Enhanced recovery after surgery protocol in colorectal surgery

Ali H. El-Shewy, Wael M. Abdalla, Muhammad A. Baghdadi

Department of General Surgery, Faculty of Medicine, Zagazig University, Sharkia, Egypt

Correspondence to Muhammad A. Baghdadi, MD, College of Medicine, Zagazig University, Sharkia 44512, Egypt. Tel: +20 100 084 6047; e-mail: uccello081@gmail.com

Received: 26 July 2019
Revised: 3 August 2019
Accepted: 24 August 2019
Published: 14 February 2020

The Egyptian Journal of Surgery 2020, 39:94–101

Background/purpose
Principles of enhanced recovery have been used to enable early recovery and discharge from hospital and minimize potential complications, and thereby improve patient outcomes following colorectal surgery. Enhanced recovery after surgery (ERAS) implementation involves a team consisting of surgeons, anesthetists, an ERAS coordinator, and staff from units that care for the surgical patient. We compare ERAS with traditional protocol in colorectal surgery to detect advantages of ERAS over traditional care in colorectal surgery and to encourage application of ERAS in our hospitals.
Patients and methods
This study was carried on 18 patients who were scheduled for colorectal surgery in the GIT Surgical Unit in the Department of General Surgery, Zagazig University Hospitals, from April 2018 till April 2019. The patients were divided into two groups: group A was managed by traditional protocol and group (B) was managed by enhanced recovery protocol (ERAS).
Results
We found that ERAS decreased both primary hospital length of stay from 12 to 5 days and total hospital stay from 13.7 to 7 days. ERAS decreased mean cost from 6800 to 3900 pounds. General postoperative complications were also reduced from 22 to 11%. Pain scores in first postoperative day improved from 6 to 4, first time to flatus passage was reduced from 3.6 to 1.8 days, and mean time to first solid meal decreased from 5.5 to 3.2 days.
Conclusions
ERAS are multimodal perioperative care programs that resulted in an ERAS, reduced morbidity rates as well as primary and overall hospital stay, and improved postoperative pain and bowel function.

Keywords:
colorectal surgery, enhanced recovery protocol, traditional protocol

Egyptian J Surgery 39:94–101

1110-1121

Introduction

Enhanced recovery after surgery (ERAS) is a multimodal, multidisciplinary approach in the care of surgical patient to reduce stress response and organ dysfunction, and thereby shorten the time required for full recovery [1].

The concept of enhanced recovery has uniformly provided a major enhancement in recovery leading to decrease in hospital stay and apparent reduction in medical morbidity [2].

An ERA started mainly with colorectal surgery in Denmark by Professor Henrik Kehlet, a gastrointestinal surgeon from Copenhagen, but has been shown to improve outcomes in almost all major surgical specialties [3].

Results from previously published reports and systematic reviews have been encouraging, with wide adoption in Europe. However, in countries where health care management and resources are decentralized, ERAS programs can face substantial challenges for implementation [2].

The programs of enhanced recovery are generally based on the preoperative improvement of the patient clinical condition, the intraoperative and postoperative avoidance of medications that could slow the resumption of physiological activities, and the promotion of positive habits in the early postoperative period [4].

Evidence-based studies have proved that many of the conventional methods to surgical care, such as preoperative chemical and mechanical bowel preparation, the use of surgical drains, nasogastric tubes, and the use of graduated diets, are unnecessary or even harmful [5].

The methods used in ERAS include rapid preparation of a patient for the operation, connected with oral and written information about the surgical procedure, the use of epidural or regional anesthesia, minimally invasive surgical techniques, nonroutine use of nasogastric tubes and abdominal drains, optimal pain control, and aggressive postoperative rehabilitation including early oral nutrition and ambulation [5].

Patients and methods

This was a prospective randomized study that used simple randomization by closed envelop method in which a comparison was held between two groups of patients who were scheduled for colorectal surgery. Traditional protocol (TC) was applied on group A, which contained nine cases, whereas enhanced recovery protocol (ERAS) was applied on group B, which contained nine cases. The study was approved by Institutional Review Board (IRB) and ethical committee of Zagazig University Hospitals (IRB#: 2018-1-146). The study was conducted in the GIT Surgical Unit in the Department of General Surgery, Zagazig University Hospitals, from April 2018 till April 2019. Informed consent was taken from the patients, after receiving adequate information about the study (the characteristics of the study, benefits, and possible adverse effects). Patients' age ranged between 18 and 70 years old. Patients who have been planned for elective colorectal surgery with resection anastomosis or reversal of colostomy were included in the study. Patients either with complications such as obstruction, peritonitis, and the presence of distant metastases were excluded from the study. Full laboratory investigations including tumor markers were performed. Abdominal ultrasonography, computed tomography, MRI, and chest radiography were done. Colonoscopy and biopsy were performed for patients with colonic cancer. TC applied on group A, which contained nine patients, included preoperative, intraoperative, and postoperative measures. Preoperative measures included mechanical bowel preparation by frequent enemas for 3 days before operation, lactulose ingestion 48 h before operation as laxative, patient was kept NPO the day before operation, and chemical preparation using metronidazole and neomycin was applied for 3 days before operation. Intraoperative measures included urinary catheter insertion before induction of anesthesia. Drains were used routinely to drain any collected fluid and nasogastric tube for stomach decompression. Postoperative measures included that patient was NPO for 3 days, diet was advanced gradually starting by sips of water and clear fluids for 3 days, then soft diet for 3 days, and then normal diet.

Group B (ERAS was applied on nine patients):

(1) Preoperative:
   (a) Patient is informed about details of technique.
   (b) No enemas were used for right side resection or reversal of colostomy. For left side and rectal lesions, one enema was used at night of operation and another one at morning of operation.
   (c) Patient is allowed carbohydrate (CHO) rich clear fluids 4 h before operation.
   (d) Cefoperazone and metronidazole intravenous infusion is given 12 h and then 30 min preoperatively.
   (e) Clexane subcutaneously is given the night of operation.
(2) Intraoperative:
   (a) No nasogastric tubes were used in most of cases, if so, it is removed at the end of surgery.
   (b) Warm intravenous fluids were used monitored by hemodynamic and central venous pressure (CVP).
   (c) Use of epidural analgesia with epidural infusion of bupivacaine was done in some cases.
   (d) Drains were not used routinely, and only one drain was applied in some cases.
(3) Postoperative:
   (a) Early diet.
   (b) Patient was advised to chew gums then sips of water at the night of operation.
   (c) If tolerated clear fluids allowed in the first day after operation.
   (d) Then semisolid in the second day after operation.
   (e) Catheter was removed on the same day of the operation if it was applied.
   (f) Patient started early mobilization:
      (1) Sitting on bed then starting to be out of bed on the day of operation.
      (2) Out of bed for 2 h in the first postoperative day (POD).
      (3) Out of bed for 6 h in the POD 2.
   (g) Drain if present removed on the first day after operation if not containing considerable amount of fluid and no intra-abdominal collection was detected.
   (h) Intravenous fluids stopped by the POD 2.
   (i) Paracetamol intravenous infusion (Perfalgan) was given as analgesic.
   (j) Metoclopramide intravenous (Primperan) was given for prevention of postoperative nausea

and vomiting (PONV), and if not controlled, ondansteron (Zofran) was given.

(4) Postoperative care and follow-up:
   (a) Patient was discharged with the following discharge criteria:
      (1) Full mobilization.
      (2) Oral analgesia.
      (3) Passage of flatus and stool.
      (4) Tolerate solid meals without nausea and vomiting.
(5) Patient followed up in a return visit after 1 week and then after 1 month.
(6) Outcome measures:
   Primary outcome measures included the following:
   (a) Primary hospital stay.
   (b) Total hospital stay.
   (c) Postoperative complication:
      (1) General (pulmonary thromboembolism).
      (2) Surgical (wound infection, anastomotic leakage, and bowel obstruction).
   (d) Readmission rates, re-exploration rates, and mortality rates.
   (e) Cost-effectiveness.
(3) Secondary outcome measures included the following:
   (a) Pain (measured by pain score and duration of opioid use).
   (b) Bowel function (measured by PONV, first time to flatus passage, and first time of solid meal).

Results

The range of age for TC patients was from 25 to 70, whereas for ERAS patients was from 23 to 60 years old. The range of BMI was 20–35 for TC patients and 22–36 kg/m^2 for ERAS group. There was no significant difference regarding both age and BMI (Table 1).

Two cases were diabetic and two cases were hepatic in the TC group, whereas in ERAS group, one case was hepatic, two cases were hypertensive, and one case was diabetic (Table 1).

In the TC group, there were two cases of rectum cancer operated by low anterior resection, three cases of right cancer colon treated by right hemicolectomy and ileo-transverse anastomosis, and four cases of reversal of colostomy. In the ERAS group, two cases of low anterior resection, three cases of reversal of colostomy, and four cases of right hemicolectomy (Table 1).

In the TC group, all patients were prepared 3 days before operation by frequent enemas, lactulose, and NPO for more than 8 h preoperative, and only four cases were educated and counseled for operation, recovery, and complications, whereas in ERAS group, all patients were counseled and given prophylactic anticoagulant the night of operation and five cases were given three enemas the day before operation and allowed fluids up to 6 h before operation (Table 2).

In the ERAS group, only in two cases nasogastric tube was used, epidural catheter was used in two cases, and transverse incision was used in one case (Table 2).

In the TC, all cases were NPO for 5 days at least. Intravenous fluids were continued all this period. Catheter was removed on the first or POD 2, and pain was controlled by NSAIDS in three cases and by opiates in six cases. However, in ERAS group, catheter

Table 1 Demographics data of patients

Demographic data	TC group (nine patients)	ERAS group (nine patients)	*P* value
Age			
Range (year)	25–70	23–60	0.220
Mean±SD	52.1±16.4	43.6±11.5	
BMI (kg/m^2)			
Range	20–35	22–36	
Mean±SD	27.8±4	28±3.2	0.56
Comorbidities			
Hypertension	0	2	
Diabetes mellitus	2	1	
Hepatic	2	1	
Operative procedure [*n* (%)]			
Anterior resection	2 (22)	2 (22)	
Right hemicolectomy	3 (33)	4 (44)	
Reversal of colostomy	4 (44)	3 (33)	

ERAS, enhanced recovery after surgery; TC, traditional protocol.

Table 2 Perioperative measures

Perioperative measures	TC group (nine patients)	ERAS group (nine patients)	*P* value
Preoperative [*n* (%)]			
Patient counseling	9 (100.0)	5 (55.5)	0.03
CHO load	0	4 (44.4)	0.02
Enema	9 (100.0)	2 (22.2)	0.003
Lactulose	9 (100.0)	2 (22.2)	0.003
Anticoagulant	3 (33.3)	9 (100.0)	0.01
Intraoperative measures [*n* (%)]			
Nasogastric tube	8 (89.0)	0	0.002
Drain	9 (100.0)	4 (44.4)	0.02
Transverse incision	0	1 (11.1)	0.3
Hypothermia prevention	0	3 (33.3)	0.1
Epidural analgesia	0	2 (22.2)	0.2
Postoperative [mean±SD (range)]			
Day of first diet	4.8±0.6 (4–6)	1.3±0.7 (0–2)	0.01
Day of mobilization	2±0.05 (1.5–2.5)	0.5±0.5 (0–1)	0.03
IVF duration	6.1±0.7 (5–7)	2.1±0.6 (1–3)	0.04
Catheter duration	2.9±0.4 (2–3)	1.11±0.3 (0–1)	0.03
Pain control modality			
Paracetamol	0	7	
NSAIDS	3	0	
Opiates	6	0	
Epidural	0	2	

CHO load, carbohydrate-load; ERAS, enhanced recovery after surgery; IVF, intravenous fluid; TC, traditional protocol.

Table 3 Primary outcome measures

	TC group (nine patients)	ERAS group (nine patients)	*P* value
Primary hospital stay			
Range	8–20	4–9	
Mean	12	5	0.01
Total hospital stay			
Range	8–25	7–15	
Mean	13.7	7	0.02
Readmission	1	1	0.3
Re-exploration	0.0	0.0	1
Wound infection	1	1	0.3
Anastomotic leakage	0.0	0.0	1
Delayed intestinal motility	4	2	0.01
Thromboembolism	1	0	0.31
Chest complication	2	1	0.26
Mortality	0.0	0.0	1

ERAS, enhanced recovery after surgery; TC, traditional protocol.

was removed on the day of operation or POD 1, and patients were encouraged on mobilization. Oral fluids were roughly allowed on the POD 1 to POD 2. Intravenous fluids are stopped and pain controlled by paracetamol in three cases, and epidural catheter was used in two cases (Table 2).

Parameters of evaluation

Primary outcome measures

Primary and total hospital stays are reduced in the ERAS group and thus cost is greatly reduced. Moreover, there was great reduction in general complications. There was no significant difference in surgical complications, readmission, and re-exploration or mortality rates between the two groups.

Regarding hospital stay, there was a significant reduction in primary and total hospital stay by at least 2 days in most of cases in the ERAS group. The mean primary hospital stay for TC group was 13.2 days and total hospital stay was 13.7 days. In ERAS group, primary stay was 7.8 and total stay was 9 days (Table 3).

Regarding complications, there was reduction in the general complications in ERAS group compared with

TC group. In TC group, one case developed postoperative Deep vein thrombosis (DVT) and two cases developed chest infection, whereas in ERAS group, no cases developed DVT and only one case developed chest infection. There was no statistical difference in surgical complications such as wound infection, anastomotic leakage, and mechanical obstruction (Table 3).

Regarding readmission and re-exploration, one case in TC group was readmitted with abdominal collection, and one case in ERAS group with wound dehiscence. No cases were re-explored or died in both groups (Table 3).

Regarding cost-effectiveness, there was great reduction in the financial costs. In TC group, range of cost was 1600–4000 pounds, whereas in ERAS range was 800–2000 pounds.

Secondary outcome measures

Regarding bowel function, there was improved bowel function in the ERAS group. Only two cases developed PONV, the mean first time for flatus passage was 1.8 days, and the mean time for first solid meal was 3.2 days. In the TC group, three cases developed PONV, the first time for flatus passage was 3.6 days, and the first solid meal was 5.5 days. There was no difference in antiemetic use duration between two groups (Table 4).

Regarding pain, there was improved pain outcome as measured by patient self-reported pain with visual analog score of pain and duration of narcotic use (no pain=0, mild=1–3, moderate=4–6, severe=7–9, worst pain=10). In TC group, mean score was 6, and narcotics were used for 3–4 days. In ERAS group, mean score was 4 and narcotic use was not more than 2 days (Table 4).

Discussion

ERAS programs were found to reduce the time spent in the hospital and to be safe in major abdominal surgery regarding anastomotic leakage. Reduction in hospital stay and morbidity is attractive, as both increase the availability of beds and might reduce the overall cost of hospital stay. There was also an improvement in pain control and reduction in opioid consumption and PONV, all lead to an accelerated return of bowel function [6].

In this study, 18 cases were operated upon by different procedures of colorectal surgery. They were randomly divided into two groups: group A included nine cases. Traditional care was applied and called TC group. Group B included nine cases. Enhanced recovery protocol was applied and was called ERAS group. The age ranged from 23 to 70 years old. This goes with the studies of Ren *et al.* [7] and differs from studies of Wang *et al.* [8] with elder range of age from 65 to 80 years old.

For both groups, most of the cases were females. This corresponds with Khoo *et al.* [9] but differs from Vlug *et al.* [10], with number of male patients more than that of female patients. The range of BMI was 20–36 kg/

Table 4 Secondary outcome measures

	TC group (nine patients)	ERAS group (nine patients)	*P* value
Time of first flatus			
Range	3–6 days	1–3 days	
Mean±SD	3.6±1.1	1.8±0.9	0.01
Time of first oral intake			
Range	3–5 days	8–12 h	
Mean±SD	4±1	10±2	0.03
Time of first solid meal			
Range	5–7 days	2–4 days	
Mean±SD	5.5±1.1	3.2±1.2	0.3
Postoperative nausea and vomiting	3	2	
Pain score in POD 1 by VAS			
Mild (1–3)	0	3	
Moderate (4–6)	3	4	
Severe (7–9)	6	2	
Pain score with VAS			
Mean	6	4	0.03
SD	0.5	0.7	
Duration of narcotic use			
Mean	3.7	0	0.002
SD	1.2	0	

ERAS, enhanced recovery after surgery; POD, postoperative day; TC, traditional protocol; VAS, visual analog scale.

m^2. This agrees with Muller *et al.* [11] and García-Botello *et al.* [12] but disagrees with Sarin *et al.* [13], with BMI from 15 to 50 kg/m^2.

Patient education and defining expectations were the cornerstones of our program to ensure that patient participation is well-established. Patients in ERAS group who were informed about surgical procedure, postoperative course, to walk on the day of surgery, and to be home in ~3–5 days were more likely to get improved satisfaction, anxiety, pain, and other outcomes. This focused on improving balance and core strength to facilitate stability and mobility after the operation. This element was included in the studies of Wang *et al.* [8] and Vlug *et al.* [10] and not included in the studies of Khoo *et al.* [9].

There has been a major move away from prolonged fasting in TC group toward permitting clear fluids especially CHO fluid up to 4 h before surgery in ERAS group. Benefits of the nutritional drink include reduced catabolism, maintaining nitrogen balance, improved postoperative insulin sensitivity, reduced length of hospital stay, and improved patient satisfaction by reducing preoperative thirst, hunger, and discomfort. This item was included in most of the studies, which allowed CHO load up to 4 h before operation, except Muller *et al.* [11], Sarin *et al*. [13], and Gatt *et al.* [14] Khoo *et al.* [9] allowed fluid up to 3 h preoperatively. Teeuwen *et al.* [15] and Wang *et al.* [8] allowed fluid up to 2 h before operation.

Low-molecular-weight heparin was given the night before surgery and continued for the entire length of the patients' hospital stay, which was found to prevent postoperative DVT or pulmonary embolism. A single dose of antibiotics, covering both aerobic and anaerobic organisms, administered just before incising the skin was found to reduce the rates of wound infection after surgery. This corresponds with Muller *et al.* [11], García-Botello *et al.* [12], and Yang *et al.* [16].

In TC group, bowel preparation was performed for 3 days preoperatively with lactulose, mannitol, and frequent enemas. In ERAS group, we used one enema in the evening before operation and another one in the morning of day of operation in cases of rectosigmoid cancer. This agreed with Teeuwen *et al.* [15]. Gatt *et al.* [14], Muller *et al*. [11], and Wang *et al.* [8], who avoided bowel preparation. Delaney *et al*. [17] and Khoo *et al.* [9] used normal bowel preparation. Sarin *et al.* [13] used no bowel preparation for right-sided resections and used full bowel preparation for left-sided and rectal lesions.

Short transverse incisions are thought to be less painful, reduce postoperative analgesic requirement, and decrease the incidence of wound dehiscence when compared with vertical wounds. In this study, transverse incision was used in two cases in ERAS group with less postoperative pain. This agrees with van Bree *et al.* [18], but was not included in the studies of Delaney *et al.* [17] and Khoo *et al.* [9].

We avoided use of nasogastric tube in ERAS group with early return of bowel function. This agrees with Wang *et al.* [8] who avoided use of nasogastric tube. Gatt *et al.* [14] used nasogastric tube during surgery and was removed on completion of surgery.

Our pain management strategy incorporated recent evidence in the analgesic protocols with use of epidural catheter and paracetamol. Patients with epidural analgesia were followed by an inpatient acute pain service to optimize pain control. In this study, epidural catheter was used in two cases and paracetamol in seven cases in ERAS group. Epidural catheter was used by Serclová *et al.* [19] and was not included in the study by Delaney *et al.* [17].

Postoperatively, early introduction of diet and fluids has been shown to be safe, reduce time of physiological ileus, and reduce the length of hospital stay. In ERAS group in this study, oral fluids were allowed in the POD 1. Khoo *et al.* [9] allowed oral fluid the day of operation and proceeded to normal diet at POD 2. Teeuwen *et al.* [15] allowed patients to drink water the night of operation and soft diet in the POD 1. In the study by Wang *et al.* [8], oral drink was allowed 2 h after operation. In the TC group, oral feeding was introduced later after 3 days or after returning of signs of bowel motility.

Patients were helped to sit on the bed in the evening of surgery, out of bed for more than 2 h in the POD 1, and for 6 h on POD 2. This corresponds with Wang *et al.* [8]. In the study by Gatt *et al.* [14], patients were able to walk length of the ward by the POD 2. This was found to decrease bad consequences such as thromboembolism, loss of muscle strength, pulmonary atelectasis, and worsening of pulmonary function.

In our study, ERAS program was found to significantly reduce hospital stay including primary hospital stay, postprocedure length, and total hospital stay. This reduction was partly facilitated by the prevention or reduction of postoperative ileus, decreased morbidity, and early recovery, all promote early discharge. The mean primary hospital stay for TC group was 12 days.

In ERAS group, the mean primary stay was 5 days. In the study by Khoo *et al.* [9], primary hospital stay was 7 for TC and 5 for ERAS group. In the study by Muller *et al.* [11], it was 10 in TC group and 6.7 in ERAS group. Teeuwen *et al.* [15] stated that it was 9 for TC and 6 for ERAS. In the study by García-Botello *et al.* [12], TC was 9 and ERAS was 5. In the study by Yang *et al.* [16], TC was 11.7 and ERAS was 6. Sarin *et al.* [13] showed that it was 6 for TC group and 4 for ERAS. This attributed to low rate of complications in these studies.

There was no statistical difference in the rates of readmission and mortality. Only one case was readmitted in TC group with abdominal collection, which was drained by ultrasound-guided aspiration and one case in ERAS group with wound dehiscence, which was closed by tension suture. No cases were re-explored or died in both groups. This corresponds with Serclová *et al.* [19] and Vlug *et al.* [10], with no difference in readmission and mortality rates. Wang *et al.* [8] and Sarin *et al.* [13] showed decreased rate of readmission in ERAS group, with no difference in mortality rates. García-Botello *et al.* [12] and Muller *et al.* [11] showed increased readmission rate in ERAS group. This may be owing to early discharge. Only with Khoo *et al.* [9], there was slight reduction in rates of mortality in ERAS group.

Hospital costs were greatly reduced in ERAS group owing to reduction of days of hospital stay. Hospital cost as an outcome measure was reported in two studies by García-Botello *et al.* [12] and Ren *et al.* [7], who stated that costs were significantly decreased in ERAS group.

In our study, ERAS was found also to decrease general postoperative complications such as chest complications and thromboembolism. This is owing to early mobilization and use of prophylactic anticoagulant. In TC group, one case developed postoperative DVT and two cases developed chest infection. In ERAS group, no cases developed DVT and only one case developed chest infection. No significant difference was found between TC and ERAS groups regarding surgical complications such as wound infection, anastomotic leak, persistent ileus, bleeding, and abdominal collection. This corresponds with Vlug *et al.* [10] and Yang *et al.* [16].

There was improved bowel function in the ERAS group. Only two (22%) cases developed PONV, the mean first time for flatus passage was 1.8 days, and the mean time for first solid meal was 3.2 days. In the TC group, four (44%) cases developed PONV, the first time for flatus passage was 3.6 days, and the first solid meal was 5.5 days. In the study by García-Botello *et al.* [12], the first time to flatus passage was 1 day in ERAS and 3 days in TC group. In the study by Yang *et al.* [16], the mean time to first flatus passage was 2 days in ERAS and 4 days in TC group.

In a study by Sarin *et al.* [13], 24% of cases developed PONV in ERAS group compared with 42% in TC group. The mean time to first solid meal was 2.7 days in ERAS group compared with 4.7 in TC group.

There was also great improvement in pain scores in ERAS group in POD 1 and POD 2, with no difference in POD 3. In TC group, six cases had severe pain and three cases had moderate pain, with mean score in POD 1 of 6, and narcotics were used for 3–4 days. In ERAS group, three cases had mild pain, four case had moderate pain, and two cases had severe pain, with mean score of 4, and no narcotics were used. This corresponds with Sarin *et al.* [13], where pain score in POD 1 decreased from 3.2 in TC group to 2.6 in ERAS group, and no difference was found by POD 3. Andersen *et al.* [20] showed improved pain outcome in POD 1, with similar outcomes in POD 7. Delaney *et al.* [17] and Gatt *et al.* [14] found no difference in pain outcome between the two groups.

In the study by Sarin *et al.* [13], ERAS decreased both mean primary hospital stay from 6 to 4 days and total hospital length of stay from 6.4 to 4.4 days. Readmission rates decreased from 21 to 9.4%. Pain scores improved in POD 1 from 3.2 to 2.6. Mean time to first solid meal decreased from 4.7 to 2.7 days. In this study, ERAS decreased primary hospital length of stay from 12 to 5 days and total hospital stay from 13.7 to 7 days, and the mean cost decreased from 6800 to 3900 pounds. General postoperative complications were also reduced from 22 to 11%. Pain scores in POD 1 improved from 6 to 4, first time to flatus passage was reduced from 3.6 to 1.8 days, and mean time to first solid meal decreased from 5.5 to 3.2 days.

Conclusions

(1) ERAS is a multidisciplinary evidence-based program associated with improved patient outcomes and decreased recovery time in the perioperative care of patients undergoing colorectal surgery.
(2) ERAS is a feasible and applicable program that can be used easily in our hospitals.

(3) ERAS has many advantages over TC, as ERAS protocols reduce health care costs, significantly reduce patient morbidity, with an acceleration of postoperative recovery, reduce the length of hospital stay, improve postoperative pain control, minimize usage of analgesia, and accelerate bowel function.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

References

1 Ljungqvist O. ERAS – enhanced recovery after surgery: moving evidence-based perioperative care to practice. J Parenter Enteral Nutr 2014; 38:559–566.

2 Gillissen F, Hoff C, Maessen JM, Winkens B, Teeuwen JH, von Meyenfeldt MF, Dejong CH. Structured synchronous implementation of an enhanced recovery program in elective colonic surgery in 33 hospitals in The Netherlands. World J Surg 2013; 37:1082–1093.

3 Kain ZN, Vakharia S, Garson L, Engwall S, Schwarzkopf R, Gupta R, *et al.* The perioperative surgical home as a model practice. Colorectal Dis 2014; 118:1126–1130.

4 Gravante G, Caruso R, Andreani S, Giordano P. Mechanical bowel preparation for colorectal surgery: a meta-analysis on abdominal and systemic complications on almost 5000 patients. Int J Colorectal Dis 2008; 23:1145–1150.

5 Kehlet H, Wilmore D. Evidence-based surgical care and the evolution of fast-track surgery. Ann Surg 2008; 248:189–198.

6 Nygren J, Thacker J, Carli F, Fearon KC, Norderval S, Lobo DN, *et al.* Guidelines for perioperative care in elective rectal/pelvic surgery: enhanced recovery after surgery (ERAS) society recommendations. Clin Nutr 2012; 31:801–816.

7 Ren L, Zhu D, Wei Y, Pan X, Liang L, Xu J, *et al.* Enhanced recovery after surgery (ERAS) program attenuates stress and accelerates recovery in patients after radical resection for colorectal cancer: a prospective randomized controlled trial. World J Surg 2012; 36:407–414.

8 Wang G, Jiang ZW, Zhao K, Gao Y, Liu FT, Pan HF, *et al.* Fast track rehabilitation program enhances functional recovery after laparoscopic colonic resection. Hepatogastroenterology 2012; 59:2158–2163.

9 Khoo CK, Vickery CJ, Forsyth N, Vinall NS, Eyre-Brook IA. A prospective randomized controlled trial of multimodal perioperative management protocol in patients undergoing elective colorectal resection for cancer. Ann Surg 2007; 245:867–872.

10 Vlug MS, Wind J, Hollmann MW, Ubbink DT, Cense HA, Engel AF, *et al.* Laparoscopy in combination with fast track multimodal management is the best perioperative strategy in patients undergoing colonic surgery: a randomized clinical trial (lafa-study). Ann Surg 2011; 254:868–875.

11 Muller S, Zalunardo MP, Hubner M, Clavien PA, Demartines N. A fast-track program reduces complications and length of hospital stay after open colonic surgery. Gastroenterology 2009; 136:842–847.

12 García-Botello S, Cánovas de Lucas R, Tornero C, Escamilla B, Espí-Macías A, Esclapez-Valero P, *et al.* Implementation of a perioperative multimodal rehabilitation protocol in elective colorectal surgery. a prospective randomised controlled study. Cir Esp 2011; 89:159–166.

13 Sarin A, Litonius ES, Naidu R, Yost CS, Varma MG, Chen LL. Successful implementation of ERAS program shortens length of stay and improves postoperative pain, and bowel and bladder function after colorectal surgery. a multidisciplinary clinical study. BMC Anesthesiol 2016; 3:16–55.

14 Gatt M, Anderson AD, Reddy BS, Hayward-Sampson P, Tring IC, MacFie J. Randomized clinical trial of multimodal optimization of surgical care in patients undergoing major colonic resection. Br J Surg 2005; 92:1354–1362.

15 Teeuwen PH, Bleichrodt RP, Strik C, Groenewoud JJ, Brinkert W, van Laarhoven CJ, *et al.* Enhanced recoveiy after surgery (ERAS) versus conventional postoperative care in colorectal surgery. J Gastrointest Surg 2010; 14:88–95.

16 Yang D, He W, Zhang S, Chen H, Zhang C, He Y. Fast-track surgery improves postoperative clinical recovery and immunity after elective surgery for colorectal carcinoma: randomized controlled clinical trial. World J Surg 2012; 36:1874–1880.

17 Delaney CP, Zutshi M, Senagore AJ, Remzi FH, Hammel J, Fazio VW. Prospective, randomized, controlled trial between a pathway of controlled rehabilitation with early ambulation and diet and traditional postoperative care after laparotomy and intestinal resection. Dis Colon Rectum 2003; 46:851–859.

18 van Bree SH, Vlug MS, Bemelman WA, Hollmann MW, Ubbink DT, Zwinderman AH, *et al.* Faster recovery of gastrointestinal transit after laparoscopy and fast-track care in patients undergoing colonic surgery. Gastroenterology 2011; 141:872–880.

19 Serclová Z, Dytrych P, Marvan J, Nová K, Hankeová Z, Ryska O, *et al.* Fast-track in open intestinal surgery: prospective randomized study (Clinical trials Gov identifier no. nCt00123456). Clin Nutr 2009; 28:618–624.

20 Andersen H, Lewis S, Thomas S. Early enteral nutrition within 24 h of colorectal surgery versus later commencement of feeding for postoperative complications. Cochrane Database Syst Rev 2006; 4:CD004080.