

Feasibility of Enhanced Recovery in Emergency Colorectal Operation



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- BACKGROUND:** Emergency colorectal operations account for considerable surgical morbidity, leading to increased recognition of the importance of standardized care. Enhanced recovery pathways (ERPs) have successfully provided a framework to standardize elective surgical care, with some ERP elements spreading to emergency procedures. This study aims to characterize the degree of spread and demonstrate feasibility of ERP extension to emergency colorectal operations.
- STUDY DESIGN:** Patients undergoing colorectal operations were identified from a national ERP collaborative. Adherence to ERP process measures—multimodal pain control, early Foley removal, postoperative venous thromboembolism prophylaxis, early mobilization, early feeding, and 30-day clinical outcomes—was analyzed. Multivariable logistic regression was used to evaluate association between process measure adherence and 30-day clinical outcomes.
- RESULTS:** A total of 31,511 patients underwent colorectal operations at 235 hospitals; 3,086 were emergencies and 28,425 were elective. For emergency cases, rates of early Foley removal (92.0%) and venous thromboembolism prophylaxis (75.7%) were highest. Rates of multimodal pain control (55.9%), early mobilization (37.1%), and early liquid intake (33.4%) were modest. Nonadherence was more common in patients younger than 65 years (43.4%), with independent functional status (94%), American Society of Anesthesiologists Physical Status Classification 1 to 3 (62.5%), and without physiologic derangement (39.9%). Lack of mobilization or liquid intake was independently associated with increased odds of ileus (odds ratio [OR] 1.43; 95% CI, 1.18 to 1.75 and OR 2.41; 95% CI, 1.96 to 2.95) and prolonged length of stay (OR 2.29; 95% CI, 1.85 to 2.83 and OR 2.05; 95% CI, 1.70 to 2.47).
- CONCLUSIONS:** Although the unplanned nature of emergency colorectal operations historically excluded patients from ERPs, our findings suggest ERPs have observable diffusion beyond elective surgical procedures. Deliberate implementation with adherence auditing can improve ERP uptake and outcomes in emergency colorectal operations. (*J Am Coll Surg* 2021;232:178–185. © 2020 by the American College of Surgeons. Published by Elsevier Inc. All rights reserved.)

More than 900,000 patients undergo emergency general surgery procedures every year in the US.¹ Given the unplanned nature of emergency general surgery procedures

and aging of the general population, patients often present for operations with a myriad of comorbid conditions, physiologic derangement, or both. The fallout is a high

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Abbreviations and Acronyms

ASA	= American Society of Anesthesiology
CAUTI	= catheter-associated urinary tract infection
ERP	= enhanced recovery pathway
ISCR	= Improving Surgical Care and Recovery Program
OR	= odds ratio
SSI	= surgical site infection
VTE	= venous thromboembolism

rate of postoperative complications, often upwards of 50%.¹⁻³ In spite of the potential for improved patient outcomes, the nature of unplanned presentations combined with a heterogeneous population and severity of underlying diseases has made systematic quality improvement efforts challenging for emergency general surgery procedures. Local efforts have developed clinical pathways and standardized clinical care for some emergency general surgery patient populations, but there are few reports of sustained and scalable efforts.⁴

Enhanced recovery pathways (ERPs) have been an effective framework for promoting evidence-based perioperative care and reducing unnecessary variation in elective operations, such as colorectal operations. Implementation of ERPs for elective operations has been associated with reduced healthcare use, improved patient outcomes, and enhanced patient experience.⁵⁻¹¹ Most hospitals begin ERP efforts with patients undergoing elective surgical procedures. However, there is often clinician-driven spread to emergency operations, particularly for colorectal

operations.^{4,12} Such diffusion can help us understand the degree to which an ERP can be reproduced for nonelective procedures, and which pathway components hold the greatest opportunity to improve outcomes.

The objectives of this study were to characterize the patient population undergoing emergency colorectal operation cared for postoperatively in a national ERP collaborative targeting elective operations, compare adherence to pathway components for emergency vs elective operations, and describe associations between adherence to individual ERP components and the following complications: surgical site infection (SSI), venous thromboembolism (VTE), unplanned readmission, ileus, catheter-associated urinary tract infection (CAUTI), and prolonged length of stay in patients undergoing emergency colorectal operations.

METHODS

Data source

This retrospective study used the clinical data registry for the Improving Surgical Care and Recovery (ISCR) Program. This national cohort collaborative was launched in 2016 to accelerate ERP adoption in the US by developing resources and implementation support for surgical pathways in colorectal, gynecology, and orthopaedics. This program was designed to function within the framework of the Comprehensive Unit-Based Safety Program (CUSP), an effective model for sustainable safety improvement that has been associated with preventing harm in multiple areas.¹³⁻¹⁹ The collaborative is ongoing and preparing to launch the final pathway for emergency general surgery. So far, more than 300 hospitals across the US have participated in ISCR. Most hospitals are mid-sized community hospitals, although they range from small community to large academic centers.

The ISCR data registry was built on the platform of the NSQIP, a multinational initiative developed by the American College of Surgeons to enable surgical quality improvement using valid, risk-adjusted clinical outcomes data.^{20,21} The ISCR data registry uses the NSQIP platform to collect a parsimonious set of evidence-based process and outcomes measures for ERP implementation.^{22,23} Trained surgical clinical reviewers from each site extract data from the electronic health record for individual surgical cases using standard data definitions. The methodology for selection of surgical cases entered in the ISCR data registry depends on hospital case volume and resources. High-volume hospitals use a standard sampling methodology on an 8-day cycle, and small hospitals usually include all surgical cases for their designated service lines.

Table 1. Enhanced Recovery Protocol Components

Process measure	Definition
Early mobilization	Mobilization within 24 hours of operation
Early liquid intake	Liquid intake within 24 hours of operation
Early Foley removal	Foley removal within 48 hours of operation, or documented reason for maintenance (low rectal resection)
Multimodal pain control	Use of scheduled, nonopioid pain medication in addition to, or in place of, opioid pain medication within 24 hours of operation
VTE prophylaxis	VTE chemoprophylaxis within 48 hours of operation

VTE, venous thromboembolism.

Inclusion criteria

Cases eligible for inclusion in this analysis were patients 18 years or older who underwent colorectal operations (NSQIP targeted procedures for colectomy and proctectomy CPT codes) between 2017 and 2019.²¹ We included complete case files with an answer for every ERP process measure, and excluded cases that indicated “not applicable” for a pathway component. Based on ISCR registry audits, “not applicable” was most often used when clinical documentation was missing in the electronic health record and did not reflect the process being actually “not applicable” in the individual case.

Variables

Variables included adherence to 5 ERP components (Table 1), operation urgency (emergent or elective), patient demographics (age, sex, race, and BMI), COPD, functional status (American Society of Anesthesiologists [ASA] Physical Status Classification System,²⁴ and preoperative sepsis (sepsis, septic shock, or systematic inflammatory response syndrome). A combination of literature review and technical expert panel input defined the ERP components.^{22,23} Emergency status was defined at the time of operation by the operative surgeon or anesthesiologist, and elective cases included both scheduled outpatient and nonemergent, unscheduled cases. Limitations of this data set did not allow for distinction between scheduled and unscheduled nonemergent cases. Age and BMI were analyzed as categorical variables.

Outcomes of interest included postoperative SSIs (superficial, deep, and organ space in aggregate), postoperative VTE event, 30-day unplanned readmission, ileus (return of bowel function occurring more than 3 days postoperatively), CAUTI, and prolonged length of stay (length of stay > 75th percentile of entire ISCR data set

Table 2. Demographic and Clinical Characteristics of Patients Undergoing Colorectal Operations (n = 31,311)

Variable	Emergency (n = 3,086)		Elective (n = 28,425)	
	n	%	n	%
Age				
<50 y	642	20.8	5,682	20.0
50 to 64 y	937	30.4	9,849	34.7
≥ 65 y	1,507	48.8	12,894	45.4
Sex				
Male	1,486	48.2	13,281	46.7
Female	1,600	51.9	15,143	53.3
Race				
Non-Hispanic white	2,409	78.1	22,005	77.5
Black/Hispanic/Asian/other	674	21.9	6,405	22.5
American Society of Anesthesiology class				
I and II	867	28.1	11,721	41.3
III	1,473	47.8	15,345	54.0
IV and V	744	24.1	1,347	4.7
BMI				
< 18.5 kg/m ²	292	9.5	1,003	3.5
18.5 to 25 kg/m ²	856	27.7	9,227	32.5
25 to 30 kg/m ²	923	29.9	9,871	34.7
> 30 kg/m ²	1,015	32.9	8,324	29.3
COPD				
No	2,684	91.4	26,256	95.2
Yes	254	8.7	1,313	4.8
Functional status				
Independent	2,713	96.0	26,153	97.9
Partially dependent	102	3.6	533	2.0
Totally dependent	10	0.4	39	0.2
Preoperative sepsis				
None	1,562	50.6	27,115	95.4
Systemic inflammatory response syndrome	286	9.3	643	2.3
Sepsis	1,019	33.0	623	2.2
Septic shock	219	7.1	44	0.2

colorectal population, including both emergency and elective cases). All data definitions are standard in NSQIP and are identified within 30 days after the index procedure.

Statistical analysis

Pathway component adherence was reported using percentages and differences between groups undergoing elective and emergency colorectal operations were evaluated using chi-square tests. The effect of pathway component adherence on the 5 outcomes was evaluated using logistic regression models that risk-adjusted for patient

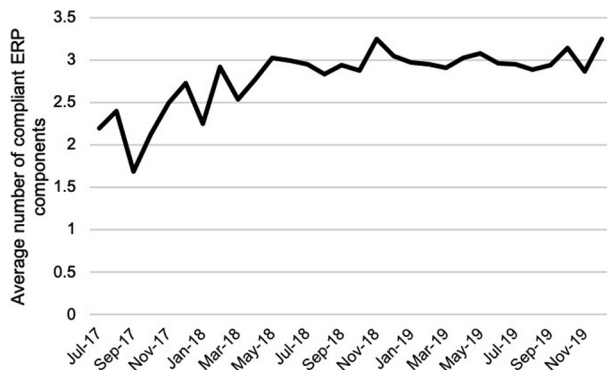


Figure 1. Average number of adherent enhanced recovery protocol (ERP) components over time in patients undergoing emergency colorectal operations.

demographics, COPD, functional status, preoperative sepsis, and a CPT risk score to account for variation in operative type and approach (a CPT-specific logit value to approximate outcomes risk of an individual CPT code, based on several years of NSQIP data),^{20,25} and accounted for clustering of cases within hospitals (PROC Survey Logistic, SAS, version 9.4, SAS Institute). Logistic regression models were not generated for CAUTI outcomes due to low event rate. Sensitivity analyses were performed to evaluate the influence of critically ill patients, excluding 2,227 patients classified as ASA class IV or V, in septic shock, or totally dependent functional status.

RESULTS

Of 31,511 colorectal cases meeting our inclusion criteria, representing 235 hospitals, 28,425 (90.2%) were elective and 3,086 (9.8%) were emergent. There were 11,727 cases that did not meet inclusion criteria and therefore were not included in the final analysis. Table 2 summarizes demographic and clinical characteristics for both operative groups. Notably, 50.2% of emergency patients were 64 years or younger, 75.9% were classified between ASA class I and III, 96.0% were assigned independent functional status, and 50.6% had no preoperative physiologic derangement (Table 2).

ERP process measure adherence to all 5 process measures (ie early mobilization, early liquid intake, early Foley removal, multimodal pain control, and VTE prophylaxis) for patients undergoing emergency colorectal operations was 10.2%. The mean number of ERP components adhered to demonstrated an increasing trend over time (Fig. 1). When examining process measures individually, Foley catheter removal within 48 hours (92.0%) and VTE prophylaxis within 24 hours (75.7%) of operation had the

highest percent adherence (Table 3). Of patients who did not receive multimodal pain control, early mobilization, or liquid intake, 43.4% were younger than 65 years, 94% were independently functioning before operation, 62.5% were classified between ASA I and III, and 39.9% were without physiologic derangement. Percent adherence was consistently lower for all pathway components for emergency patients compared with elective patients (Table 3).

The emergency group had higher postoperative complications compared with the elective group for VTE (2.05% vs 0.94%), SSI (6.47% vs 4.27%), unplanned readmission (13.42% vs 10.29%), CAUTI (0.70% vs 1.06%), ileus (32.80% vs 12.54%), and prolonged length of stay (49.12% vs 16.30%). After adjusting for demographic characteristics, clinical and functional characteristics, and CPT risk score, delayed liquid intake (odds ratio [OR] 2.03; 95% CI, 1.63 to 2.53), mobilization more than 24 hours (OR, 1.94; 95% CI, 1.59 to 2.36), and Foley catheter removal (OR, 1.71; 95% CI, 1.21 to 2.42) were all significant predictors of prolonged length of stay (Table 4). Delayed liquid intake (OR 2.51; 95% CI, 1.98 to 3.17) and mobilization (OR, 1.48; 95% CI, 1.20 to 1.83) predicted the incidence of ileus. Although unplanned readmission was higher in the emergency group compared with the elective group, pathway components were not associated with risk of readmission. Delayed liquid intake reached significance for risk of VTE and delayed mobilization showed significance for risk of SSI (Table 4).

Sensitivity analyses were performed by excluding critically ill patients, potential confounders for predicting pathway component adherence on outcomes. Adherence to pathway components increased slightly for multimodal pain control (58.1%), early liquid intake (38.4%), early Foley catheter removal (92.6%), VTE prophylaxis (77.1%), and early mobilization (44.7%). Predictors of prolonged length of stay remained significant: delayed liquid intake (OR 1.86; 95% CI, 1.46 to 2.38), mobilization (OR 1.77; 95% CI, 1.40 to 2.23), and Foley catheter removal (OR 1.85; 95% CI, 1.23 to 2.78). Similarly, predictors of ileus maintained significance: delayed liquid intake (OR, 2.38; 95% CI, 1.84 to 3.08) and mobilization (OR, 1.38; 95% CI, 1.09 to 1.75).

DISCUSSION

The unpredictability of emergency general surgery procedures has made it challenging to study variation in processes of care. Consistent adherence to evidence-based practices and reduced variation has clearly translated into meaningful improvement in outcomes of

Table 3. Percent Adherence to Enhanced Recovery Pathway Components Compared by Surgical Group (n = 31,311)

Pathway component	Adherence				p Value
	Emergency (n = 3,086)		Elective (n = 28,425)		
	n	%	n	%	
Multimodal pain control	1,725	55.9	23,684	83.3	< 0.001
Early liquid intake	1,030	33.4	22,564	79.4	< 0.001
Foley catheter removal	2,840	92.0	27,224	95.8	< 0.001
VTE prophylaxis	2,337	75.7	24,249	85.3	< 0.001
Early mobilization	1,145	37.1	18,967	66.7	< 0.001

VTE, venous thromboembolism.

elective operations.^{26,27} The question remains as to what role ERPs will play in advancing the field of emergency general surgery. Emergency colorectal operations were a natural starting point to begin to determine whether ERPs are feasible, as elective colorectal pathways have substantial evidence supporting efficacy. Also, the existing data registry for a national ERP collaborative contained patients who had emergency colorectal operations. Despite emergency presentation, patients in our analysis were often younger than 65 years, ASA classes I to III, of independent functional status, and without physiologic derangement. We found wide variation in adherence to the 5 pathway components, with only one-third drinking liquids within 24 hours, yet nearly all had their Foley catheter removed within 48 hours postoperatively. Mobilization within 24 hours also demonstrated low adherence; this component and early liquid intake were found to be significant predictors for ileus and prolonged length of stay.

Interestingly, when examining participants in a national ERP collaborative, we found that there was significant diffusion of certain pathway components from elective to emergency colorectal operations. Highest adherence was demonstrated in early Foley catheter

removal and initiation of VTE prophylaxis within 24 hours of operation. As CAUTIs and VTE are tied to Medicare reimbursement and often tracked hospital-wide, this finding might be more reflective of hospital-wide efforts to reduce healthcare-associated conditions and less specifically attributable to ERP implementation.²⁸ Similarly, external forces might have also been a factor in spreading this multimodal pain control to emergency patients. Nearly 60% of the emergent patients in our analysis had multimodal pain control within 24 hours of operation. However, the opioid crisis and priority to curb opioid use was a prominent national message at the time of the national collaborative, perhaps influencing adherence to this pathway component. We anticipate the combination of external influences and hospitals that have modernized their care and achieved a cultural transformation around standardization of evidence-based perioperative care would have the highest degree of success in ERP application.

Early mobilization and early liquid intake had low adherence in the emergency colorectal population. Although this finding might be expected for frail patients with complex pathologies, the majority of patients not drinking or mobilizing early were younger than 65 years,

Table 4. Enhanced Recovery Pathway Components as Predictors of Postsurgical Outcomes for Patients Undergoing Emergency Colorectal Operations

Process measure	Outcome measure				
	VTE	SSI	Readmission	Ileus	Prolonged LOS
Failure to use multimodal analgesia	1.10 (0.62–1.95)	1.09 (0.77–1.54)	1.02 (0.081–1.29)	1.03 (0.85–1.25)	0.95 (0.76–1.19)
Failure to advance diet	2.57 (1.12–5.93)*	0.71 (0.51–1.00)	0.96 (0.73–1.26)	2.51 (1.98–3.17)*	2.03 (1.63–2.53)*
Failure to remove Foley catheter	1.73 (0.83–3.57)	0.98 (0.53–1.82)	0.98 (0.65–1.48)	1.37 (0.99–1.90)	1.71 (1.21–2.42)*
Failure to prescribe VTE prophylaxis within 48 hours	1.21 (0.72–2.03)	0.98 (0.69–1.39)	1.14 (0.87–1.49)	1.02 (0.86–1.21)	1.15 (0.94–1.41)
Failure to mobilize within 24 hours	1.14 (0.58–2.24)	1.62 (1.13–2.32)*	1.08 (0.86–1.37)	1.48 (1.20–1.83)*	1.94 (1.59–2.36)*

Data are presented as odds ratio (95% CI).

*Statistically significant.

LOS, length of stay; SSI, surgical site infection; VTE, venous thromboembolism.

living independently, and had no signs of physiologic derangement before operation. Therefore, we believe there is substantial opportunity to enhance adherence to these components with deliberate implementation, including provider and patient education and performance feedback. Our findings stand in contrast to earlier literature characterizing a broad emergency general surgery population finding high likelihood of morbidity even when adjusting for comorbidities, and patients are often older with more comorbidities and chronic illnesses.^{1,2} Other literature has found that patients undergoing emergency general surgery procedures were more likely to experience postoperative complications than their elective surgical counterparts.^{29,30} This literature, combined with the clinical assumption that patients undergoing emergency general surgery procedures have a different risk profile than patients undergoing elective operations, might contribute to a paucity of standardized care pathways in the literature.

It is important to note that we examined emergency colorectal operations only, which are primarily for perforated diverticulitis, volvulus, or large bowel obstructions. These might represent a different patient population than emergency general surgery procedures for other perforated viscus, incarcerated hernia, and ischemic small bowel. Although emergency operations might have higher complication rates than elective procedures, there is an opportunity for ERP or other “fast-track” postoperative clinical care protocols for some operations. However, without knowledge of surgical indication in our data set, conclusions about why patients failed to receive pathway elements are beyond the scope of this study.

Although not all components of a traditional elective ERP are possible in an emergency population, previous studies have demonstrated feasibility. Two studies reported successful implementation of enhanced recovery in patients with obstructing colon cancers, leading to decreased postoperative complications.^{31,32} Several studies have implemented modified versions of an ERP in emergency patients and improved outcomes. Two studies focused on intraoperative elements and resumption of diet within 48 to 96 hours post operation and 2 on the pre- and intraoperative surgical phase.^{4,12,33,34} However, a UK-based multicenter randomized trial only modestly improved process measure uptake and failed to show a benefit in mortality outcomes for patients undergoing emergency laparotomy.³⁵ Lack of information on ERP implementation has been a common shortcoming of studies on emergency operations. This information is especially important, as elective surgery literature suggests higher adherence to pathway elements improves outcomes.^{35,36}

Our results expand and strengthen the ERP literature for emergency colorectal and emergency general surgery populations. First, our analysis used data from a multicenter collaborative, suggesting that our findings are reproducible in different practice settings and with varying groups of surgeons and anesthesiologists. Second, data were rigorously collected and trained surgical clinical reviewers abstracted and entered data in the American College of Surgeons NSQIP platform. This latter point is particularly relevant for nuanced clinical outcomes, such as ileus, which cannot be reliably obtained from administrative data. Although emergency colorectal operations were not the main focus of the national collaborative, our findings are compelling and suggest that additional work should be done to understand the adaptation of ERP to this population.

This study has several limitations. First, limiting our sample to patients with complete (yes/no) data for pathway components can bias our results. Our goal was to evaluate feasibility of ERP, not efficacy, therefore, we made the decision to exclude cases where “not applicable” was selected. This decision was based on data entry audits that demonstrated this most often reflected the fact that clinical documentation was missing from the electronic health record. This might limit generalizability to hospitals with the resources to implement an ERP with a standardized method of electronic medical record documentation and data abstraction. Second, the data were abstracted by humans and can be prone to error. However, the abstractors are trained by American College of Surgeons to collect data for NSQIP and are familiar with surgical procedures and the variables being collected. Third, variability in data collection methodology-based available hospital resources can introduce bias in the cases captured in this study. Fourth, surgical indication was not captured in this data set. Variation in presenting pathology and indication for operations are potential confounders in our results. This study is a first exploration of ERP use in emergency operations, and indication will be an important variable to capture in the emergency patient population going forward. Finally, experience with ERP before and during this study is not accounted for in this analysis, so variance in experience with ERP over time both within hospitals and between hospitals might bias the results. It is possible that the hospitals with extensive ERP experience before data collection account for much of the encouraging use of ERPs in emergencies seen in this study. However, controlling for clustering of patients at the hospital-level should account for some of this variation in multivariate analysis.

CONCLUSIONS

This study characterized the population undergoing emergency colorectal operations and adherence to colorectal pathway components in a national collaborative of hospitals implementing ERP in elective operations. Our results suggest there are patients undergoing emergency operations who are young and healthy enough at baseline to feasibly receive ERP postoperative care. Foley catheter removal and VTE prophylaxis administration were easily adapted to an emergency population, other pathway components have substantial opportunity for improvement. Early liquid intake and early mobilization are 2 such components, and were also found to be significant predictors of ileus and prolonged length of stay. These findings can assist in selecting the most impactful components when developing standardized care for emergency patients. As emergency surgery has lagged behind other disciplines in the development of standardized care pathways, our findings imply both feasibility and opportunity. Additional research and quality improvement initiatives are needed to develop emergency surgery care pathways and determine their impact on patient outcomes.

Author Contributions

Study conception and design: Fischer, Knapp, Cohen, Ko, Reinke, Wick

Acquisition of data: Fischer, Knapp, Wick

Analysis and interpretation of data: Fischer, Knapp, Cohen, Ko, Reinke, Wick

Drafting of manuscript: Fischer, Knapp, Cohen, Ko, Reinke, Wick

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REFERENCES

- Gale SC, Shafi S, Dombrovskiy VY, et al. The public health burden of emergency general surgery in the United States: a 10-year analysis of the Nationwide Inpatient Sample—2001 to 2010. *J Trauma Acute Care Surg* 2014;77:202–208.
- Havens JM, Peetz AB, Do WS, et al. The excess morbidity and mortality of emergency general surgery. *J Trauma Acute Care Surg* 2015;78:306–311.
- Scott JW, Olufajo OA, Brat GA, et al. Use of national burden to define operative emergency general surgery. *JAMA Surg* 2016;151. e160480–e160480.
- Lohsiriwat V, Jitmongkarn R. Enhanced recovery after surgery in emergency colorectal surgery: review of literature and current practices. *World J Gastrointest Surg* 2019;11:41–52.
- Greco M, Capretti G, Beretta L, et al. Enhanced recovery program in colorectal surgery: a meta-analysis of randomized controlled trials. *World J Surg* 2014;38:1531–1541.
- Miller TE, Thacker JK, White WD, et al. Reduced length of hospital stay in colorectal surgery after implementation of an enhanced recovery protocol. *Anesth Analg* 2014;118:1052–1061.
- Rawlinson A, Kang P, Evans J, Khanna A. A systematic review of enhanced recovery protocols in colorectal surgery. *Ann R Coll Surg Engl* 2011;93:583–588.
- Roulin D, Donadini A, Gander S, et al. Cost-effectiveness of the implementation of an enhanced recovery protocol for colorectal surgery. *Br J Surg* 2013;100:1108–1114.
- Thiele RH, Rea KM, Turrentine FE, 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;220:430–443.
- Varadhan KK, Neal KR, Dejong CH, et al. 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;29:434–440.
- Deiss T, Chen L-I, Sarin A, Naidu RK. Patient-reported outcomes 6 months after enhanced recovery after colorectal surgery. *Periop Med* 2018;7:19.
- Wisely JC, Barclay KL. Effects of an enhanced recovery after surgery programme on emergency surgical patients. *ANZ J Surg* 2016;86:883–888.
- Pecorelli N, Hershorn O, Baldini G, et al. Impact of adherence to care pathway interventions on recovery following bowel resection within an established enhanced recovery program. *Surg Endosc* 2017;31:1760–1771.
- Pronovost P, Needham D, Berenholtz S, et al. An intervention to decrease catheter-related bloodstream infections in the ICU. *N Engl J Med* 2006;355:2725–2732.
- Pronovost PJ, Goeschel CA, Colantuoni E, et al. Sustaining reductions in catheter related bloodstream infections in Michigan intensive care units: observational study. *BMJ* 2010;340:c309.
- Sexton JB, Berenholtz SM, Goeschel CA, et al. Assessing and improving safety climate in a large cohort of intensive care units. *Crit Care Med* 2011;39:934–939.
- Timmel J, Kent PS, Holzmüller CG, et al. Impact of the Comprehensive Unit-based Safety Program (CUSP) on safety culture in a surgical inpatient unit. *Jt Comm J Qual Patient Saf* 2010;36:252–260.
- Waters HR, Korn R Jr, Colantuoni E, et al. The business case for quality: economic analysis of the Michigan Keystone Patient Safety Program in ICUs. *Am J Med Qual* 2011;26:333–339.
- Wick EC, Hobson DB, Bennett JL, et al. Implementation of a surgical comprehensive unit-based safety program to reduce surgical site infections. *J Am Coll Surg* 2012;215:193–200.
- Cohen ME, Ko CY, Bilimoria KY, et al. Optimizing ACS NSQIP modeling for evaluation of surgical quality and risk:

- patient risk adjustment, procedure mix adjustment, shrinkage adjustment, and surgical focus. *J Am Coll Surg* 2013;217:336–346.e331.
21. Khuri SF. The NSQIP: a new frontier in surgery. *Surgery* 2005;138:837–843.
 22. Ban KA, Gibbons MM, Ko CY, Wick EC. Surgical technical evidence review for colorectal surgery conducted for the AHRQ safety program for improving surgical care and recovery. *J Am Coll Surg* 2017;225:548–557.e543.
 23. Ban KA, Gibbons MM, Ko CY, et al. Evidence review conducted for the agency for healthcare research and quality safety program for improving surgical care and recovery: focus on anesthesiology for colorectal surgery. *Anesth Analg* 2019;128:879–889.
 24. American Society of Anesthesiologists. ASA Physical Status Classification System. Available at: <https://www.asahq.org/standards-and-guidelines/asa-physical-status-classification-system>. Published 2019. Accessed August 18, 2020.
 25. Raval MV, Cohen ME, Ingraham AM, et al. Improving American College of Surgeons National Surgical Quality Improvement Program risk adjustment: incorporation of a novel procedure risk score. *J Am Coll Surg* 2010;211:715–723.
 26. Ahmed J, Khan S, Lim M, et al. Enhanced recovery after surgery protocols—compliance and variations in practice during routine colorectal surgery. *Colorectal Dis* 2012;14:1045–1051.
 27. Arrick L, Mayson K, Hong T, Warnock G. Enhanced recovery after surgery in colorectal surgery: impact of protocol adherence on patient outcomes. *J Clin Anesth* 2019;55:7–12.
 28. Centers for Medicare and Medicaid Services. Hospital-acquired conditions. Available at: https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/HospitalAcqCond/Hospital-Acquired_Conditions. Published 2020. Accessed August 18, 2020.
 29. Ingraham AM, Cohen ME, Bilimoria KY, et al. Comparison of 30-day outcomes after emergency general surgery procedures: potential for targeted improvement. *Surgery* 2010;148:217–238.
 30. Ingraham AM, Cohen ME, Raval MV, et al. Comparison of hospital performance in emergency versus elective general surgery operations at 198 hospitals. *J Am Coll Surg* 2011;212:20–28.e21.
 31. Shang Y, Guo C, Zhang D. Modified enhanced recovery after surgery protocols are beneficial for postoperative recovery for patients undergoing emergency surgery for obstructive colorectal cancer: a propensity score matching analysis. *Medicine (Baltimore)* 2018;97[39]:e12348.
 32. Shida D, Tagawa K, Inada K, et al. Modified enhanced recovery after surgery (ERAS) protocols for patients with obstructive colorectal cancer. *BMC Surg* 2017;17:18.
 33. Huddart S, Peden C, Swart M, et al. Use of a pathway quality improvement care bundle to reduce mortality after emergency laparotomy. *Br J Surg* 2015;102:57–66.
 34. Tengberg L, Cihoric M, Foss N, et al. Complications after emergency laparotomy beyond the immediate postoperative period—a retrospective, observational cohort study of 1139 patients. *Anaesthesia* 2017;72:309–316.
 35. Stephens T, Peden C, Pearse R, et al. Improving care at scale: process evaluation of a multi-component quality improvement intervention to reduce mortality after emergency abdominal surgery (EPOCH trial). *Implement Sci* 2018;13:142.
 36. Ripollés-Melchor J, Ramírez-Rodríguez JM, Casanfrancés R, et al. Association between use of enhanced recovery after surgery protocol and postoperative complications in colorectal surgery: the Postoperative Outcomes Within Enhanced Recovery After Surgery Protocol (POWER) study. *JAMA Surg* 2019;154:725–736.

Invited Commentary

If Enhanced Recovery Is So Good for Our Patients, Should We Be Applying It to Every Case?



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There are robust data supporting the use of enhanced recovery protocols (ERPs) in patients undergoing elective colorectal operations,^{1,2} but data for ERP application in emergency procedures are sparse. In this study of the feasibility of enhanced recovery in emergency colorectal operations, Fischer and colleagues³ propose that there is meaningful benefit to expanding ERPs to the nonelective setting. With increasing ERP expansion to select populations, such as geriatric patients⁴ and other surgical disciplines,⁵ it seems reasonable to expand ERP to emergency colorectal patients, where we expect higher variability in patient presentation, disease severity, and outcomes and there should be an important opportunity for optimization.^{6,7} The authors created this cohort of both elective and emergent cases using the Improving Surgical Care and Recovery Program, a NSQIP initiative in which the culture for surgical quality should be ripe for “accelerated ERP adoption.”

Despite this important question using an appropriate data set, there is a heavy burden on the authors to get past the selection bias of this type of study design. Although the number of ERP components are increasingly delivered in the emergent setting over time (Fig. 1 in the study), we have to wonder, why are there such discrepancies across the variables? Why do half as many patients get diet advancement or early mobilization after an emergent case? Is it really the patient disease severity? Emergent patients in this data set have higher rates of sepsis and higher American Society of Anesthesiologists physical status class. However, the similarly high rate of early Foley removal would imply that catheters