



# Improved outcomes with implementation of an Enhanced Recovery After Surgery pathway for patients undergoing elective colorectal surgery in the Philippines

Mayou Martin T. Tampo<sup>1</sup>, Mark Augustine S. Onglao<sup>1</sup>, Marc Paul J. Lopez<sup>1</sup>, Marie Dione P. Sacdalan<sup>1</sup>, Ma. Concepcion L. Cruz<sup>2</sup>, Rosielyn T. Apellido<sup>1</sup>, Hermogenes J. Monroy III<sup>1</sup>

<sup>1</sup>Division of Colorectal Surgery, Philippine General Hospital, University of the Philippines Manila, Manila; <sup>2</sup>Department of Anesthesiology, Philippine General Hospital, University of the Philippines Manila, Manila, Philippines

**Purpose:** This study aims to evaluate surgical outcomes (i.e. length of stay [LOS], 30-day morbidity, mortality, reoperation, and readmission rates) with the use of the Enhanced Recovery After Surgery (ERAS) pathway, and determine its association with the rate of compliance to the different ERAS components.

**Methods:** This was a prospective cohort of patients, who underwent the following elective procedures: stoma reversal (SR), colon resection (CR), and rectal resection (RR). The primary endpoint was to determine the association of compliance to an ERAS pathway and surgical outcomes. These were then retrospectively compared to outcomes prior to the implementation of ERAS.

**Results:** A total of 267 patients were included in the study. The overall compliance to the ERAS component was 92.0% (SR, 91.8%; CR, 93.1%; RR, 90.7%). There was an associated decrease in morbidity rates across all types of surgery, as compliance to ERAS increased. The average total LOS decreased in all groups but was only found to have statistical significance in SR (12.1 ± 6.7 days vs. 10.0 ± 5.4 days, P=0.002) and RR (19.9 ± 11.4 days vs. 16.9 ± 10.5 days, P=0.04) groups. Decreased postoperative LOS was noted in all groups. Morbidity rates were significantly higher after ERAS implementation, but reoperation and mortality rates were found to be similar.

**Conclusion:** Increased compliance to ERAS protocol is associated with a decrease in morbidity across all surgery types. The implementation of an ERAS protocol significantly decreased mean hospital LOS, without any increase in major surgical complications. Having your own hospital ERAS pathway improves documentation and accuracy of reporting surgical complications.

**Keywords:** *Enhanced Recovery After Surgery; Length of stay; Compliance*

## INTRODUCTION

The concept of “fast-track surgery” or “Enhanced Recovery After

Received: May 16, 2020 • Revised: Aug 15, 2020 • Accepted: Sep 2, 2020  
Correspondence to: Mark Augustine S. Onglao, M.D.  
Division of Colorectal Surgery, Philippine General Hospital, University of the Philippines Manila, Taft Ave, Ermita, Manila 1000, Philippines  
Tel: +63-9399148310, Fax: +63-85548400  
E-mail: [maconglao@gmail.com](mailto:maconglao@gmail.com)  
ORCID: <https://orcid.org/0000-0003-2175-9959>

© 2022 The Korean Society of Coloproctology

This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<https://creativecommons.org/licenses/by-nc/4.0>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

Surgery (ERAS)” was pioneered in the 1990s by Professor Henrik Kehlet, an anesthesiologist from Denmark. It is a bundle of “best evidence-based practices” delivered by a multi-professional health care team, with the intention of assisting patients to recuperate expeditiously after surgery [1, 2]. Clinical (or critical) pathways have been described to improve outcomes in various fields of surgery [3-16], including colorectal surgery [17-23]. Clinical pathways designed for the colorectal surgery patient have resulted in decreased hospital length of stay (LOS) and cost; and decreased, or no difference, in morbidity rates when compared to conventional care [17-21, 23-26].

From the year 2010 to 2014, the Division of Colorectal Surgery at the Philippine General Hospital performed an average of 147

stoma closures, 118 colonic surgeries, and 72 rectal surgeries annually. For patients undergoing stoma reversal (SR), the mean hospital LOS was 17.9 days, while the mean postoperative LOS was 9.1 days. The leak rate was 5.47% [27]. With an average of 1,436 admissions per year to be accommodated to an allotted 14 hospital beds [28], prolonged patient hospital stay greatly impacts on the unit's capacity to cater to a greater number of patients and contributes to delays in admission and eventual management.

The objective of this study was to determine the association of compliance to the ERAS pathway and surgical outcomes and to compare them with outcomes before ERAS implementation for patients undergoing stoma closure and elective colorectal resections within a resource-limited environment.

## METHODS

### Study design

This was a prospective cohort study of adult surgical patients admitted by the Division of Colorectal Surgery who underwent any of the following procedures on an elective basis: SR, colon resection (CR), and rectal resection (RR). All patients aged 18 years and above are included in the study. Patients who underwent emergency surgery, had metastatic disease, underwent multivisceral resection, and those undergoing palliative and incomplete tumor resection were excluded from the study. An approval for this study was obtained from the Institutional Ethics and Review Board Committee of Philippine General Hospital (No. (SUR) 2017-087-01) with a waiver for informed consent.

### The ERAS pathway

A detailed ERAS pathway was constructed specifically for SR, CR, and RR. All patients were referred to a multidisciplinary team that involved surgeons, anesthesiologists, nurses, nutritionists, and rehabilitation medicine practitioners. Each health care provider accomplished a checklist for the different ERAS components as recommended by the ERAS Society [29, 30]. However, the investigators agreed on some modifications to fit the setting and limitations of our institution. The components of the ERAS pathway with the investigators' modifications are summarized in Supplementary Fig. 1.

### Data collection

Nonsurgical staff research personnel were specifically trained to fill out and complete the data collection form. The data were recorded on an Excel spreadsheet containing information on compliance to ERAS elements, perioperative, and follow-up data. All patients enrolled in the study were followed up until 30 days after discharge to check for development of complications, readmission, reoperation, or unexpected demise.

### Outcome

The primary endpoint was to determine the association of com-

pliance to the ERAS pathway and surgical outcomes that included LOS, morbidity, mortality, readmission, and reoperation rates. Secondary endpoint was to retrospectively compare the same outcomes from patients before (pre-ERAS group) and after (ERAS group) the implementation of the ERAS pathway.

### Data analysis

A minimum sample size requirement of 89 patients for each procedure was needed to achieve an 80% power and a level of significance of 10% for a 2-sided test of hypothesis using simple logistic regression analysis. This computation was based on a 50% expected probability of having a disease postoperatively among patients who were noncompliant to ERAS and a corresponding odds ratio (OR) of 0.33 (describing the odds of having a disease postoperation among ERAS compliant patients). The computation was performed using PASS 2008 (NCSS, LLC, Kaysville, Utah, USA). Descriptive statistics were used to summarize the demographic and clinical characteristics of the patients. Frequency and proportion were used for categorical variables, and mean and standard deviation for normally distributed continuous variables. The ORs and corresponding 95% confidence intervals (CIs) from binary logistic regression were computed to determine if ERAS percent compliance was associated with multiple outcomes such as prolonged LOS, prolonged preoperative stay, prolonged postoperative stay, and morbidity. Null hypotheses were rejected at 0.05  $\alpha$ -level of significance. Stata ver. 13.1 (Stata Corp., College Station, TX, USA) was used for data analysis. The Student t-test, Fisher exact, and  $2 \times 2$  chi-square test were used, as appropriate, to determine statistical difference between the pre-ERAS and the ERAS groups.

## RESULTS

A total of 267 patients were enrolled in the ERAS pathway. Eighty-nine patients were enrolled for each surgical type—SR, CR, and RR. The mean age for SR, CR, and RR were 48, 55, and 59 years, respectively. The patients who underwent CR and RR were mostly cancer patients (CR, 86 of 89; RR, 89 of 89). An open procedure was done on all SR patients, 73.0% for CR, and 75.3% for RR. For SR, majority were ileostomy closure (70.8%). Majority of SR patients had no malnutrition risk (62.9%), CR patients mostly had a mild malnutrition risk (85.4%), and RR patients mostly had a moderate risk (80.9%). Majority of SR and CR (57.3%, respectively) were performed by senior residents; they are the residents of Department of General Surgery who are in the 4th and 5th year of their training. The rest of SR were performed by junior residents (33.7%); they are the residents of Department of General Surgery in their 3rd year of training. For CR, 38.2% were performed by Fellows; they are colorectal specialists in training. These cases were mostly laparoscopic cases. For RR, majority (70.8%) was performed by colorectal specialists-in-training. The consultants are colorectal specialists and they are mostly in supervisory

**Table 1.** Demographic and clinical profile of patient under the ERAS pathway (University of the Philippines-Philippine General Hospital in 2015–2018)

Variable	Stoma closure	Colon surgery	Rectal surgery
No. of patients	89	89	89
Age (yr)	48.7 ± 15.6	55.4 ± 55.4	59.4 ± 11.5
Sex			
Male	53 (59.6)	44 (49.4)	55 (61.8)
Female	36 (40.4)	45 (50.6)	34 (38.2)
Operative time (min)	98.6 ± 83.4	221.1 ± 286.3	258.7 ± 121.9
Estimated blood loss (mL)	42.5 ± 82.3	314.0 ± 360.8	441.1 ± 514.5
Surgical approach			
Ileostomy, parastomal	53 (59.6)	0 (0)	0 (0)
Ileostomy, midline	10 (11.2)	0 (0)	0 (0)
Colostomy, parastomal	17 (19.1)	0 (0)	0 (0)
Colostomy, midline	4 (4.5)	0 (0)	0 (0)
Hartmann reversal	5 (5.6)	0 (0)	0 (0)
Laparoscopic	0 (0)	24 (27.0)	22 (24.7)
Open	0 (0)	65 (73.0)	67 (75.3)
Diagnosis			
Benign	53 (59.6)	2 (2.2)	0 (0)
Malignant	36 (40.4)	87 (97.8)	89 (100)
Age-combined comorbidity index			
0	46 (51.7)	1 (1.1)	0 (0)
1	17 (19.1)	0 (0)	0 (0)
2	18 (20.2)	29 (32.6)	25 (28.1)
3	5 (5.6)	20 (22.5)	32 (36.0)
4	2 (2.2)	23 (25.8)	26 (29.2)
5	1 (1.1)	17 (19.1)	6 (6.7)
Nutritional status			
Underweight	3 (3.4)	5 (5.6)	3 (3.4)
Normal	56 (62.9)	64 (71.9)	59 (66.3)
Overweight	25 (28.1)	18 (20.2)	17 (19.1)
Obese	6 (6.7)	2 (2.2)	10 (11.2)
Malnutrition risk			
None	56 (62.9)	0 (0)	0 (0)
Mild	33 (37.1)	76 (85.4)	16 (18.0)
Moderate	0 (0)	8 (9.0)	72 (80.9)
Severe	0 (0)	5 (5.6)	1 (1.1)
Surgeon level			
Junior	30 (33.7)	4 (4.5)	0 (0)
Senior	51 (57.3)	51 (57.3)	26 (29.2)
Fellow	8 (9.0)	34 (38.2)	63 (70.8)
Consultant	0 (0)	0 (0)	0 (0)

Values are presented as number only, mean ± standard deviation, or number (%). ERAS, Enhanced Recovery After Surgery.

**Table 2.** Compliance rate of patients under the ERAS pathway (University of the Philippines-Philippine General Hospital in 2015–2018)

Compliance rate (%)	Stoma reversal (n=89)	Colon resection (n=89)	Rectal resection (n=89)	Overall (n=267)
<50	0 (0)	0 (0)	0 (0)	0 (0)
50–69	0 (0)	0 (0)	1 (1.1)	1 (0.4)
70–89	21 (23.6)	21 (23.6)	20 (22.5)	62 (23.2)
90–100	68 (76.4)	68 (76.4)	68 (76.4)	204 (76.4)
Mean compliance rate (%)	91.8	93.1	90.7	92.1

Values are presented as number (%). ERAS, Enhanced Recovery After Surgery.

roles during the procedures. The rest of the demographics and clinical profiles of the patients included in the study are shown in Table 1.

The average compliance of all patients to the ERAS pathway was 92.1% (SR, 91.8%; CR, 93.1%; and RR, 90.7%) and is summarized in Table 2. Logistic regression analysis (Table 3) showed that there was an associated decrease in morbidity rates in SR, CR, and RR, as compliance to the different ERAS elements increased with an OR of 0.96 (95% CI, 0.92–0.99; P = 0.012). The compliance for each ERAS category is shown in Table 4.

The outcomes obtained after ERAS implementation was compared retrospectively to the outcomes before ERAS. This includes hospital LOS, overall morbidity rate, reoperation rate, mortality rate, and readmission rates. Comparing the 2 time periods, there was a significant reduction in the overall total LOS (15.9 ± 9.9 days vs. 13.7 ± 8.3 days, P = 0.002) and postoperative LOS (7.9 ± 5.6 days vs. 5.8 ± 4.4 days, P < 0.001) after ERAS implementation. The overall morbidity rate was noted to be increased (5.2% vs. 29.2%, P < 0.001), however, the reoperation rate (5.2% vs. 7.5%, P = 0.20) and mortality rate (0.4% vs. 0.4%, P > 0.99) had no significant difference. These findings are summarized in Table 5.

## DISCUSSION

Clinical pathways provide detailed guidance in every step in the management of patients with a specific condition over a given time period, and include progress and outcome details. These aim to improve the continuity and coordination of care across varying disciplines and sectors within the hospital setting. Focus is given to quality and coordination of care among members of a multi-disciplinary team [31].

The ERAS protocol was developed in Europe in 2001 and formed the ERAS Study Group. Their goal was to improve not the speed, but the quality of recovery. This concept used a multidisciplinary approach, using scientific and evidence-based protocols, followed by a change in management with an interactive and continuous audit [32]. The combination of these various methods was assumed to lead to earlier postoperative recovery, avoidance

**Table 3.** Logistic regression of percent adherence to ERAS protocol to predict morbidity

Adherence	Morbidity		OR (95% CI)	P-value
	Positive	Negative		
All patients	79	150		
Actual percent adherence	90.2 ± 7.8	93.0 ± 7.5	0.96 (0.92–0.99)	0.012*
> 90% adherence	53 (67.1)	122 (81.3)	0.47 (0.25–0.87)	0.017*
< 90% adherence	26 (32.9)	28 (18.7)	2.14 (1.15–3.99)	0.017*
Colon	25	64		
Actual percent adherence	91.1 ± 6.4	93.9 ± 6.7	0.94 (0.88–1.01)	0.085
> 90% adherence	17 (68.0)	51 (79.7)	0.54 (0.19–1.53)	0.247
< 90% adherence	8 (32.0)	13 (20.3)	1.85 (0.65–5.21)	0.247
Rectal	20	25		
Actual percent adherence	88.6 ± 8.5	92.3 ± 9.5	0.95 (0.89–1.02)	0.180
> 90% adherence	11 (55.0)	21 (84.0)	0.23 (0.06–0.93)	0.039*
< 90% adherence	9 (45.0)	4 (16.0)	4.30 (1.07–17.17)	0.039*
Stoma	34	61		
Actual percent adherence	90.6 ± 8.2	92.3 ± 7.3	0.97 (0.92–1.03)	0.290
> 90% adherence	25 (73.5)	50 (82.0)	0.61 (0.22–1.67)	0.336
< 90% adherence	9 (26.5)	11 (18.0)	1.64 (0.60–4.46)	0.336

Values are presented as number only, mean ± standard deviation, or number (%).

ERAS, Enhanced Recovery After Surgery; OR, odds ratio; CI, confidence interval.

\*P < 0.05.

**Table 4.** Compliance rate for each ERAS component (University of the Philippines-Philippine General Hospital in 2015–2018)

No.	ERAS component	Stoma reversal (%)	Colon resection (%)	Rectal resection (%)
1	Preoperative information, education, counseling	98.8	100	98.8
2	Preoperative optimization	97.8	95.5	95.5
3	Preoperative bowel preparation	96.6	96.6	100
4	Preoperative fasting/carbohydrate treatment	95.5	97.8	100
5	Preanesthetic medication	96.6	95.5	97.8
6	Prophylaxis against thromboembolism	21.3	69.7	65.0
7	Antimicrobial prophylaxis/skin prep	100	98.8	100
8	Standard anesthetic protocol	82.0	93.3	92.1
9	Postoperative nausea and vomiting	93.3	97.8	96.6
10	Lap/modifications of surgical access	78.7	91.0	87.6
11	Nasogastric intubation	95.5	96.6	93.3
12	Preventing intraoperative hypothermia	91.0	83.1	92.1
13	Perioperative fluid management	94.4	92.1	92.1
14	Drainage of peritoneal cavity	46.1	92.1	67.4
15	Urinary drainage	95.5	95.5	89.9
16	Prevention of postop ileus	93.3	92.2	93.3
17	Postoperative analgesia	93.3	94.4	94.4
18	Early oral intake	95.5	92.2	86.5
19	Perioperative nutritional care	100	100	95.5
20	Postoperative glucose control	98.8	97.8	96.1
21	Early mobilization	97.8	100	98.8

ERAS, Enhanced Recovery After Surgery.

**Table 5.** Comparison of outcomes before (2012–2014) and after (2015–2018) ERAS pathway implementation (University of the Philippines-Philippine General Hospital in 2015–2018)

Outcome	Stoma reversal			Colon resection			Rectal resection			Overall		
	Before ERAS (n = 188)	After ERAS (n = 89)	P-value	Before ERAS (n = 112)	After ERAS (n = 89)	P-value	Before ERAS (n = 164)	After ERAS (n = 89)	P-value	Before ERAS (n = 464)	After ERAS (n = 267)	P-value
Total LOS (day)	12.06 ± 6.67	10.02 ± 5.43	0.01*	16.46 ± 9.83	14.53 ± 6.9	0.12	19.86 ± 11.38	16.85 ± 10.45	0.04*	15.90 ± 9.91	13.7 ± 8.31	0.002*
Postoperative LOS (day)	6.25 ± 4.31	5.10 ± 4.81	0.04*	9.42 ± 7.25	5.98 ± 3.86	0.001*	8.63 ± 5.27	6.53 ± 0.71	0.001*	7.86 ± 5.63	5.82 ± 4.36	0.001*
Overall morbidity	6 (3.2)	27 (30.3)	0.001*	9 (8.0)	21 (23.6)	0.003*	9 (5.5)	30 (33.7)	0.001*	24 (5.2)	78 (29.2)	<0.001*
Reoperation	6 (3.2)	4 (4.5)	0.73	9 (8.0)	6 (6.7)	0.079	9 (5.5)	10 (11.2)	0.01*	24 (5.2)	20 (7.5)	0.20
Mortality	0 (0)	0 (0)	>0.99	1 (0.9)	0 (0)	>0.99	1 (0.6)	1 (1.1)	>0.99	2 (0.4)	1 (0.4)	>0.99

Values are presented as mean ± standard deviation or number (%).

ERAS, Enhanced Recovery After Surgery; LOS, length of stay.

\*P < 0.05.

of medium-term sequelae of conventional postoperative care, and reduction of hospital stay leading to a decrease in the cost of hospitalization [18]. Applying these principles to clinical practice, meta-analyses by Varadhan et al. [24] and Zhuang et al. [26] have demonstrated that the use of an ERAS protocol versus conventional perioperative care among colorectal patients has reduced hospital LOS, without resulting in differences in complication, re-admission, and mortality rates.

The utility of clinical pathways results in standardization of patient care, reduction of hospital LOS, more judicious allocation of resources, and decreased costs without compromising outcome. Compared to conventional practice, which is largely a conundrum of handed-down practices supported by experiential substantiation, the processes involved in a clinical pathway present a more logical, holistic, and evidence-based practice. Evidence of an effective and beneficial clinical pathway process may allow for not only improved patient outcomes, but improved delivery of limited health services as well—a concern that is very much felt in our setting. The Division of Colorectal Surgery handles 1,436 admissions per year with a limited capacity of 14 elective beds [28]. The decreased LOS that can be gained by following the ERAS pathway provides a safe and faster turn-over rate to help our unit cater to more patients and increase our efficiency, particularly in cancer care.

A source of apprehension in implementing ERAS and facilitating earlier patient discharge, particularly for patients who have complications that may have only appeared after they have been sent home, is the potential for readmission. Delaney et al. [33] demonstrated that patients with high levels of comorbidity who underwent complex colorectal surgery have benefited from an ERAS program, with rapid recovery and early discharge with low complication and readmission rates.

In our study, the majority of the patients enrolled under the ERAS protocol were with significant comorbidities and underwent major abdominal and pelvic resections. All patients enrolled

in our study were well-informed by a nurse navigator of symptoms that should alert them to seek immediate medical consult, prior to their discharge. Medical care is made accessible to the patient and the caregiver such that in the event that a complication or morbidity is suspected, they can easily contact the nurse navigator and an immediate consult is scheduled for prompt patient assessment by the surgical team. Our results showed a complication rate of 29.2%, a readmission rate of 10.9%, and a reoperation rate of 7.5% (Table 5).

Better outcomes were also observed with better compliance to the ERAS protocol [34, 35]. Our study showed that there was an associated decrease in morbidity rates across all types of surgery as compliance to the different ERAS elements increased (Table 3). Patients that were ≥90% adherent to ERAS were less likely to have morbidity. Looking at the compliance of each individual ERAS component (Table 4), the authors believe that had the most important components that have the most impact on outcomes were compliance to standard anesthetic protocol, drainage of peritoneal cavity, and preoperative fluid management.

The implementation of an ERAS protocol has been repeatedly cited in the literature to reduce hospital stay [36-39]. In this study, the mean hospital LOS after ERAS implementation (total LOS, 13.7 ± 8.3 days) was higher compared to the ones reported in the literature by Miller et al. [40] (4.6 ± 3.6 days) and Thiele et al. [41] (6 ± 4.2 days). A primary reason is the patient's need for admission for supervised implementation of a nutritional plan as many of our patients are in a state of malnutrition on initial presentation. Also, our patients cannot afford nutritional supplements at home, but they can get them for free if they are admitted. This is especially true for patients undergoing CRs. The longer hospital stay may be further explained by certain inefficiencies inherent to our system. Our hospital does not offer a same-day admission and operation. The patients are required to be admitted one to 2 days prior to surgery before they can be scheduled in the operat-

**Table 6.** Details of morbidities before and after ERAS pathway implementation (University of the Philippines-Philippine General Hospital in 2015–2018)

Morbidity	Stoma reversal		Colon resection		Rectal resection	
	No. of cases	CD classification	No. of cases	CD classification	No. of cases	CD classification
Before ERAS						
Anastomotic leak	6	III	6	III	8	III
Stricture					1	III
After ERAS						
Ileus	15	I–II	10	I–II	15	I–II
Anastomotic leak	4	III	5	III	3	III
Urinary retention	2	II	1	II	3	II
UTI	1	II				
Pneumonia	1	II				
SSSI	2	I				
Dehydration	1	I				
Diarrhea	1	I	1	I		
Stoma torsion			1	III		
Port site hematoma			1	I		
Seroma			1	I		
Delusion			1	I		
Pelvic abscess					3	III
Coloanal dehiscence					3	III
Skin dehiscence					1	III
					1	I

ERAS, Enhanced Recovery After Surgery; CD, Clavien-Dindo; UTI, urinary tract infection; SSSI, superficial surgical site infection.

ing room. There is also the problem of limited slots in the operating room schedule. There are situations where a patient's scheduled surgery may be deferred if the early morning cases were extended beyond the allotted time.

On the other hand, the postoperative LOS seems to be improved. The patients after ERAS implementation had a mean postoperative LOS of  $5.8 \pm 4.4$  days. This is slightly higher compared to 4.1 days reported by Sarin et al. [42], and almost similar to  $5.66 \pm 4.8$  days reported by Wahl et al. [43].

Comparing hospital LOS between the 2 time periods (before ERAS vs. after ERAS implementation), it was noted that the overall hospital stay was significantly reduced after ERAS implementation ( $15.9 \pm 9.9$  days vs.  $13.7 \pm 8.3$  days,  $P = 0.002$ ). The postoperative LOS was also significantly reduced ( $7.9 \pm 5.6$  days vs.  $5.8 \pm 4.4$  days,  $P < 0.001$ ) and was also observed across all types of surgery (SR: 6.25 days vs. 5.10 days,  $P = 0.04$ ; CR: 9.42 days vs. 5.98 days,  $P < 0.001$ ; RR: 8.63 days vs. 6.53 days,  $P = 0.001$ ). This finding is proof that, at least in our institution, ERAS implementation had a significant impact in terms of hospital LOS. A shorter hospital LOS, theoretically, translates to a faster turnaround time for managing patients by the hospital's colorectal unit.

It was also widely demonstrated in the literature that implemen-

tation of ERAS decreased complications after colorectal surgery [24]. This was also confirmed with a meta-analysis as reported by Greco et al. [44]. In our study, overall complications increased after ERAS implementation as compared to our data before ERAS. This is because the ERAS pathway provided a platform for caregivers to be more vigilant in detecting surgical morbidities. As part of the protocol, patients enrolled in the ERAS pathway have a checklist that was filled out by the different members of the ERAS team before, during, and after operation. Moreover, an ERAS nurse navigator is in constant communication with the patients even after the patients are discharged from the hospital. Strict adherence to this protocol led to an increased reporting of complications. In comparison with the records before ERAS, it was noted that during ERAS implementation, the documentation of surgical morbidities dramatically improved. Table 6 shows a summary of how morbidities were reported before and after ERAS.

Even with increased morbidity noted after ERAS, comparison of the reoperation rate before and after ERAS was noted to be similar (5.2% vs. 7.5%,  $P = 0.20$ ). The mortality rate was also similar (0.4% vs. 0.4%,  $P > 0.99$ ) (Table 5). In addition, before the ERAS was implemented, the data on patient readmission was not reported. With the ERAS pathway in place, we were able to docu-

ment our readmission rates at 10.86%, which was only slightly higher (vs. 9.2%) than that reported in the literature [45].

In conclusion, increased compliance to ERAS protocol is associated with a decrease in morbidity across all surgery types. The implementation of an ERAS protocol significantly decreased mean hospital LOS, without any increase in major surgical complications. Having your own hospital ERAS pathway improves documentation and accuracy of reporting surgical complications.

## CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

## FUNDING

None.

## SUPPLEMENTARY MATERIALS

Supplementary materials for this study are presented online (available at <https://doi.org/10.3393/ac.2020.09.02>).

## REFERENCES

1. Mythen MG, Swart M, Acheson N, Crawford R, Jones K, Kuper M, et al. Perioperative fluid management: consensus statement from the enhanced recovery partnership. *Perioper Med (Lond)* 2012;1:2.
2. Hoffmann H, Kettelhack C. Fast-track surgery: conditions and challenges in postsurgical treatment: a review of elements of translational research in enhanced recovery after surgery. *Eur Surg Res* 2012;49:24-34.
3. Pande RU, Nader ND, Donias HW, D'Ancona G, Karamanoukian HL. Review: fast-tracking cardiac surgery. *Heart Surg Forum* 2003;6:244-8.
4. Cerfolio RJ, Bryant AS, Bass CS, Alexander JR, Bartolucci AA. Fast tracking after Ivor Lewis esophagogastrectomy. *Chest* 2004;126:1187-94.
5. Koval KJ, Chen AL, Aharonoff GB, Egol KA, Zuckerman JD. Clinical pathway for hip fractures in the elderly: the Hospital for Joint Diseases experience. *Clin Orthop Relat Res* 2004;(425):72-81.
6. Rigberg DA, Dorafshar A, Sridhar A, Quinones-Baldrich W, Moore WS. Abdominal aortic aneurysm: stent graft vs clinical pathway for direct retroperitoneal repair. *Arch Surg* 2004;139:941-6.
7. Chang SS, Cole E, Smith JA Jr, Baumgartner R, Wells N, Cookson MS. Safely reducing length of stay after open radical retropubic prostatectomy under the guidance of a clinical care pathway. *Cancer* 2005;104:747-51.
8. Soria V, Pellicer E, Flores B, Carrasco M, Candel Maria F, Aguayo JL. Evaluation of the clinical pathway for laparoscopic cholecystectomy. *Am Surg* 2005;71:40-5.
9. Andtbacka RH, Babiera G, Singletary SE, Hunt KK, Meric-Bernstam F, Feig BW, et al. Incidence and prevention of venous thromboembolism in patients undergoing breast cancer surgery and treated according to clinical pathways. *Ann Surg* 2006;243:96-101.
10. Antevil JL, Rivera L, Langenberg BJ, Hahm G, Favata MA, Brown CV. Computed tomography-based clinical diagnostic pathway for acute appendicitis: prospective validation. *J Am Coll Surg* 2006;203:849-56.
11. Madan AK, Speck KE, Ternovits CA, Tichansky DS. Outcome of a clinical pathway for discharge within 48 hours after laparoscopic gastric bypass. *Am J Surg* 2006;192:399-402.
12. Salinas FV, Liu SS, Mulroy MF. The effect of single-injection femoral nerve block versus continuous femoral nerve block after total knee arthroplasty on hospital length of stay and long-term functional recovery within an established clinical pathway. *Anesth Analg* 2006;102:1234-9.
13. Ho DM, Huo MH. Are critical pathways and implant standardization programs effective in reducing costs in total knee replacement operations? *J Am Coll Surg* 2007;205:97-100.
14. Kennedy EP, Rosato EL, Sauter PK, Rosenberg LM, Doria C, Marino IR, et al. Initiation of a critical pathway for pancreaticoduodenectomy at an academic institution: the first step in multidisciplinary team building. *J Am Coll Surg* 2007;204:917-24.
15. Clarke T, Sohn H, Kelso R, Petrosyan M, Towfigh S, Mason R. Planned early discharge-elective surgical readmission pathway for patients with gallstone pancreatitis. *Arch Surg* 2008;143:901-6.
16. Chase DM, Lopez S, Nguyen C, Pugmire GA, Monk BJ. A clinical pathway for postoperative management and early patient discharge: does it work in gynecologic oncology? *Am J Obstet Gynecol* 2008;199:541.
17. Basse L, Jacobsen DH, Billesbølle P, Kehlet H. Colostomy closure after Hartmann's procedure with fast-track rehabilitation. *Dis Colon Rectum* 2002;45:1661-4.
18. Fearon KC, Ljungqvist O, Von Meyenfeldt M, Revhaug A, Dejong CH, Lassen K, et al. Enhanced recovery after surgery: a consensus review of clinical care for patients undergoing colonic resection. *Clin Nutr* 2005;24:466-77.
19. Kremer M, Ulrich A, Büchler MW, Uhl W. Fast-track surgery: the Heidelberg experience. *Recent Results Cancer Res* 2005;165:14-20.
20. 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;245:867-72.
21. Joh YG, Lindsetmo RO, Stulberg J, Obias V, Champagne B, Delaney CP. Standardized postoperative pathway: accelerating recovery after ileostomy closure. *Dis Colon Rectum* 2008;51:1786-9.
22. Ludwig K, Enker WE, Delaney CP, Wolff BG, Du W, Fort JG, et al. Gastrointestinal tract recovery in patients undergoing bowel

- resection: results of a randomized trial of alvimopan and placebo with a standardized accelerated postoperative care pathway. *Arch Surg* 2008;143:1098-105.
23. Zargar-Shoshtari K, Connolly AB, Israel LH, Hill AG. Fast-track surgery may reduce complications following major colonic surgery. *Dis Colon Rectum* 2008;51:1633-40.
  24. Varadhan KK, Neal KR, Dejong CH, Fearon KC, Ljungqvist O, Lobo DN. The enhanced recovery after surgery (ERAS) pathway for patients undergoing major elective open colorectal surgery: a meta-analysis of randomized controlled trials. *Clin Nutr* 2010;29:434-40.
  25. Spanjersberg WR, Reurings J, Keus F, van Laarhoven CJ. Fast track surgery versus conventional recovery strategies for colorectal surgery. *Cochrane Database Syst Rev* 2011;(2):CD007635.
  26. Zhuang CL, Ye XZ, Zhang XD, Chen BC, Yu Z. Enhanced recovery after surgery programs versus traditional care for colorectal surgery: a meta-analysis of randomized controlled trials. *Dis Colon Rectum* 2013;56:667-78.
  27. Department of Surgery, University of the Philippines-Philippine General Hospital (UP-PGH). ISIS: Integrated Surgical Information System [Internet]. Manila: UP-PGH; c2006 [cited 2020 May 16]. Available from: <https://isis2.upm.edu.ph/isis/users/login>.
  28. Division of Colorectal Surgery, Department of Surgery, University of the Philippines-Philippine General Hospital (UP-PGH). Annual report 2018. Manila: UP-PGH; 2019.
  29. Gustafsson UO, Scott MJ, Schwenk W, Demartines N, Roulin D, Francis N, et al. Guidelines for perioperative care in elective colonic surgery: Enhanced Recovery After Surgery (ERAS<sup>®</sup>) Society recommendations. *World J Surg* 2013;37:259-84.
  30. 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<sup>®</sup>) Society recommendations. *World J Surg* 2013;37:285-305.
  31. Napolitano LM. Standardization of perioperative management: clinical pathways. *Surg Clin North Am* 2005;85:1321-7.
  32. Ljungqvist O, Scott M, Fearon KC. Enhanced recovery after surgery: a review. *JAMA Surg* 2017;152:292-8.
  33. Delaney CP, Fazio VW, Senagore AJ, Robinson B, Halverson AL, Remzi FH. 'Fast track' postoperative management protocol for patients with high co-morbidity undergoing complex abdominal and pelvic colorectal surgery. *Br J Surg* 2001;88:1533-8.
  34. Gustafsson UO, Hausel J, Thorell A, Ljungqvist O, Soop M, Nygren J, et al. Adherence to the enhanced recovery after surgery protocol and outcomes after colorectal cancer surgery. *Arch Surg* 2011;146:571-7.
  35. Gustafsson UO, Opperstrup H, Thorell A, Nygren J, Ljungqvist O. Adherence to the ERAS protocol is associated with 5-year survival after colorectal cancer surgery: a retrospective cohort study. *World J Surg* 2016;40:1741-7.
  36. Carmichael JC, Keller DS, Baldini G, Bordeianou L, Weiss E, Lee L, et al. Clinical practice guidelines for enhanced recovery after colon and rectal surgery from the American Society of Colon and Rectal Surgeons and Society of American Gastrointestinal and Endoscopic Surgeons. *Dis Colon Rectum* 2017;60:761-84.
  37. Braga M, Pecorelli N, Scatizzi M, Borghi F, Missana G, Radrizzani D, et al. Enhanced recovery program in high-risk patients undergoing colorectal surgery: results from the PeriOperative Italian Society Registry. *World J Surg* 2017;41:860-7.
  38. Forsmo HM, Pfeffer F, Rasdal A, Østgaard G, Mohn AC, Körner H, et al. Compliance with enhanced recovery after surgery criteria and preoperative and postoperative counselling reduces length of hospital stay in colorectal surgery: results of a randomized controlled trial. *Colorectal Dis* 2016;18:603-11.
  39. Nelson G, Kiyang LN, Crumley ET, Chuck A, Nguyen T, Faris P, et al. Implementation of Enhanced Recovery After Surgery (ERAS) across a provincial healthcare system: the ERAS Alberta colorectal surgery experience. *World J Surg* 2016;40:1092-103.
  40. Miller TE, Thacker JK, White WD, Mantyh C, Migaly J, Jin J, et al. Reduced length of hospital stay in colorectal surgery after implementation of an enhanced recovery protocol. *Anesth Analg* 2014;118:1052-61.
  41. Thiele RH, Rea KM, Turrentine FE, Friel CM, Hassinger TE, McMurry TL, et al. Standardization of care: impact of an enhanced recovery protocol on length of stay, complications, and direct costs after colorectal surgery. *J Am Coll Surg* 2015;220:430-43.
  42. Sarin A, Litonius ES, Naidu R, Yost CS, Varma MG, Chen LL. Successful implementation of an Enhanced Recovery After Surgery program shortens length of stay and improves postoperative pain, and bowel and bladder function after colorectal surgery. *BMC Anesthesiol* 2016;16:55.
  43. Wahl TS, Goss LE, Morris MS, Gullick AA, Richman JS, Kennedy GD, et al. Enhanced Recovery After Surgery (ERAS) eliminates racial disparities in postoperative length of stay after colorectal surgery. *Ann Surg* 2018;268:1026-35.
  44. Greco M, Capretti G, Beretta L, Gemma M, Pecorelli N, Braga M. Enhanced recovery program in colorectal surgery: a meta-analysis of randomized controlled trials. *World J Surg* 2014;38:1531-41.
  45. ERAS Compliance Group. The impact of enhanced recovery protocol compliance on elective colorectal cancer resection: results from an international registry. *Ann Surg* 2015;261:1153-9.

ERAS elements	PGH-ERAS modification
1. Pre-operative information, education and counseling	Routine dedicated preoperative counseling
2. Pre-operative optimization	Pre-operative optimization of medical conditions Smoking and alcohol consumption should be stopped 4 weeks before surgery Preoperative specialized nutritional support should be considered for malnourished patients.
3. Pre-operative bowel preparation	Stoma closure: No mechanical bowel prep Colonic surgery: One dose fleet enema for left colonic resection, rest none Rectal surgery: Two doses of fleet enema (12 hours and 3 hours prior to surgery) Laparoscopic surgery (colon and rectal): Full MBP (oral Ciprofloxacin and Metronidazole 1 day prior to surgery, 2 doses of Castor oil, 1 dose of fleet enema)
4. Pre-operative fasting and carbohydrate (CHO) treatment	Full diet until 6 hours prior to surgery, clear liquids until 2 hours prior, NPO 2 hours prior A modified CHO drink concocted by the PGH-Dietary service (see Guidelines, Appendix C) 250 ml will be given while the patient is on clear liquids 4 hours and 2 hours prior to the procedure.
5. Pre-anesthetic medication	Pre-anesthetic medications in the form of short acting sedatives are not used routinely but may be given if the primary anesthesiologist deems that the patient may benefit from anxiolysis prior to the operation.
6. Prophylaxis against thromboembolism	Well-fitting compression stockings Intermittent pneumatic compression For pharmacological prophylaxis with LMWH, given only to high risk patients based on the ACCP guidelines for prevention of VTE in Nonorthopedic Surgical Patients <sup>34</sup>
7. Antimicrobial prophylaxis and skin preparation	Philippine College of Surgeons (PCS)-recommended monotherapeutic agents are given as prophylactic antibiotics 30 minutes to 1 hour prior to cutting at the OR. Additional doses given according to half-life of the drug and duration of surgery. Povidone-iodine (most of the time) or chlorhexidine-alcohol depending on what is available
8. Standard anesthetic protocol	Open surgery: Epidural anesthesia for stoma closure peristomal approach Open surgery: Combined general and epidural anesthesia for stoma closure midline approach, colonic surgery, and rectal surgery Laparoscopic surgery: Combined general and epidural anesthesia for colonic surgery and rectal surgery
9. Post operative nausea and vomiting (PONV)	Antiemetic given intraoperatively (either Metoclopramide, Ondansetron, or Dexamethasone) Postoperatively, Metoclopramide given as needed once PONV is present
10. Laparoscopy and modifications of surgical access	Laparoscopic surgery advocated for all patients that could feasibly and safely undergo the procedure
11. Nasogastric intubation	Postoperative nasogastric tubes should not be used routinely. Nasogastric tubes inserted during surgery should be removed before reversal of anaesthesia.
12. Preventing intra-operative hypothermia	Intraoperatively, the anesthesiologist ensures normothermia by maintaining a core body temperature of 37-38C using a suitable warming blanket or mattress, use of warming fluids for infusion and intraoperative washing, and regulating the ambient temperature of the operating room. Intraoperative temperature monitoring is done continuously using a nasopharyngeal temperature probe for patients under general anesthesia. While for patients purely under epidural anesthesia, intraoperative temperature monitoring is done using an ear/forehead temperature probe hourly. This is continued at the post anesthesia care unit (PACU).
13. Perioperative fluid management	Perioperative fluid management is done as follows: intravenous fluids, ideally, a balanced crystalloid such as Sterofundin, is initiated 1 hour prior to operation at maintenance rate following the Holliday Segar formula (4cc/kg/hr for the first 10 kg, 2cc/kg/hr for the second 10 kg and 1 cc/kg/hr for each kilo beyond the first 20kg). Vasopressors should be considered for intra- and postoperative management of epidural-induced hypotension provided the patient is normovolaemic. The enteral route for fluid postoperatively should be used as early as possible, and intravenous fluids should be discontinued as soon as is practicable.
14. Drainage of peritoneal cavity	Drainage not routine after closure of stoma and colonic surgery Drain placed routinely after low rectal surgery (Low anterior resection, Abdomino-transanal resection, Abdominoperineal resection)
15. Urinary drainage	For colonic surgery, foley catheter removed on the first day postoperatively unless with contraindications For rectal surgery, foley catheter removed on the second day postoperatively unless with contraindications For both colonic and rectal surgery, the bladder catheter can be removed regardless of the usage or duration of thoracic epidural analgesia.
16. Preventing post-operative ileus	Multimodal approach Mid-thoracic epidural analgesia and laparoscopic surgery should be utilized if possible. Fluid overload and nasogastric decompression should be avoided. Use of chewing gum (sugar-free) TID while the patient is still on liquids Laxatives and prokinetics not advocated (low evidence, not readily available, added cost)
17. Post-operative analgesia	During skin closure, the wound is infiltrated routinely with 0.25% Bupivacaine. A multimodal approach to managing post-operative pain is used utilizing Paracetamol and Non steroidal anti-inflammatory drugs (NSAIDs) with the aim of minimizing opioid use. VAS score monitoring begins immediately post op then every 12 hours up to 48 hours post op. Rescue pain medications are given for VAS score of 4/10 and above.
18. Early oral intake	After surgery, if without contraindications to diet progression: Clear liquids once patient is back in the wards hours after surgery General liquids to soft diet on the first postoperative day Full diet on the second post operative day
19. Perioperative nutritional care	Patients screened for nutritional status and if at risk of under-nutrition given active nutritional support. Perioperative fasting minimized. Postoperatively patients should be encouraged to take fluids or soft diet as soon as lucid after surgery. Oral nutritional supplements (ONS) used to supplement total intake.
20. Post-operative glucose control	Based on institutional practice : NON-DIABETIC: no need for CBG monitoring except for prolonged NPO which is not the case in the ERAS program. DIABETIC: CBG monitoring Q4, with Endocrine service is on board CBG <160 = no insulin; CBG 160-200 = 4u Humulin R SC; CBG 200-300 = 6-10u Humulin R SC; CBG 300-400 = 10-14u Humulin R SC; CBG > 400 = call Endocrinologist on board
21. Early mobilization	Early mobilization is encouraged in the following manner: patients may sit up for 3-6 hours, as tolerated, on the first post-operative day. A physical therapist may begin conditioning exercises. On the second post-operative day, the patients are encouraged to ambulate up to 6 hours, as tolerated. During the patient's remaining hospitalization days, 6 hours of ambulation is encouraged daily.

Supplementary Fig. 1. Philippine General Hospital-Enhanced Recovery After Surgery (PGH-ERAS) modifications used in the study.