Postoperative ERAS Interventions Have the Greatest Impact on Optimal Recovery

Experience With Implementation of ERAS Across Multiple Hospitals

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Background: Enhanced recovery after surgery (ERAS) programs incorporate evidence-based practices to minimize perioperative stress, gut dysfunction, and promote early recovery. However, it is unknown which components have the greatest impact.

Objective: This study aims to determine which components of ERAS programs have the largest impact on recovery for patients undergoing colorectal surgery.

Methods: An iERAS program was implemented in 15 academic hospitals. Data were collected prospectively. Patients were considered compliant if >75% of the preoperative, intraoperative, and postoperative predefined interventions were adhered to. Optimal recovery was defined as discharge within 5 days of surgery with no major complications, no readmission to hospital, and no mortality. Multivariable analysis was used to model the impact of compliance and technique on optimal recovery.

Results: Overall, 2876 patients were enrolled. Colon resections were performed in 64.7% of patients and 52.9% had a laparoscopic procedure. Only 20.1% of patients were compliant with all phases of the pathway. The poorest compliance rate was for postoperative interventions (40.3%) which was independently associated with an increase in optimal recovery (RR = 2.12, 95% CI 1.81–2.47). Compliance with ERAS interventions remained associated with improved outcomes whether surgery was performed laparoscopically (RR = 1.55, 95% CI 1.23–1.96) or open (RR = 2.29, 95% CI 1.68–3.13). However, the impact of ERAS compliance was significantly greater in the open group ($P < 0.001$).

Conclusions: Postoperative compliance is the most difficult to achieve but is most strongly associated with optimal recovery. Although our data support that ERAS has more effect in patients undergoing open surgery, it also showed a significant impact on patients treated with a laparoscopic approach.

Keywords: enhanced recovery, implementation, knowledge translation, outcomes

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Enhanced recovery after surgery (ERAS) programs incorporate evidence-based practices to minimize perioperative stress, gut dysfunction, iatrogenic infections, postoperative pain, and promote early mobilization and recovery.[1] These multimodal care pathways include multiple interventions within the preoperative, intraoperative, and postoperative course of the patient's care journey. Early results from randomized controlled trials of ERAS programs for colorectal surgery patients illustrate a benefit to patients managed in an ERAS program as compared with standard care, with decreased rates of complications, accelerated recovery, and early discharge from hospital. A meta-analysis of 6 trials demonstrated a 52% reduction in 30-day morbidity (0.36–0.73, 95% CI) and a 2.5-day (3.9–1.1 95% CI) decrease in hospital stay.[2]

While ERAS programs have been shown to be effective in improving outcomes, multiple reports have demonstrated that they are very difficult to implement. This is in part due to the fact that several of the components deviate from traditional surgical practice, but also because implementation requires a sustained collaborative effort from members of a multidisciplinary team.[3–6] In addition, there is variability in the ERAS components adopted by programs and recommended in guidelines. Finally, there remains a question of whether there is additional benefit of ERAS for patients undergoing a laparoscopic approach.[7]

The purpose of this paper is to assess whether compliance with various components of an ERAS program improves the recovery of patients undergoing colorectal surgery. Second, this paper examines the relative benefits of ERAS interventions on patients undergoing laparoscopic surgery versus open surgery.

METHODS

Guideline and Knowledge Translation Strategy

Our group has previously reported on the process of developing an ERAS program and its implementation in our member hospitals.[8] The iERAS guideline is based on best evidence and was created through a consensus process of stakeholders including anesthesiologists, general surgeons, surgical residents, nurses, physiotherapists, dieticians and hospital administrators under the auspices of the Best Practice in General Surgery program at the University of Toronto. The guideline is divided into preoperative, intraoperative, and postoperative interventions and is intended to be prescriptive, easy to follow, without the requirement of additional hospital resources. Please refer to www.bestpracticeinsurgery.ca for all guideline recommendations and supporting evidence. Implementation of the guideline was a multipronged knowledge translation (KT) strategy and involved a multidisciplinary team of champions from each participating hospital site. Briefly, the strategy included education of patients and caregivers with written materials and videos, engagement of all members of the care team including residents, nursing, anesthetists, surgeons via educational rounds and workshops, sharing of standardized order sets between sites along with regular surgical nurse educator teleconferences. Contingency plans were also established for early short-term complications such as ileus and urinary retention. Audit and feedback of individual hospital's compliance was a regular part of the process.

Patients

After education and dissemination of the guideline, this prospective cohort study enrolled consecutive consenting patients from 15 academic hospitals across the province of Ontario, Canada between September 2012 and April 2015. Patients were eligible for the study if they were undergoing elective colorectal surgery, and were 18 years of age or older. Patients were excluded if they underwent multivisceral resections, ileostomy construction or reversal without bowel resection, or exclusively small bowel surgery.

Outcomes and Definitions

Data regarding baseline demographics, compliance with ERAS process variables and outcomes including complications within 30 days of surgery, length of stay, mortality, and postoperative readmissions were collected prospectively. All the patients kept a log while in hospital of their activity, oral intake, and pain scores. This log was completed daily and was collected by a dedicated study data collection person at each site. Patients were also contacted at 30 days following hospital discharge to collect data regarding emergency and hospital readmissions, along with postdischarge complications.

Compliance with ERAS variables was measured for each component of the program and the definition of compliance was defined a priori. The patient's care was considered compliant with the preoperative, intraoperative, or postoperative care pathways if 75% (any 3 out of 4) of the measured ERAS recommendations within that care pathway as outlined in Table 1 were met. This definition of compliance allowed for "real world" variation between patients, accepting that all components may not be appropriate or achievable for all patients. Overall compliance with the ERAS program was defined as meeting the definition of compliance in each of the 3 care pathways.

Length of stay was defined as the number of days patients stayed in hospital following their primary surgery. Readmissions were defined as any readmission to a patient care ward (surgical or medical ward or intensive care unit) within a hospital within the first 30 days of operation. Complications were defined as any complication occurring within the first 30 days following surgery and were stratified using the Clavien Dindo score.[9] Major complications were complications requiring an invasive procedure, surgery, intensive care unit admission, or resulting in death (Clavien Dindo score 3–5). Anastomotic leak was defined as a leak determined on imaging or at reoperation. Optimal recovery postsurgery was defined as discharge within 5 days of surgery with no major complication, no anastomotic leak, no readmission to hospital, and no death within 30-days postsurgery.

This research was funded by a grant from the Council of Academic Hospitals of Ontario. The research ethics board approved the study protocol at each participating hospital and patient consent was obtained to collect data prospectively.

Analysis

Data were compiled by hospital for the entire patient cohort. Data were summarized using means and standard deviations for continuous factors and frequencies and proportions for categorical factors. Comparisons of continuous factors across levels of compliance were conducted using design-adjusted independent samples *t* tests to account for the clustering of patients within sites. Similarly, comparisons of categorical factors across levels of compliance or levels of recovery were conducted using design-adjusted chi-squared tests for association. Multivariable log-binomial generalized estimating equations were used to model optimal recovery onto compliance, adjusting for patient, and disease-related characteristics. Relative risks and 95% confidence intervals were reported to demonstrate differences between patients with compliant courses with those whose operative experience was not compliant with ERAS guidelines. The independent impact of compliance with preoperative, intraoperative, and postoperative phases of care was evaluated in separate models, and was also stratified by operative approach (eg, laparoscopic vs open approaches). All models were adjusted for patients clustered within site (hospital) and used an exchangeable covariance matrix.

RESULTS

Data were collected on 2876 patients, of whom 52.2% were male, 64.7% underwent a colon resection, and 52.9% had a laparoscopic procedure (Table 2). In this cohort of patients, 38.7% (n = 1111)

TABLE 1. Indicators Used to Assess Compliance* With iERAS Guidelines

Care Pathways†	Measured ERAS Recommendation
Preoperative	Patient received patient education booklet. Patient had counseling regarding expected length of stay. Reduced preoperative fasting: high carbohydrate clear fluids until 2 h prior to surgery. Appropriate mechanical bowel prep—fleet enema for left-sided resections, oral bowel prep for low anterior resections, and no prep for right-sided resections.
Intraoperative	Oral analgesic prior to surgery with acetaminophen and/or gabapentin. Use of fluid monitor intraoperatively.‡ Avoidance of abdominal drains and NG tubes Thoracic epidural analgesia for open surgeries or lidocaine infusion for laparoscopic or when an epidural could not be performed.
Postoperative	Early mobilization—dangling day of surgery, walking POD1. Early enteral feeding—clear fluids day of surgery, offered solids POD1. Chewing gum 3×/d on POD1. Avoidance or early removal of Foley catheters (removed by POD1 for colon, and by POD3 for rectal surgery).

*Compliance was defined as adherence to any 3 out of 4 recommendations within each care pathway. Overall compliance was defined as achieving compliance with all 3 care pathways.

†It should be noted that separate guidelines for the prevention of surgical site infection and venous thromboembolism were included in the ERAS protocol; however, they were not included in this analysis.

‡Goal-directed fluid therapy was emphasized and outlined in the guideline.

POD1 indicates postoperative day 1; POD3, postoperative day 3.

TABLE 2. Patient Characteristics

	Overall n = 2867	ERAS Compliant n = 578	ERAS Noncompliant n = 2289	*P* Value
Age in years, mean (SD)	60.31 (15.94)	60.14 (16.15)	61.01 (15.05)	0.24
Under 65	1626 (56.5)	322 (19.8)	1304 (80.2)	0.41
65–79	949 (33.0)	202 (21.3)	747 (78.7)	
80 and older	301 (10.5)	54 (17.9)	247 (82.1)	
Sex, n (%)				0.97
Male	1501 (52.2)	302 (20.1)	1199 (79.9)	
Female	1375 (47.8)	276 (20.1)	1099 (79.9)	
BMI, mean (SD)	27.23 (5.70)	27.30 (5.13)	27.21 (5.83)	0.74
<18.5	85 (3.0)	12 (14.1)	73 (85.9)	0.18
18.5–24.9	987 (34.3)	191 (19.4)	796 (80.7)	
25.0–29.9	1052 (36.6)	220 (20.9)	832 (79.1)	
30.0–34.9	496 (17.3)	112 (22.6)	384 (77.4)	
35.0 and greater	256 (8.9)	43 (16.8)	213 (83.2)	
Anemia*				0.049
Yes	989 (34.9)	179 (18.1)	810 (81.3)	
No	1849 (65.2)	392 (21.2)	1457 (78.8)	
Diagnosis, n (%)				<0.001
Cancer	1961 (68.2)	439 (22.4)	1522 (77.6)	
Diverticular		48 (19.3)	201 (80.7)	
IBD	512 (17.8)	79 (15.4)	433 (84.6)	
Other	403 (14.0)	12 (7.8)	142 (92.2)	
Surgery location, n (%)				0.006
Colon	1862 (64.7)	346 (18.6)	1516 (81.4)	
Rectum	1014 (35.3)	232 (22.9)	782 (77.1)	
Type of surgery, n (%)				<0.001
Lap	1520 (52.9)	402 (26.5)	1118 (73.6)	
Converted	271 (9.4)	38 (14.0)	233 (86.0)	
Open	1085 (37.7)	138 (12.7)	947 (87.3)	
Stoma, n (%)				<0.001
Yes	656 (22.8)	104 (15.9)	552 (84.2)	
No	2220 (77.2)	474 (21.4)	1746 (78.7)	
ASA score				0.025
1	41 (1.4)	9 (22.0)	32 (78.1)	
2	841 (29.2)	181 (21.5)	660 (78.5)	
3	1675 (58.2)	345 (20.6)	1330 (79.4)	
4	265 (9.2)	33 (12.5)	232 (87.6)	
NR	54 (1.9)	10 (18.5)	44 (81.5)	
Creatinine†, n (%)				0.026
Abnormal	237 (9.3)	35 (14.8)	202 (85.2)	
Normal	2312 (90.7)	483 (20.9)	1829 (79.1)	

*Anemia is defined as <120 g/L females; <130 g/L males.
†Abnormal creatinine defined as <50 or >110.
ASA indicates American Society of Anesthesiologists; BMI, body mass index; IBD, inflammatory bowel disease.

developed a minor complication and 8.9% (n = 256) developed a major complication. This included anastomotic leaks in 4.9% (n = 140) cardiac or vascular events in 2.4% (n = 14), and pulmonary events 0.5% (n = 14). There were 15 deaths (0.5%). The median length of stay was 5 days with a range of 1 to 116 days. The 30-day readmission rate was 8.2% (235) of patients. Optimal recovery, as defined in the Methods section, was achieved in 49.7% (1428) of patients.

Adherence to individual ERAS guideline recommendations was quite variable. Half of the guidelines had a 70% or greater compliance rate (Table 3). The most readily adopted guidelines were related to patient counseling within the preoperative care pathway with receipt of the patient education booklet and instruction on expected postoperative course of hospital stay. The poorest uptake was for postoperative recommendations as adherence was approximately 50% for each intervention.

In total, 74.7% of individual patients were managed in compliance with the preoperative care pathway, 56.6% in compliance with the intraoperative care pathway, and only 40.3% in compliance with the postoperative care pathway. Only 20.1% of patients were managed in compliance with all 3 of the care pathways.

Almost all factors of the ERAS pathway were significantly associated with optimal recovery in bivariate analysis (Table 3). In multivariate analysis, when controlling for disease and patient characteristics, the modifiable factors significantly associated with an optimal recovery included use of a laparoscopic approach and overall compliance with ERAS recommendations (Table 4). Other patient and disease factors associated with optimal recovery included having colon surgery instead of rectal surgery, having surgery for cancer compared with inflammatory bowel disease or diverticular disease. Anemia, older age, American Society of Anesthesiologists greater than 2 and creation of a stoma were associated with delayed recovery (Table 4).

When analyzed separately, compliance with the postoperative components of the program had the largest impact on success. Table 5 demonstrates that compliance with postoperative interventions was associated with a 2-fold likelihood for optimal recovery RR = 2.12 (95% CI 1.81–2.47). This effect was independent of

TABLE 3. Compliance Rates With Measured ERAS Recommendations and Bivariate Analysis of Compliance Rates for Patients Who Had an Optimal Versus Delayed Recovery

Care Pathway	ERAS Recommendations	Compliance in Total Cohort n (%)	Compliance in Optimal Recovery Cohort (n = 1428)	Compliance in Delayed Recovery Cohort (n = 1448)	*P* Value
Compliance with each preoperative intervention	Received patient education booklet and counseling	2366 (82.3)	1214 (85.0)	1152 (79.6)	<0.001
	Instructed on length of stay	2415 (84.0)	1252 (87.7)	1163 (80.3)	<0.001
	Consumed fluid carbohydrate rich drink morning of surgery	1783 (62.0)	955 (66.9)	828 (57.2)	<0.001
	Appropriate bowel prep Fleet enema for left-sided resections, oral mechanical bowel prep for low anterior resections	2166 (75.3)	1054 (73.8)	1112 (76.8)	0.063
Compliance with each intraoperative intervention	Administration of acetaminophen and/or gabapentin prior to surgery	2007 (69.8)	1050 (73.5)	957 (66.1)	<0.001
	Use of fluid monitor intraoperatively	769 (26.7)	404 (28.3)	365 (25.2)	0.062
	Avoidance of abdominal drains and nasogastric tubes	2442 (84.9)	1299 (91.0)	1143 (78.9)	<0.001
	Use of Lidocaine infusion and/or Epidural	2182 (75.9)	1065 (74.6)	1117 (77.1)	0.11
Compliance with each postoperative intervention	Early enteral feeding—clear fluids day of surgery, offered solids POD1	1636 (56.9)	956 (67.0)	680 (47.0)	<0.001
	Early ambulation—dangling day of surgery, walking POD1	1367 (47.5)	796 (55.7)	571 (39.4)	<0.001
	Chewing gum 3×/d	1511 (52.5)	866 (60.6)	645 (44.5)	<0.001
	Avoidance and early removal of Foley catheters (POD1 for colon, POD3 for rectal surgery)	1543 (53.7)	880 (61.6)	663 (45.8)	<0.001
Compliance with each phase of care*	Preoperative care pathway	2147 (74.7)	1121 (78.5)	1026 (70.9)	<0.001
	Intraoperative care pathway	1627 (56.6)	866 (60.6)	761 (52.6)	<0.001
	Postoperative care pathway	1160 (40.3)	738 (51.7)	422 (29.1)	<0.001
Overall compliance†	Compliance with all 3 care pathways	578 (20.1)	390 (27.3)	188 (13.0)	<0.001

*Compliance was defined as adherence to 75% (3 out of 4) of these measured recommendations within each care pathway.
†Overall compliance was defined as compliance with all aspects of care.
POD1 indicates postoperative day 1; POD3, postoperative day 3.

whether the procedure was performed using a laparoscopic or open approach. Table 6 evaluates the independent effect of laparoscopic and open technique on optimal recovery while controlling for patient factors and disease factors. Postoperative compliance with ERAS was significantly associated with optimal recovery for patients treated with either a laparoscopic [RR = 1.81 (95% CI 1.48–2.22)] or an open technique, [RR = 2.51 (95% CI 2.01–3.13)] (Table 6). However, the impact of ERAS compliance was significantly greater in the open group ($P = 0.044$).

TABLE 4. Multivariable Regression Examining Overall Impact of ERAS Compliance on Optimal Recovery While Adjusting for Patient and Surgical Factors

	Multivariable (Adjusted) for Optimal Recovery	
	RR (95% CI)	*P* Value
Age	0.99 (0.98–0.99)	<0.001
Male sex	0.80 (0.66–0.98)	0.029
BMI	1.01 (0.99–1.02)	0.22
Abnormal creatinine (yes vs no)	0.83 (0.60–1.15)	0.26
Anemia (yes vs no)	0.71 (0.59–0.85)	<0.001
Diagnosis		
– Cancer	1.00 (Ref)	
– Diverticular disease	0.75 (0.59–0.95)	0.019
– Inflammatory bowel disease	0.70 (0.53–0.91)	0.009
– Other	0.74 (0.49–1.13)	0.16
Procedure (rectal vs colon)	0.61 (0.49–0.75)	<0.001
Approach		
– Laparoscopic	3.14 (2.60–3.78)	<0.001
– Converted	1.02 (0.73–1.44)	0.88
– Open	1.00 (Ref)	–
Stoma (colostomy or ileostomy)	0.59 (0.45–0.77)	<0.001
ASA (Gr. 3 or higher vs Gr 1–2)	0.82 (0.69–0.98)	0.028
Overall compliance with ERAS	1.85 (1.55–2.20)	<0.001

ASA indicates American Society of Anesthesiologists; IBD, inflammatory bowel disease.

DISCUSSION

This is the largest study to date evaluating compliance with ERAS strategies and the impact of adoption on patient outcomes after elective colorectal surgery. Others have demonstrated that compliance with ERAS programs is challenging and variable.[4,5] In this study, overall compliance with the entire program was somewhat lower than previously reported; however, rates and patterns of compliance with preoperative, intraoperative, and postoperative interventions were similar. In this program, there were no added resources for physician or nurse participation, no added funds for fluid monitors or restructuring of hospital wards to facilitate ambulation of patients. Each hospital decided how the guideline would be instituted within their budgetary constraints and local culture. The funding received for this study was used to develop implementation strategies and gather and analyze data for feedback to participating centres. While funding for data collection and reporting are necessary, extra resources for clinical care are not required and thus, it is feasible for hospitals to adopt this quality initiative with multidisciplinary team buy-in and commitment.

Prior to undertaking this initiative, a retrospective baseline audit was completed at 7 of the hospital sites in patients undergoing

TABLE 5. Separate Multivariable Regression Models Evaluating the Independent Impact of Compliance on Optimal Recovery Through Each Aspect of the Care Pathway

Phase of Compliance	RR (95% CI)	*P* Value
Preoperative compliance	1.30 (1.02–1.64)	0.031
Intraoperative compliance	1.14 (0.92–1.41)	0.24
Postoperative compliance	2.12 (1.81–2.47)	<0.001

TABLE 6. Multivariable Regression Models Evaluating the Independent Impact of Compliance on Optimal Recovery Stratified by Approach

Phase of Compliance	Laparoscopic RR (95% CI)	Laparoscopic *P* Value	Open and Converted RR (95% CI)	Open and Converted *P* Value	*P* Value for Interaction Between Approach and Compliance*
Overall ERAS compliance	1.55 (1.23–1.96)	<0.001	2.29 (1.68–3.13)	<0.001	0.044
Preop compliance	1.33 (1.05–1.69)	0.019	1.25 (0.90–1.73)	0.19	0.73
Intraop compliance	1.01 (0.78–1.30)	0.95	1.31 (0.98–1.76)	0.071	0.30
Postop compliance	1.81 (1.48–2.22)	<0.001	2.51 (2.01–3.13)	<0.001	0.011

*The p-value for the interaction is derived from a model that tests whether or not the effect of compliance is significantly different between a model restricted to laparoscopic patients compared to a model restricted to open and converted patients.

colorectal surgery between July1, 2008 and June 30, 2009.[3] Comparing the data from this study to the findings from this initial audit there was a clear increase in compliance with ERAS recommendations with this KT initiative: Preoperative counseling doubled from 41.4% to 82.2%; carbohydrate loading increased from 0% to 62%; appropriate mechanical bowel preparation increased from 32.4% to 75.3%; and use of intraoperative lidocaine or epidurals increased from 21.1% to 75.8%. The fewest gains however were seen with postoperative interventions, clear fluids on the day of surgery only increased slightly from 41.7% to 56.8%; and, early removal of the Foley catheter changed only marginally (51.8%–53.7%).

We had the least success with adoption of the postoperative components, with only a 40% compliance rate. The lowest compliance was with early removal of the urinary catheter. Despite evidence suggesting that early removal decreases urinary tract infections, and does not lead to an increase in urinary retention, regardless of epidurals,[10–12] this behavior was very difficult to change. Several other studies have also demonstrated that early removal of urinary catheters is one of the most difficult parts of the ERAS protocol to implement, with roughly a 50% compliance rate.[4,5,13] In a study examining reasons for noncompliance with ERAS recommendations in colorectal surgery patients, early urinary catheter removal in colorectal surgery patients Roulin et al[13] found that it was the surgeon who was responsible for the break in protocol in 97% of cases as opposed to the nurse, anesthesiologist, or patient.

This is the first study to use the composite score of optimal recovery as the primary outcome to describe what physicians and caregivers are trying to achieve with ERAS; early discharge, with no complications or death and no return to hospital. In this study approximately 50% of patients successfully achieved this goal. Previous reports have used length of stay and complication rates as separate outcomes and do not report readmissions. The strongest predictor of optimal recovery, in multivariable analysis, was compliance with the postoperative care pathway. It could be argued that the relationship between improved patient outcomes and compliance with the postoperative pathway was confounded by early patient complications. Although this may be the case for a small subset of patients, the majority of these postoperative interventions occur within the first 12 to 24 hours of surgery (with the exception of urinary catheter removal for rectal surgery) prior to any manifestation of a definite complication.

Finally, this study clearly demonstrates the beneficial impact of ERAS for all patients undergoing colorectal surgery and reveals that ERAS and laparoscopic surgery independently improve outcomes. Although the overall impact of ERAS is significantly greater in patients undergoing open surgery, compliance with ERAS for laparoscopic patients increases the likelihood of optimal recovery by approximately 1.5 times. A previously published meta-analysis of 9 studies (6 observational and 3 randomized controlled trials) by Spanjersberg et al[7] concluded that there was no added benefit of an ERAS pathway for patients undergoing laparoscopic colorectal surgery. This meta-analysis combined the results of 597 patients treated with a laparoscopic technique, compared with 1520 patients within our study. The combination of an increased sample size and more robust outcome of optimal recovery as opposed to length of stay may have enabled our study to have sufficient power to observe this difference.

In addition to ERAS components, 2 other potential modifiable factors were found to significantly impact patient outcomes on multivariate analysis. These 2 factors were operative technique and preoperative hemoglobin levels. The association of anemia with poor operative outcomes has been documented in other studies of colorectal surgery patients.[14,15] Observational data also suggest that correction of anemia results in a reduction in the need for perioperative blood transfusions,[16] reduced morbidity, and length of hospital stay.[17] A current randomized controlled trial is ongoing to better understand the effect of intravenous iron on perioperative outcomes.[18]

The strengths of this study are that data were collected prospectively, the large sample size, the inclusion of multiple institutions, the breadth of data collected on process elements, and the definition of optimal recovery used to describe patient outcomes. Although it was not a randomized controlled trial, it allows us to understand the impact of an intervention on the process of care and patient outcomes at many different hospital sites in real time. Change is difficult to make, although possible where there is support from all levels of care, including nursing, anesthesia, surgery, trainees, and hospital administration.

There are several limitations to this study. First, patient data were collected only from consenting patients. This limited the number of patients who were enrolled and also may have selected for patients who were more keen or motivated to leave hospital. On the other hand, this process of informed consent ensured the collection of more accurate follow-up data regarding complications and return to hospital visits and more accurate patient process level data regarding ambulation and diet. Third, the first feedback of the data to the centers was delayed and it was not available on a regular basis to complete the true cycle of audit and feedback as part of the KT intervention. Finally, a causal association can only be inferred, as this was an observational study and controlled for only known potential confounding variables.

In summary, with a KT initiative that requires minimal funding but maximal multidisciplinary team participation, ERAS can be adopted across multiple hospital sites. The most difficult elements of the ERAS pathway to implement are the most strongly associated with success for our patients. Moving forward, strategies that emphasize the need for early removal and avoidance of urinary catheters, motivation, and assistance with patient ambulation, and early feeding should be implemented. Strategies should include patients having both open and laparoscopic surgery since ERAS has a benefit in both.

In addition, ERAS protocols must continue to adapt to reflect best evidence as new research develops.

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