

Original Article

# Implementation of Modified Early Recovery after Surgery in Minimally Invasive Colorectal Surgery at a Single Community Hospital

Wei-Lin Wang<sup>4</sup>  
Yan-Jiun Huang<sup>1,2</sup>  
Yen-Jung Lu<sup>3</sup>  
En-Kwang Lin<sup>3</sup>  
Chia-Che Chen<sup>2</sup>  
Yiu-Shun Tong<sup>4</sup>  
Li-Jen Kuo<sup>2</sup>  
Chien-Hsin Chen<sup>3\*</sup>  
Po-Li Wei<sup>1,2\*</sup>

<sup>1</sup>Department of Surgery, College of Medicine, Taipei Medical University,

<sup>2</sup>Division of Colorectal Surgery, Department of Surgery, Taipei Medical University Hospital, Taipei Medical University,

<sup>3</sup>Division of Colorectal Surgery, Department of Surgery, Taipei Municipal Wanfang Hospital,

<sup>4</sup>Division of Acute Care Surgery and Traumatology, Department of Surgery, Taipei Medical University Hospital, Taipei, Taiwan

## Key Words

Early recovery after surgery (ERAS);  
Colorectal cancer

**Aims.** The benefits of early recovery after surgery (ERAS) in perioperative management and postoperative recovery of colorectal surgery are well known. We assessed the outcomes and quality improvement of patients with colorectal cancer achieved through the implementation of modified ERAS (mERAS) at a community hospital.

**Methods.** A retrospective review of patients with colorectal cancer who underwent minimally invasive surgery was conducted. The primary end points assessed included emergency department (ED) visit within 3 days after discharge (3-day ED visit) and readmission within 14 days after discharge (14-day readmission). The secondary end points included time to first flatus, time to first soft diet intake, surgical morbidity, and postoperative hospital stay.

**Results.** A total of 424 patients with colorectal cancer (51% male and 49% female patients; mean age, 63 years) who underwent minimally invasive surgery from January 2014 to December 2018 in our hospital were enrolled. The pre-ERAS and post-ERAS groups consisted of 243 and 181 patients, respectively. Overall, no statistical difference was observed in 14-day readmission between the two groups. The most common reasons for post-ERAS 14-day readmission were ileus (2/4, 50%), intra-abdominal abscess (1/4, 25%), and colitis (1/4, 25%).

The post-ERAS group (2%, 4/181) had a higher 3-day ED visit rate than the pre-ERAS group (0%, 0/243;  $p < 0.033$ ). The most common reasons for visiting the ED were wound infection (2/4, 50%), ileus (1 of 4, 25%), and wound pain (1/4, 25%).

Patients in the post-ERAS group had earlier time to first flatus ( $2.3 \pm 1.0$  days), earlier time to soft diet intake ( $1.9 \pm 1.5$  days), and shorter postoperative hospital stay ( $7.8 \pm 3.6$  days) than those in the pre-ERAS group ( $2.6 \pm 1.0$ ,  $3.8 \pm 1.7$ , and  $9.3 \pm 4.2$  days, respectively;  $p < 0.001$ ).

**Conclusions.** Implementation of the ERAS pathway in a community hospital has a positive effect on the length of postoperative stay and is not associated with increased 14-day readmission. The majority of patients returning to the ED do not require hospital readmission. The main reason for ED return is wound complications.

[J Soc Colon Rectal Surgeon (Taiwan) 2020;31:32-40]

Received: July 8, 2019.

Accepted: September 10, 2019.

Correspondence to: Dr. Po-Li Wei, Division of Colorectal Surgery, Department of Surgery, Taipei Medical University Hospital, No. 252, Wuxing Street, Sinyi District, Taipei 11031, Taiwan.

\* Chien-Hsin Chen and Po-Li Wei contributed equally.

**C**olorectal cancer (CRC) is the third most common cancer and fourth leading cause of cancer death worldwide.<sup>1</sup> In Taiwan, CRC is the most common cancer and the third leading cause of cancer death.<sup>2</sup> Surgical resection is the main treatment modality for CRC, and many studies have shown the benefits of minimally invasive surgery including laparoscopic surgery with regard to less postoperative wound pain, shorter postoperative hospital stay, and early recovery.<sup>3-5</sup>

Early recovery after surgery (ERAS) is a multimodal concept for further improving perioperative management and outcomes of patients who have undergone surgical resection. It was first introduced by Kehlet et al. in 1994 for patients undergoing CRC surgery, and it has been gradually implemented in other fields of surgery because of its more favorable outcomes in terms of safety and early recovery.<sup>6,7</sup> The core aspects of ERAS include no perioperative fasting, optimal nutrition and fluid management, decreased use of tubes, optimized pain control, and early mobilization.<sup>8</sup> Moreover, ERAS has been known to reduce psychological stress during the perioperative period, and it results in shorter hospital stay and fewer postoperative complications.<sup>9,10</sup>

In our hospital, concepts of ERAS were introduced in June 2016, and they were further modified and implemented in colorectal surgery. All scheduled colorectal operations are performed through a minimally invasive approach in our hospital. This study aimed to evaluate the clinical benefits of ERAS in minimally invasive colorectal surgery at a single community hospital. In addition, we assessed quality improvement of patients with colorectal cancer by monitoring the emergency department visit within 3 days after discharge (3-day ED visit) and readmission within 14 days after discharge (14-day readmission).

## Methods

Our ERAS protocol focused on preoperative, intraoperative, and postoperative care of patients with CRC who underwent minimally invasive surgery. It included several essential elements such as water in-

take 2 hours before operation, early postoperative oral intake, early ambulation, early urinary catheter removal, no intraoperative nasogastric tube insertion, prevention of fluid overload during and after surgery, and nonopioid oral pain control. Our modified ERAS (mERAS) pathway differs from the conventional pathway in terms of oral bowel preparation. In mERAS, all patients used compression stockings and intermittent pneumatic compression from the beginning of operation until they were out of bed. Intraoperative fluid infusion was restricted to less than 2000 mL to avoid any fluid overload.<sup>11</sup> Postoperative pain control involved intraoperative lidocaine injection into the wound and oral nonsteroid anti-inflammatory drug intake. We started with postoperative water intake 2 hours after operation and then shifted to 2 days of a clear liquid diet followed by at least 2 weeks of a lower residual soft diet. Early mobilization was encouraged for all patients receiving ERAS within 2 hours after return to the ward. Urinary catheters were removed on postoperative day 1, except for elderly patients at fall risk. Patients were discharged from the hospital with fair oral intake, tolerable wound pain under oral analgesics, and recovery without complications. A comparison between the conventional pathway as per the ERAS society colorectal guideline and the mERAS protocol in our hospital is provided in Table 1. Our mERAS program implementation was supervised by surgeons, anesthesiologists, nutritional specialists, and nursing staff from the institutes involved. The major difference in our mERAS is that all patients use well-fitting compression stockings and intermittent pneumatic compression from operation until out of bed post operation for risk reduction of venous thromboembolism attack during colorectal surgery.<sup>12</sup>

This study was designed as a retrospective single-center study. Patients who underwent minimally invasive CRC surgery in our hospital from January 2014 to December 2018 were enrolled. Patients were excluded if they were <18 years old, underwent emergent operation, had American Association of Anesthesiologist (ASA) score IV, had recurrent cancer, or had incomplete records. Then, we divided them into pre-ERAS and post-ERAS groups according to time

**Table 1.** Comparison of conventional and modified ERAS protocols

Conventional ERAS protocol	Modified ERAS protocol
<b>Preoperative</b>	
Preadmission patient education and counseling	Preadmission education and preanesthesia consultation
No bowel preparation	Oral bowel preparation 1 day before operation
Preoperative oral carbohydrate/no fasting	No solid food since midnight of the operation day; only clear liquids up to 2 hours before surgery
Preoperative long-acting sedative medication	None
Thrombosis prophylaxis	All patients use well-fitting compression stockings and intermittent pneumatic compression from operation until out of bed after operation
Antibiotic prophylaxis before incision	Single-dose cephalosporin at 1000 mg 15-30 minutes before the incision and repeatedly if surgery lasted longer than 4 hours
Postoperative nausea and vomiting prophylaxis administered	Yes
<b>Intraoperative</b>	
Epidural or spinal anesthesia	None
Upper-body forced-air heating cover used	Yes
Nasogastric tube used postoperatively	No
Resection-site drainage	Yes
<b>Postoperative</b>	
Termination of urinary drainage within 24 hours after surgery	Yes
Stimulation of gut motility	Attempt oral water intake 2 hours after operation
Postoperative epidural analgesia	None
Patient weight on postoperative day 1	None
Nonopiate oral analgesics/NSAIDs*	Yes
Termination of intravenous fluid infusion	Termination of intravenous fluid infusion on postoperative day 1
Perioperative oral nutrition	Clear liquid diet for 1-2 days and then low residual soft diet intake
Audit of compliance/outcomes	Yes

\* NSAIDs, nonsteroid anti-inflammatory drugs.

of ERAS implementation to evaluate results and values from mERAS care.

Patient data, namely demographics, clinical elements, stage of cancer, intraoperative blood loss, operation time, complications, and outcomes, were collected from electronic patient charts. Primary end points included 3-day ED visit and 14-day readmission rates. Postoperative recovery, morbidity, surgical mortality, and postoperative hospital stay were analyzed as secondary end points. Postoperative recovery factors included time to first flatus or defecation, time to soft diet intake, and postoperative hospital stay. Morbidity was recorded as grade II or higher complications as defined by the Clavien-Dindo classification system.

## Statistics

We compared statistics of the pre-ERAS and post-

ERAS groups for all relevant patient characteristics and perioperative data. The two groups were compared using *t* tests and chi-square tests, as appropriate. All analyses were performed using SPSS 18 version 3.1.2 (R Foundation for Statistical Computing, Vienna, Austria). The statistical significance level for all comparisons was set at  $p < 0.05$ . The study was approved by the Research Ethics Board of Taipei Medical University Hospital in Taipei, Taiwan (IRB: N201907006).

## Results

A total of 424 consecutive patients undergoing minimally invasive CRC surgery in our hospital were retrospectively analyzed. Among them, 181 patients received the mERAS pathway (post-ERAS group), and 243 patients were cared for in the conventional

manner before ERAS implementation (pre-ERAS group). Baseline patient characteristics, including sex, age, body mass index, preoperative carcinoembryogenic antigen level, ASA classification, cancer stage, comorbidities such as diabetes and hypertensive heart disease, operation time, and blood loss, are shown in Table 2. No statistically significant difference was observed among them.

In our study, no statistical difference was observed between pre-ERAS and post-ERAS groups with regard to 14-day readmission ( $p = 1.000$ ). Fourteen-day readmission was observed in 5 of 243 (2.0%) patients and 4 of 181 (2.2%) patients of the pre-ERAS and post-ERAS groups, respectively. In the pre-ERAS group, the reasons for which patients required medical treatment were wound infection (1/5, 20%), poor appetite-related weakness (1/5, 20%), neorectal (colorectal) abscess (1/5, 20%), adhesion ileus (1/5, 20%), and pneumonia (1/5, 20%). In the post-ERAS group, the reasons for which patients required medical treatment were adhesion ileus (2/4, 50%), intra-abdominal

abscess (1/4, 25%), and colitis (1/4, 25%).

Regarding the 3-day ED visit, the post-ERAS group had a higher ED return rate than the pre-ERAS group ( $p = 0.033$ ). Moreover, 4 of 181 patients (2.2%) in the post-ERAS group visited ED within 3 days after discharge in comparison with none of the patients in the pre-ERAS group ( $p = 0.033$ ). The causes of ED visit were mostly wound problems (3/4, 75%), including pain, infection, or discharge, and ileus (1/4, 25%).

No surgical mortality was observed in our study postoperatively within 30 days. Table 3 presents time to first flatus, time to soft diet intake, postoperative hospital stay, and surgical morbidity. Early first flatus and soft diet intake were noted in the post-ERAS group ( $2.3 \pm 1.0$  days and  $1.9 \pm 1.5$  days, respectively) compared with the pre-ERAS group ( $2.6 \pm 1.0$  days and  $3.8 \pm 1.7$  days, respectively). Moreover, we observed shorter postoperative hospital stay in the post-ERAS group than in the pre-ERAS group ( $7.8 \pm 3.6$  vs.  $9.3 \pm 4.2$  days,  $p < 0.001$ ).

No significant difference was noted in surgical

**Table 2.** Demographic data

	Group	Pre-ERAS	Post-ERAS	<i>p</i> value
Patient number		243	181	
Age (years)	(Mean $\pm$ SD)	63.6 $\pm$ 12.5	63.5 $\pm$ 13.9	0.995
Sex	Male	123	96	0.662
	Female	120	85	
Body mass index	(Mean $\pm$ SD)	24.1 $\pm$ 3.8	24.2 $\pm$ 4.2	0.856
Albumin (g/dL)	(Mean $\pm$ SD)	4.03 $\pm$ 0.35	4.09 $\pm$ 0.47	0.167
Carcinoembryogenic antigen (ng/mL)	Median	3.28	3.32	0.510
American Association of Anesthesiologist class	< 3	203	152	0.904
	$\geq$ 3	40	29	
Diagnosis	Colon cancer	175	136	0.472
	Rectal cancer	68	45	
Stage	I	78	65	0.566
	II	50	39	
	III	85	52	
	IV	29	25	
Comorbidity	No	98	72	0.909
	Yes	145	109	
Diabetes	No	201	142	0.269
	Yes	42	39	
Hypertension	No	162	113	0.366
	Yes	81	68	
OP* time (minutes)	(Average $\pm$ SD)	172.22 ( $\pm$ 66.11)	174.41 ( $\pm$ 62.03)	0.729
Bleeding (mL)	(Average $\pm$ SD)	30.14 ( $\pm$ 27.56)	30.14 ( $\pm$ 33.08)	0.998

\* Operation.

**Table 3.** Postoperative outcomes

	Group	Pre-ERAS	Post-ERAS	<i>p</i> value
Time to first flatus (days)	(Mean ± SD)	2.6 ± 1.0	2.3 ± 1.0	< 0.001
Time to soft diet (days)	(Mean ± SD)	3.8 ± 1.7	1.9 ± 1.5	< 0.001
Postoperative hospital stay (days)	(Mean ± SD)	9.3 ± 4.2	7.8 ± 3.6	< 0.001
Morbidity	No	230	167	0.320
	Yes	13	14	
	Pulmonary	1	0	
	Neurology	1	0	
	Wound infection	1	3	
	Leakage	5	4	
	Ileus	3	3	
	Intra-abdominal abscess	2	1	
	Others	0	5	
ED visit within 3 days after discharge	No	243	177	0.033
	Yes	0	4	
	Wound infection/discharge	0	2	
	Adhesion ileus	0	1	
	Wound pain	0	1	
Readmission within 14 days after discharge	No	238	177	1.000
	Yes	5	4	
	Wound infection/discharge	1	0	
	Poor appetite and weakness	1	0	
	Neorectal abscess	1	0	
	Adhesion ileus	1	2	
	Pneumonia	1	0	
	Intra-abdominal abscess	0	1	
	Colitis	0	1	

morbidity between the pre-ERAS (13/243, 5.3%) and post-ERAS (14/181, 7.7%) groups. In the pre-ERAS group, of the 243 patients, 1 patient had aspiration pneumonia (0.41%), 1 developed cerebral vascular accident (0.41%) after operation, 1 had wound infection (0.41%), 5 had anastomosis leakage (2.0%), 3 had ileus (1.23%), and 2 had intra-abdominal abscess (0.82%).

In the post-ERAS group, of the 181 patients, 3 had wound infection (1.65%), 1 developed intra-abdominal abscess (0.55%), 1 had intra-abdominal abscess combined with acute kidney injury (0.55%), 1 had urinary tract infection (0.55%), 1 had postoperative diarrhea (0.55%), 1 developed fever with leukocytosis after drain tube removal (0.55%), and 1 had anastomosis site bleeding (0.55%). Additionally, 3 patients had anastomosis leakage (1.6%), 2 had ileus (1.1%), and 1 had both leakage and ileus after operation.

## Discussion

The development of an evidence-based colorectal surgery ERAS program at a community hospital is currently driven by the changing medical environment. ERAS is an evidence-based multimodal concept to improve perioperative care quality and outcomes of surgical patients.<sup>5,13</sup> It ameliorates clinical outcomes, including early gut motility, shorter length of hospital stay, fewer complications, and lower readmission rates, compared with those of the non-ERAS period.

The mERAS pathway has been implemented in our hospital since June 2016. Regarding the primary outcome of early 3-day ED visit, 4 of 181 patients (2.2%) in the post-ERAS group were identified with early 3-day ED visits versus none in the pre-ERAS group ( $p = 0.033$ ). The causes of early 3-day ED visits were mostly wound pain and infection, which did not

require readmission. Amri et al. reported that surgical site infection rates were significantly higher among people with an operation time longer than 140 minutes ( $p = 0.05$ ). Furthermore, Amri et al. pointed out that patients with a history of smoking ( $p = 0.04$ ), alcohol consumption ( $p = 0.04$ ), or type 2 diabetics ( $p = 0.046$ ) were more likely to have surgical site infection.<sup>14</sup> On average, our operation time was approximately 171 minutes in either the pre- or post-ERAS groups, and data showed no statistical difference. According to a previous study by Li et al., patient compliance may affect the outcome of surgical site infection.<sup>15</sup>

Regarding the primary outcome of 14-day readmission, our data showed that on average, approximately 2% of our patients required readmission for further management in the post-ERAS period. In the post-ERAS group, of the four patients who required nonoperative treatment, two had adhesion ileus (50%), one had intra-abdominal abscess (25%), and one had colitis (25%). No significant difference was observed in the 14-day readmission rate between the pre- and post-ERAS groups ( $p = 1.000$ ). This finding clearly demonstrated that the implementation of ERAS did not result in more complications; rather, each element within the ERAS program played an essential role. A Korean study aimed to identify the risk factors for surgical site infections in patients undergoing CRC surgery by determining relationship between the short prophylactic antibiotic use group (within 24 hours) and the long prophylactic antibiotic use group (beyond 24 hours). The results showed that discontinuation of prophylactic antibiotics within 24 hours after colorectal surgery had no significant influence on the incidence of surgical site infection.<sup>16</sup> We adopted the following measures within our ERAS program: perioperative and postoperative compression stocking and intermittent pneumatic compression device use, intraoperative fluid restriction, intraoperative lidocaine injection into the wound, oral nonsteroid anti-inflammatory drug administration, early oral water intake since 2 hours after operation and a shift to a clear liquid diet and then to a soft diet, early mobilization since 2 hours after return to the ward, and urinary catheter removal in the morning of postoperative day

1. Another Canadian research group reported that an average of 20% of their colorectal patients in their ERAS program had an ED visit or readmission within 30 days after discharge.<sup>17</sup> Their group reported that early ED visits were most commonly due to surgical site infections and urinary tract infections, whereas for hospital readmission, intra-abdominal abscess and ileus were the main causes. This is in line with our findings. Overall, the results of our study demonstrated a considerably lower readmission rate than those in previous studies; however, when considering the reported return to the hospital is between 8% and 20%. With respect to the ERAS program, our study showed that the mERAS program does not increase the risks of ED visits and readmissions.<sup>17,18</sup>

Furthermore, many studies<sup>19,20</sup> have shown no increase in readmission rates, but few have provided in-detail explanations of the causes of early ED return after discharge. Many minor complications were initially managed at ED, and this might overestimate the benefits of the ERAS program. However, further studies are required to clarify this. In addition, no surgical mortality was observed in our study within 30 days postoperatively.

Patients undergoing laparoscopic surgery were more likely to have a shorter length of hospital stay, were less likely to be readmitted, and had fewer surgical complications. For open surgery patients, no significant reduction in the length of hospital stay was noted between the pre- and post-ERAS groups, an observation similar to that in randomized controlled trials.<sup>21,22</sup> Thus, minimally invasive surgery coupled with ERAS program has been shown to improve patient outcomes.<sup>23,24</sup>

Regarding the secondary outcomes of the study, the time to first flatus and soft diet intake were earlier in the post-ERAS group ( $2.3 \pm 1.0$  and  $1.9 \pm 1.5$  days, respectively) than in the pre-ERAS group ( $2.6 \pm 1.0$  and  $3.8 \pm 1.7$  days, respectively) ( $p < 0.001$ ). Moreover, postoperative hospital stay was shorter in the post-ERAS group than in the pre-ERAS group ( $7.8 \pm 3.6$  vs.  $9.3 \pm 4.2$  days,  $p < 0.001$ ). Moreover, in the ERAS program, a major shift from prolonged fasting to allowing clear fluids up to 2 hours before surgery and solids up to 6 hours before surgery has been im-

plemented in the preoperative period.<sup>25,27</sup> Therefore, our patients were allowed clear liquids up to 2 hours before surgery.

Overall, the implementation of a multidisciplinary ERAS pathway at a major community hospital is associated with a shortened length of hospital stay and early time to flatus and soft diet intake without increasing the 14-day readmission rate. These results are consistent with findings from other centers and in various patient populations<sup>28-33</sup> and lend impetus to the further incorporation of new tools and concepts in future.

## Conclusion

The use of a multimodal evidence-based program is associated with a shorter length of postoperative stay and is not associated with an increased 14-day readmission. The majority of patients returning to the ED do not require hospital readmission. Adoption of such programs in the management of surgical patients should be encouraged.

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原 著

## 在單一社區醫院微創大腸直腸癌手術經驗中 實施經修改的手術後早期恢復

王偉林<sup>4</sup> 黃彥鈞<sup>2</sup> 盧延榕<sup>3</sup> 林恩光<sup>3</sup> 陳嘉哲<sup>2</sup>湯堯舜<sup>4</sup> 郭立人<sup>2</sup> 陳建信<sup>3</sup> 魏柏立<sup>1,2</sup><sup>1</sup>台北醫學大學醫學院 外科<sup>2</sup>台北醫學大學附設醫院 外科部 大腸直腸外科<sup>3</sup>萬芳醫院 外科部 大腸直腸外科<sup>4</sup>台北醫學大學附設醫院 外科部 急症外傷科

**目的** 手術後早期恢復 (ERAS) 的好處在結腸直腸手術的手術期管理和術後恢復方面是眾所周知的。我們試圖藉由社區醫院實施經修改的 ERAS (mERAS) 來研究病患照護的結果和品質控制。

**方法** 對接受常規性微創手術的結腸直腸癌病患進行回顧性研究。主要探討焦點的評估包括出院後三天重返急診就診以及出院後 14 天再入院比率。次要探討焦點的評估包括術後第一次排氣時間、第一次軟食進食時間、手術後住院天數與術後併發症率。

**結果** 收集 2014 年 1 月至 2018 年 12 月共 424 名結腸直腸病患 (51% 為男性, 49% 為女性; 平均年齡為 63 歲) 接受常規性結腸直腸癌手術。ERAS 前組有 243 名病患, ERAS 後組有 181 例。在 14 天再入院方面是兩組統計學上沒有顯著的差異。在 ERAS 後組最常見的 14 天再入院原因為腸阻塞 (2/4, 50%), 以及腹內膿瘍 (1/4, 25%) 和結腸炎 (1/4, 25%)。與 ERAS 前組相比, ERAS 後組 (2%, 4/181) 之出院後 3 天內重返急診的比率較高 ( $p < 0.033$ ), 重返急診最常見的因素是傷口感染 (2/4, 50%), 其次是腸阻塞 (1/4, 25%) 以及傷口疼痛 (1/4, 25%)。

與 ERAS 前組 ( $2.6 \pm 1.0$  days) 相比, ERAS 後組 ( $2.3 \pm 1.0$  days) 有更早術後排氣  $p < 0.001$ 。與 ERAS 前組 ( $3.8 \pm 1.7$  days) 相比, 在 ERAS 後組 ( $1.9 \pm 1.5$  days) 也觀察到較早軟質食物之進食 ( $p < 0.001$ )。ERAS 後組之術後住院天數比 ERAS 前組短 The ( $7.8 \pm 3.6$  vs.  $9.3 \pm 4.2$  days) ( $p < 0.001$ )。

**結論** 在社區醫院實施 ERAS 對術後住院天數有明顯縮短之影響, 且與 14 天再入院無明顯關聯。重返急診的主要原因是傷口併發症, 然而, 大多數重返急診不需再入院接受治療。

**關鍵詞** 術後早期恢復、ERAS、結腸直腸癌。