.96			
6 MWT(m)			144.370**	1.484	13.228**
Time 1	555.51 ± 63.06	564.22 ± 61.48			
Time 2	593.38 ± 60.12	577.37 ± 47.83			
Time 3	544.05 ± 60.41	524.15 ± 43.20			
QOR-15			606.029**	8.570*	5.140*
The day before surgery	93.15 ± 3.81	93.93 ± 4.72			
POD 1	58.67 ± 6.80	56.67 ± 6.86			
POD 3	66.41 ± 6.55	64.11 ± 4.79			
POD 7	75.24 ± 4.57	72.37 ± 6.50			
GAD-7			40.388**	3.913*	4.174*
Time 1	1.77 ± 1.36	1.66 ± 1.53			
Time 2	0.89 ± 0.93	1.26 ± 1.06			
Time 3	0.65 ± 0.79	1.06 ± 0.80			
PHQ-9			96.706**	2.422	0.308
Time 1	1.12 ± 1.39	1.20 ± 1.05			
Time 2	0.29 ± 0.52	0.44 ± 0.50			
Time 3	0.22 ± 0.55	0.41 ± 0.50			

Hb: Hemoglobin; ALB: Albumin; TP: Total Protein; POD 1: Postoperative Day 1; POD 3: Postoperative Day 3; POD 7: Postoperative Day 7; Time 1, on the day of admission; Time 2, on the day before surgery; Time 3, on the day of discharge \* $P < 0.05$ , \*\* $P < 0.001$

**Table 3:** Comparison of postoperative recovery indexes in different groups (n=189).

Variables	Intervention group (n=94)	Reference group (n=95)	t/ $\chi^2$	P
Time of first ambulation (h)	22.65 ± 8.63	25.64 ± 8.35	-2.424	0.016
Time of first flatus (h)	49.71 ± 23.73	68.47 ± 27.61	-2.617	0.010
Time of first defecation(h)	87.61 ± 43.64	127.41 ± 57.04	-2.347	0.020
Postoperative hospital stay (d)	12.16 ± 3.77	15.22 ± 5.27	-3.300	0.001
Overall hospital stay (d)	19.10 ± 4.22	23.31 ± 6.60	-2.169	0.031
Hospital charge (RMB)	57971.14 ± 13465.29	66526.07 ± 18019.05	-3.700	0.002
Postoperative complications			2.860	0.125
No	82(87.23)	74(77.89)		
Yes	12(12.77)	21(22.11)		
Hb (g/L)				
Time 1	120.07 ± 23.05	114.18 ± 23.97	1.723	0.086
Time 2	128.07 ± 18.41	121.52 ± 17.92	2.482	0.014
Time 3	111.60 ± 17.78	104.28 ± 15.86	2.985	0.003
ALB (g/L)				
Time 1	38.27 ± 7.03	36.75 ± 4.26	1.806	0.073
Time 2	39.96 ± 4.04	39.65 ± 5.36	0.438	0.662
Time 3	34.37 ± 6.85	34.31 ± 2.81	0.077	0.939
TP (g/L)				
Time 1	61.10 ± 6.17	61.10 ± 9.82	-0.002	0.999

Time 2	64.88 ± 5.82	65.67 ± 6.27	-0.899	0.370
Time 3	58.37 ± 6.85	54.70 ± 5.96	3.928	<0.001
6 MWT(m)				
Time 1	555.51 ± 63.06	564.22 ± 61.48	-0.961	0.338
Time 2	593.38 ± 60.12	577.37 ± 47.83	2.028	0.044
Time 3	544.05 ± 60.41	524.15 ± 43.20	2.603	0.010
QOR-15				
The day before surgery	93.15 ± 3.81	93.93 ± 4.72	-1.245	0.215
POD 1	58.67 ± 6.80	56.67 ± 6.86	2.010	0.046
POD 3	66.41 ± 6.55	64.11 ± 4.79	2.765	0.006
POD 7	75.24 ± 4.57	72.37 ± 6.50	3.522	0.001
GAD-7				
Time 1	1.77 ± 1.36	1.66 ± 1.53	0.488	0.626
Time 2	0.89 ± 0.93	1.26 ± 1.06	-2.538	0.012
Time 3	0.65 ± 0.79	1.06 ± 0.80	-3.599	<0.001
PHQ-9				
Time 1	1.12 ± 1.39	1.20 ± 1.05	-0.464	0.643
Time 2	0.29 ± 0.52	0.44 ± 0.50	-2.086	0.038
Time 3	0.22 ± 0.55	0.41 ± 0.50	-2.454	0.015

POD 1: postoperative day 1; POD 3: postoperative day 3; POD 7: postoperative day 7; Time 1, on the day of admission; Time 2, on the day before surgery; Time 3, on the day of discharge.

## Conclusion

In this study, the preoperative rehabilitation nursing intervention for patients with gastrointestinal cancer is expected to reduce the pain caused by the operation, reduce hospitalisation time and costs, and promote and improve the quality of postoperative recovery. At the same time, this is an opportunity to enable medical practitioners realise the clinical application value of preoperative rehabilitation nursing intervention and provide a reference for its promotion.

## Declarations

**Author contributions:** Ling Hang conceived and designed the study; Ling Hang and Zhen-zhen Su drafted the manuscript; Hua-min Luo and Jian Zhang undertook the data collection and analysis; Yang Xia and Dan-dan Hong critically revised the manuscript for important intellectual content. All authors read and approved the final manuscript.

**Conflict of interest:** None.

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