Enhanced Recovery After Surgery Pathway with Intensive Perioperative Nutritional Intervention Accelerates Postoperative Recovery in Gastrointestinal Surgery: A Single-Center Prospective Cohort Study Postprint

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Abstract

Objective: To explore the safety and efficacy of an enhanced recovery after surgery (ERAS) protocol with intensive clinical nutrition intervention in gastrointestinal surgery.

Methods: This was a single-center prospective cohort study. Consecutive patients undergoing gastrointestinal surgery in the Department of General Surgery at Peking Union Medical College Hospital between December 2015 and April 2018 were enrolled. Patients who received surgical treatment and ERAS management in the Gastrointestinal and Nutrition Metabolism specialty group were assigned to the ERAS group, while those receiving traditional perioperative management in other specialty groups were assigned to the control group. The ERAS protocol focused on preoperative nutritional assessment, oral or tube feeding nutritional supplementation, early postoperative enteral nutrition, combined with other ERAS management elements, primarily including minimally invasive surgery, multimodal analgesia with general anesthesia or combined epidural block, and postoperative analgesia mainly with non-steroidal anti-inflammatory drugs; the control group adopted traditional perioperative measures, mainly including open or minimally invasive surgery, general anesthesia, and postoperative analgesia with opioid analgesics. The primary outcome measure was postoperative length of hospital stay, and secondary outcome measures included total hospitalization costs, postoperative complication rate, and readmission rate within 60 days postoperatively.

Results: A total of 204 patients were included, with 102 patients in each of the ERAS and control groups. Postoperative hospital stay was significantly shorter in the ERAS group compared with the control group [(7.2$\pm$4.5)$days vs (9.8\pm4.8) days, P < 0.001], and total hospitalization costs were also significantly lower [(41,125 yuan, P<0.001]. There were no statistically significant differences between the two groups in postoperative complication rates and readmission rates within 60 days postoperatively (9.8% vs 13.7%, 2.9% vs 2.0%, P>0.001).

Conclusion: The ERAS protocol with intensive perioperative clinical nutrition intervention is safe and effective in gastrointestinal surgery, facilitating accelerated postoperative recovery in patients.

Full Text

Enhanced Recovery After Surgery Protocol with Intensive Perioperative Nutritional Intervention Accelerates Postoperative Rehabilitation in Gastrointestinal Surgery: A Single-Center Prospective Cohort Study

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Abstract

Objective To evaluate the safety and efficacy of an Enhanced Recovery After Surgery (ERAS) protocol focusing on integrated clinical nutrition for gastrointestinal surgery.

Methods This prospective single-center cohort study continuously enrolled patients undergoing gastrointestinal surgery in the Department of General Surgery at Peking Union Medical College Hospital from December 2015 to April 2018. Patients treated by the professional team of gastrointestinal and nutritional metabolism who received ERAS management were assigned to the ERAS group, while patients treated by other professional teams who received traditional perioperative management were assigned to the control group. The ERAS program specifically focused on preoperative nutritional assessment, nutritional supplements via oral or tube feeding, early postoperative enteral nutrition, combined

with other ERAS items including minimally invasive surgery, multimodal analgesia with general anesthesia or combined epidural block, non-steroidal anti-inflammatory drugs as the main postoperative analgesic medication, and so on. The control group underwent traditional perioperative management including open or minimally invasive surgery, general anesthesia, opioid analgesia, and so on. The primary outcome was postoperative length of stay; secondary outcomes included total hospitalization cost, incidence of postoperative complications, and readmission rate within 60 postoperative days.

Results Two hundred and four patients undergoing gastrointestinal surgery were enrolled, with 102 patients in the ERAS group and 102 in the control group. The postoperative length of stay in the ERAS group was significantly shorter than that in the control group [$(7.2\$\pm4.5) days vs. (9.8\pm4.8) days, P < 0.001]$, $and total hospitalization cost in the ERAS group was significantly lower than that in the control group[(41, 1$ Yuan, P<0.001]. There was no significant difference in the incidence of postoperative complications (ERAS group 9.8% vs. control group 13.7%, P=0.646) or readmission rate within 60 postoperative days (ERAS group 2.9% vs. control group 2.0%) between the two groups.

Conclusions Perioperative nutrition-focused ERAS programs are safe and effective for gastrointestinal surgery and might enhance recovery after surgery.

Keywords enhanced recovery after surgery; nutritional risk; postoperative early enteral nutrition; prehabilitation; gastrointestinal surgery

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1. Subjects and Methods

Enhanced Recovery After Surgery (ERAS) refers to the use of a series of evidence-based perioperative optimization measures to reduce patients' physiological and psychological stress and achieve accelerated postoperative recovery. This concept was first proposed by Danish anesthesiologist Kehlet [1-2] and later elaborated by academician Li Jieshou after its introduction to China. Wilmore further clarified the connection with clinical nutrition [3-4]. Since then, a series of guidelines for application in gastrointestinal and colorectal surgery have been published domestically and internationally [5-8], although a gap remains between clinical practice and guideline recommendations [9-11].

This prospective cohort study aimed to evaluate the safety and effectiveness of applying key components of perioperative nutritional management to gastrointestinal surgery. Previous studies have confirmed that ERAS protocols can reduce postoperative complications, shorten postoperative hospital stays, relieve postoperative pain, and reduce total hospitalization costs [12-16]. Preoperative nutritional assessment and intervention combined with early postoperative enteral nutrition are key components of the ERAS protocol [13,17-18]. Unfortunately, research on perioperative nutrition in gastrointestinal surgery is limited.

1.1 Study Subjects Patients with gastrointestinal tumors undergoing elective surgery at the Department of General Surgery, Peking Union Medical College Hospital between December 2015 and April 2018 were continuously enrolled. Patients who received surgical treatment and perioperative management by the Gastrointestinal and Nutritional Metabolism professional team entered the ERAS group, while those treated by other professional teams with traditional perioperative management entered the control group.

Inclusion criteria: (1) Age 18-80 years; (2) Planned elective surgery; (3) Signed informed consent.

Exclusion criteria: (1) Severe cardiopulmonary disease; (2) Liver or kidney dysfunction; (3) Combined metabolic disease; (4) Pregnancy or lactation; (5) Possible emergency surgery; (6) ICU admission; (7) Refusal to participate.

This study was approved by the Ethics Committee of Peking Union Medical College Hospital.

1.2 Perioperative Management Protocol 1.2.1 ERAS Group Management Protocol and Nutritional Intervention Components

The ERAS group management protocol included: (1) Preoperative anxiety assessment and education at outpatient and admission; (2) Preoperative nutritional risk screening using the Nutritional Risk Screening 2002 (NRS-2002) [19]. Patients with nutritional risk received preoperative oral or tube feeding nutritional supplements as prehabilitation measures, with enteral nutrition supplements providing additional calories exceeding 500 kcal daily for more than 3 days; (3) Optimized bowel preparation using standard-dose polyethylene glycol electrolyte powder (68.56 g, Shenzhen Wanhe Pharmaceutical Co., Ltd.), with reduced or omitted mechanical bowel preparation. Preoperative fasting time was shortened to 2-3 hours, with 300 ml of 17.5% glucose rehydration salt solution given; (4) Local infiltration anesthesia at the incision site before skin incision and before wound closure; (5) Intraoperative temperature protection using heated mattresses and warm air blowers; (6) Laparoscopic surgery when possible, with conversion to open surgery when necessary; (7) For total gastrectomy patients at high risk for gastric paralysis (such as those with diabetes, pyloric obstruction, or elderly patients), selective jejunostomy or nasojejunal feeding tube placement was performed for postoperative early enteral nutrition support; (8) Multimodal analgesia primarily with non-steroidal anti-inflammatory drugs, minimizing or avoiding opioid use; (9) No routine indwelling urinary catheter or gastric tube, or early removal; (10) Early postoperative enteral nutrition support starting on postoperative day 1 (POD1) or POD2, with sequential enteral nutrition transitioning from peptide-based to whole protein formulas, gradually increasing dose and infusion rate.

1.2.2 Control Group Management Protocol

The control group received traditional perioperative management: (1) Routine

outpatient and admission education; (2) Oral polyethylene glycol electrolyte powder for 2-3 days, with enema when bowel preparation was unsatisfactory; (3) Preoperative fasting for at least 6-8 hours; (4) Laparoscopic or open surgery without special temperature protection; (5) Opioid-based analgesia, with tramadol hydrochloride injection supplemented when analgesic effect was inadequate; (6) Routine indwelling urinary catheter; (7) Drainage tube removal before discharge; (8) Parenteral nutrition routinely given on POD2-3; (9) Gradual intake of small amounts of liquid and semi-liquid diet after flatus on POD1-2.

1.3 Outcome Measures The primary outcome measure was postoperative length of stay. Secondary outcome measures included total hospitalization cost, postoperative complication rate, and readmission rate within 60 days. Postoperative complications were graded using the Clavien-Dindo classification [20], with grade II or above as the threshold. Postoperative infection-related complications were defined using CDC/NHSN criteria for healthcare-associated infections [21].

1.4 Statistical Analysis Statistical analysis was performed using SPSS 21.0. Measurement data are presented as mean ± standard deviation or median (interquartile range), and analyzed using t-test or Mann-Whitney U test. Count data are presented as numbers and percentages, and analyzed using chi-square test or Fisher' s exact test. All tests were two-sided, with P<0.05 considered statistically significant.

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2. Results

2.1 General Data A total of 204 patients meeting inclusion and exclusion criteria were enrolled, with 102 patients in the ERAS group and 102 in the control group. The clinical characteristics and baseline data showed no statistical differences between the two groups. The mean ages of the ERAS and control groups were (55.0$±15.7)$years and$(53.6±13.3)years, respectively.Maleproportionswere57.8±4.59)kg/m^{2}$ and (23.49$±2.76)$kg/m^{2}$, respectively. All patients had gastrointestinal tumors, primarily gastric and colorectal cancers, plus gastrointestinal stromal tumors and neuroendocrine tumors. Preoperative nutritional risk (NRS-2002 $ $3) was present in 54.9% (56/102) of the ERAS group and 54.9% (56/102) of the control group, with all at-risk patients receiving nutritional intervention.

2.2 Postoperative General Conditions The ERAS group started postoperative nutrition significantly earlier than the control group [$(2.4$±1.8)daysvs.(5.1±1.2)days, P <$ $0.001].TheproportionofpatientswithindwellinggastrictubesanddrainagetubeswassignificantlylowerintheER$ $0.001].However, therewasnosignificantdifferenceingastrictuberetentiontime[2(0, 6)daysvs.6(5, 7)days, P >$ $0.05].TheERASgrouphadshorterpostoperativehospitalstays[(7.2±4.5)daysvs.(9.8±4.8)days, P <$ $0.001]andsignificantlylowertotalcosts[(41, 125±18, 593)Yuanvs.(51, 512±$19,453)$ Yuan, P<0.001] compared to the control group.

2.3 Postoperative Complications The postoperative complication rates were 9.8% in the ERAS group and 13.7% in the control group, with no statistically significant difference (P=0.393). Clavien-Dindo grade II or above complications in the ERAS group included healthcare-associated infection (3.9%), intestinal obstruction (2.9%), and anastomotic leak (2.9%). In the control group, grade II or above complications included healthcare-associated infection (8.8%), fat liquefaction (2.0%), gastric emptying disorder (2.0%), and liver dysfunction (1.0%). The 60-day readmission rates were 2.9% in the ERAS group and 2.0% in the control group, with no significant difference.

3. Discussion

The ERAS group demonstrated significantly reduced postoperative hospital stays and total hospitalization costs compared to the control group, without increasing postoperative complication rates or 60-day readmission rates. Given that perioperative clinical nutrition holds a key position in domestic and international guidelines [5-8], this study further confirms that intensive perioperative nutritional assessment and intervention are safe and effective for postoperative recovery.

The shorter postoperative hospital stay in this study (7.2 days) compared to some literature reports may be related to the high proportion of upper gastrointestinal diseases, especially gastric cancer, in our cohort, as recovery from gastric surgery is generally slower than from colorectal surgery [16,22]. Recent studies on gastric surgery [15-16,23-25] have shown consistent results, with ERAS protocols shortening average postoperative hospital stays by 2.5 days compared to traditional approaches. The reduction in hospitalization costs is primarily attributed to shortened hospital stays and optimized postoperative management.

There was no statistical difference in postoperative complication rates and types between the ERAS and control groups, consistent with a single-arm phase II clinical trial on ERAS protocol management in gastric cancer patients [15], which reported a 10.7% rate of Clavien-Dindo grade II or above complications, mainly liver dysfunction (2.5%), intra-abdominal infection or abscess (2.5%), and gastric emptying disorder (1.7%). Our study' s main complications were healthcare-associated infections (primarily intra-abdominal and pulmonary infections, 3.9%-4.9%). While Tanaka' s randomized controlled study [16] found statistical differences in complication rates between ERAS and traditional protocols (4.1% vs. 14.5% for grade II or above complications), the question of whether ERAS reduces postoperative complications remains debated. However, it is clear that ERAS does not increase complications, and early enteral nutrition does not increase anastomotic leak risk.

The proportion of gastrointestinal cancer patients with nutritional risk or malnutrition is as high as 46.2%-62.7% [12,26-28], which increases postoperative complications and hinders accelerated recovery. Preoperative nutritional risk

screening is therefore essential and should be routinely implemented in gastrointestinal cancer patients [29]. Recent research [30] shows that 4-8 weeks of nutritional prehabilitation significantly reduces complication rates. In our ERAS group, all patients with nutritional risk received nutritional prehabilitation, though the intervention duration was short (3-7 days), which may have limited its impact on short-term clinical outcomes. The control group did not receive nutritional prehabilitation, but the high proportion of high nutritional risk patients had limited impact on complication rates.

Key measures included preoperative nutritional assessment and intervention, prehabilitation supplementation, selective intraoperative jejunostomy or nasojejunal tube placement, and early postoperative enteral nutrition [11]. In Aarts' study [11] defining optimal recovery as discharge without severe complications or adverse events, 49.7% of patients achieved optimal recovery with median hospital stays of 5 days (range 1-116 days) across 13 medical centers. For patients undergoing total gastrectomy with persistent high nutritional risk, continued nutritional support and postoperative adjuvant chemotherapy facilitate early postoperative recovery. The ERAS group started enteral nutrition earlier than the control group without increased anastomotic leaks, and the nutrition support model centered on early enteral nutrition helped reduce total hospitalization costs.

This study has several limitations. As a single-center study, its broader applicability requires verification through larger samples and multicenter randomized controlled trials with clear inclusion and exclusion criteria. Whether ERAS is suitable for surgical patients with multiple comorbidities and critical conditions needs further exploration. Using postoperative hospital days as the primary outcome may not be the most appropriate scientific indicator, as some scholars suggest that patient health status and postoperative quality of life may be better evaluation metrics [10]. As a study focusing on perioperative nutritional intervention, rehabilitation interventions were insufficient. For gastrointestinal cancer patients with nutritional risk, longer prehabilitation periods may yield more meaningful clinical outcomes.

In conclusion, ERAS protocols with intensive perioperative nutritional assessment and intervention, combined with early postoperative enteral nutrition, are safe and effective for gastrointestinal surgery. They reduce postoperative hospital stays and total costs without increasing complications or 60-day readmission rates, enabling more rational accelerated recovery for patients.

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Note: Figure translations are in progress. See original paper for figures.