Enhanced Recovery after Colorectal Surgery: Can We Afford Not to Use It?

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BACKGROUND: Enhanced recovery pathways (ERPs) aim to reduce length of stay without adversely affecting short-term outcomes. High pharmaceutical costs associated with ERP regimens, however, remain a significant barrier to widespread implementation. We hypothesized that ERP would reduce hospital costs after elective colorectal resections, despite the use of more expensive pharmaceutical agents.

STUDY DESIGN: An ERP was implemented in January 2016 at our institution. We collected data on consecutive colorectal resections for 1 year before adoption of ERP (traditional, n = 160) and compared them with consecutive resections after universal adoption of ERP (n = 146). Short-term surgical outcomes, total direct costs, and direct hospital pharmacy costs were compared between patients who received the ERP and those who did not.

RESULTS: After implementation of the ERP, median length of stay decreased from 5.0 to 3.0 days ($p < 0.01$). There were no differences in 30-day complications (8.1% vs 8.9%) or hospital readmission (11.9% vs 11.0%). The ERP patients required significantly less narcotics during their index hospitalization (211.7 vs 720.2 morphine equivalence units; $p < 0.01$) and tolerated a regular diet 1 day sooner ($p < 0.01$). Despite a higher daily pharmacy cost ($477 per day vs $318 per day in the traditional cohort), the total direct pharmacy cost for the hospitalization was reduced in ERP patients ($1,534 vs $1,859; $p = 0.016$). Total direct cost was also lower in ERP patients ($9,791 vs $11,508; $p = 0.004$).

CONCLUSIONS: Implementation of an ERP for patients undergoing elective colorectal resection substantially reduced length of stay, total hospital cost, and direct pharmacy cost without increasing complications or readmission rates. Enhanced recovery pathway after colorectal resection has both clinical and financial benefits. Widespread implementation has the potential for a dramatic impact on healthcare costs. (J Am Coll Surg 2018;226:586–593. © 2018 by the American College of Surgeons. Published by Elsevier Inc. All rights reserved.)

Enhanced recovery pathways (ERPs) are gaining acceptance and being implemented in multiple surgical specialties, particularly in colorectal surgery. In 2001, academic surgeons in Europe published the first standardized ERP for elective colorectal surgery after preliminary data suggested multimodal pain control and early enteral nutrition improved postoperative recovery. Both early studies and more recent studies have demonstrated benefits in reducing length of stay.[1-4] Similar results have been seen with postoperative complication rates, with some studies reporting up to a 50% reduction in adverse outcomes after the implementation of an ERP.[5-12]

With benefits to ERPs repeatedly demonstrated in the literature, many societies have proposed its routine use in elective colorectal resection.[13] The American Society of Colon and Rectal Surgeons and Society of Gastrointestinal and Endoscopic Surgeons recently released guidelines on the use of ERPs in colorectal surgery.[14] These guidelines challenge certain historical surgical dogma;

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they emphasize minimization of narcotic medications, fluid restriction, and early resumption of diet.[15] Despite this, widespread clinical application of these pathways has been slow, likely due to the persistence of historical surgical dogma, as well as healthcare system resistance to perceived higher costs. Surgeons might be uncomfortable embracing an idea that contradicts historical teaching about appropriate length of stay, diet advancement, and narcotic usage.

Early experiences with ERPs have shown benefits in perioperative pain control and reduced length of stay. However, these pathways often use expensive medications, such as IV acetaminophen, IV ibuprofen, and alvimopan. Consequently, there remains concern that pharmacy costs are prohibitive to fully implementing an ERP. This concern is inappropriately exaggerated at institutions where pharmacy budgets are calculated without broader consideration for total hospital budget. Our hypothesis was that implementation of an ERP in colorectal surgery might increase daily pharmacy costs, but would reduce total hospital expenditure significantly.

METHODS

Enhanced recovery pathway

In January 2016, an ERP was universally implemented at our institution for all elective colorectal resections (Table 1). In both the traditional and ERP groups, all procedures were done by the same 3 board-certified colon and rectal surgeons. Before the operation, patients were counseled about appropriate expectations and details of the pathway. Patients were instructed to take oral gabapentin 3 days before the procedure, which was continued until hospital discharge. On the day before the operation, mechanical bowel preparation with oral neomycin and flagyl was initiated, along with consumption of 2 Glycemic Endothelial Drinks (SOF Health).[16,17] Additionally, a third Glycemic Endothelial Drink was consumed the morning of the operation. Alvimopan, a μ-receptor antagonist, was given 2 hours before the procedure and continued bid during index hospitalization for a maximum of 7 days. Intraoperatively, the protocol required that the anesthesiology team judiciously maintain a euvolemic fluid status. Postoperatively, a transversus abdominis plane block was performed as part of a multimodal pain control regimen. For the first 24 hours after the operation, scheduled IV ketorolac and acetaminophen were prescribed. After 24 hours, all IV analgesics were discontinued, and patients were started on a combination of oral acetaminophen, ibuprofen, and oxycodone, as needed. A soft diet was initiated on postoperative day 1 for laparoscopic procedures and day 2 for open procedures. The pathway emphasized early ambulation and required patients to remain out of bed 4 to 6 hours beginning on the day of the operation. These processes of care are similar to those proposed by Delaney and colleagues[18] and are consistent with what is recommended in the American Society of Colon and Rectal Surgeons and the Society of American Gastrointestinal and Endoscopic Surgeons guidelines.[14,19]

All consecutive patients undergoing elective colorectal resection from January 2015 to January 2017 at a single medical center, representing 1 year before and 1 year after implementation of our ERP were included. Patient demographics and clinical data on hospital stay were retrospectively collected. Exclusion criteria included emergency operation, procedures not requiring bowel resection, and procedures for enterostomy takedowns. Type of colectomy was divided into the following 4 groups: right colectomy, left colectomy, proctectomy (low anterior resection or abdominoperineal resection), and total abdominal colectomy. Patients were also categorized according to level of anastomosis; colon, rectum, coloanal, or no anastomosis (signifying that an end eterostomy was performed).

Perioperative quality measures and outcomes were analyzed for surgical site infection, anastomotic leak, duration of ileus, and requirement for blood transfusion. Surgical site infections were defined as superficial cellulitis, deep incisional infection requiring drainage and treatment with local wound care, or organ space infections requiring either surgical or nonsurgical interventions. Anastomotic leak was defined by breakdown of the surgical anastomosis and confirmed with clinical or radiographic findings consistent with air and fluid or contrast around the anastomosis. Prolonged ileus was defined as failure of return of bowel function 3 days after operation with clinical or radiographic findings consistent with reduced bowel motility. Placement of a nasogastric tube was not required for the diagnosis of prolonged ileus.

Individual cost data were collected and managed by the hospital billing department. Total cost of hospital stay was divided into supply, labor, and other costs.

Statistical methods

Patients were categorized into “Traditional” and “ERP” groups based on use of the ERP. Patient demographics and perioperative factors including operative approach, type of surgical resection, type of anastomosis, operative time, and estimated blood loss were compared. Primary outcomes included length of stay (LOS), total narcotic dosage, day diet was advanced, and 30-day complications. Total narcotic dosage was measured in morphine equivalent units. Hospitalization cost data were also collected

Table 1. Enhanced Recovery Pathway

Enhanced recovery pathway
Day before operation
GED carbohydrate drink ×2
Mechanical bowel preparation with 238 g polyethylene glycol dissolved in 64 oz Gatorade and bisacodyl 5 mg po ×2 tablets
Neomycin 1 g po ×3 doses and metronidazole 500 mg po ×3 doses
Diclofenac 100 mg at night
Gabapentin 300 mg po tid for 3 days before operation
Day of operation
GED carbohydrate drink in the morning
2 h before operation
Gabapentin 300 mg po
Alvimopan 12 mg po
Heparin 5,000 U subcutaneous injection
During operation
Preoperative antibiotics (typically cefazolin/metronidazole, unless allergic)
Ketorolac 15-30 mg depending on glomerular filtration rate
Euvolemic fluid administration
Transversus abdominis plane block
Postoperative analgesia: first 24 h
Ketorolac 15 mg IV q6h
Acetaminophen 1 g IV q8h
PCA with dilaudid or morphine at standard dose
Gabapentin 300 mg po tid
Postoperative analgesia: after 24 h
Discontinue PCA on d 1 for laparoscopic procedure; d 2 for open procedure
Acetaminophen 1 g po q6h
Gabapentin 300 mg po tid
Ibuprofen 800 mg po tid
Oxycodone 5-10 mg po q4h prn
General orders
Ambulate hallways ×5 every day
Sit out of bed 4-6 h/d
Remove Foley on d 1 for laparoscopic procedure; d 2 for open procedure
Discontinue IV fluids on d 1 for laparoscopic procedure; d 2 for open procedure
Dietary order
Chewing gum, 1 stick for 60 min tid
Clear liquids given as tolerated after operation
Nutritional supplement, 1 can bid
Soft diet on postoperative d 1 for laparoscopic procedure; d 2 for open procedure
Medication order
Alvimopan 12 mg po bid while in hospital, max of 7 d
Heparin 5,000 U subcutaneous tid
Bisacodyl 10 mg po bid
Ondansetron 4 mg IV q6h prn
Zolpidem 5 mg po qhs when in hospital
Discharge medication
Acetaminophen 1 g po q6h
Ibuprofen 800 mg po tid
Oxycodone 5-10 mg po q4h prn

GED, Glycemic Endothelial Drink; PCA, patient-controlled analgesia.

and compared between groups. Total individual costs were divided by LOS to determine associated daily costs. Univariate analysis for categorical variables was performed with chi-square test. Two-tailed Student's *t*-test and ANOVA were used when appropriate to analyze continuous variables. To control for differences in patient demographics and procedure types, a 1:1 propensity score match was performed to compare outcomes in patients who were matched for procedure type and laparoscopic surgery. SAS, version 9.4 (SAS Institute) was used for the propensity match. All other analyses were performed using STATA, version 13.1 software (Stata Corp), with significance determined by a p value <0.05. The study was approved by the IRB before data collection.

RESULTS

Patient demographics and operative details

From 2015 to 2017, a total of 306 patients underwent elective colorectal resection and met all inclusion and exclusion criteria (160 traditional vs 146 ERP). Patient demographics are depicted in Table 2. There were no significant differences in age, sex, American Society of Anesthesiologists classification, or comorbidities between the 2 groups. Patients receiving the ERP were more obese compared with the traditional group (BMI 28.6 ± 6.5 kg/m^2 vs 27.0 ± 5.8 kg/m^2; $p = 0.03$). The most common indication for operation was colorectal cancer, followed by diverticulitis and inflammatory bowel disease.

There were no significant differences between the 2 cohorts with regard to type of colectomy performed (Table 3). The most common operation performed before implementation of the ERP was proctectomy, which included low anterior resection and abdominoperineal resection. This is consistent with a high prevalence of cancer and inflammatory bowel disease in our patient cohort. The most common procedure performed after the initiation of the ERP was left colectomy. No significant differences in the proportion of each procedure performed existed between the 2 groups. Laparoscopy was the most commonly used approach in both groups, however, a greater proportion of patients underwent laparoscopy in

Table 2. Patient Demographic Characteristics

Variable	Traditional (n = 160)	Enhanced recovery pathway (n = 146)	p Value
Age, y, mean ± SD	57.6 ± 14.8	57.3 ± 15.1	0.85
Sex, n (%)			
Male	70 (43.8)	69 (47.3)	0.23
Female	90 (56.2)	77 (52.7)	
BMI, kg/m^2, mean ± SD	27.0 ± 5.8	28.6 ± 6.5	0.03
American Society of Anesthesiologists class, n (%)			
I-II	103 (64.4)	79 (54.1)	0.07
III-IV	57 (35.6)	67 (45.9)	
Diabetes, n (%)			
Yes	26 (16.2)	28 (19.2)	0.50
No	134 (83.8)	118 (80.8)	
Chronic kidney disease, n (%)			
Yes	13 (8.1)	10 (6.8)	0.67
No	147 (91.9)	136 (93.2)	
Coronary artery disease, n (%)			
Yes	31 (19.4)	17 (11.6)	0.07
No	129 (80.6)	129 (88.4)	
Cerebrovascular disease, n (%)			
Yes	5 (3.1)	7 (4.8)	0.45
No	155 (96.9)	139 (95.2)	
Tobacco use, n (%)			
Yes	41 (25.6)	48 (32.9)	0.16
No	119 (74.4)	98 (67.1)	
Earlier abdominal operation, n (%)			
Yes	87 (54.4)	89 (61.0)	0.25
No	73 (45.6)	57 (39.0)	
Indication for operation, n (%)			0.32
Diverticulitis	37 (23.2)	39 (26.7)	
Polyp	18 (11.3)	22 (15.1)	
Cancer	76 (47.5)	58 (39.7)	
Inflammatory bowel disease	28 (17.5)	23 (15.8)	
Prolapse	1 (0.5)	4 (2.7)	

the ERP group compared with the traditional group (81.5% vs 70.0%; p = 0.02). In addition, a fewer number of ostomies were created in the ERP group (26.7% vs 41.3%; p < 0.01). There were no differences in the type of ostomy created between the 2 groups. In both the traditional and ERP pathway, 82% of patients had postoperative transverse abdominis plane blocks and no patient had an epidural. This is reflective of our current state of practice, before initiating the ERP.

Postoperative outcomes

Postoperative outcomes are illustrated in Table 4. Median LOS decreased by 2 days (5.0 to 3.0 days; p < 0.01). Patients who received the ERP before operation discontinued patient-controlled analgesia 2 days before the traditional group (1.3 vs 3.3 days; p < 0.01) and had a significant reduction in total narcotics required during index hospitalization (211.7 vs 720.2 morphine equivalent units; p < 0.01). Overall, patients who received the ERP had a shorter hospital stay, required less narcotics, and tolerated a diet sooner. In addition, the incidence of prolonged postoperative ileus was significantly less with ERP (6.2% vs 20.0%; p < 0.01). Implementation of the ERP did not affect other 30-day complications, readmission, reoperation, or mortality rates.

Financial data

Implementation of an ERP resulted in a significant reduction in total direct cost for index hospitalization as well as total pharmacy costs (Table 5). The overall cost of the indexed admission decreased by $1,717, which translated into an annual savings of $250,682 based on the number

Table 3. Operative Details

Operative detail	Traditional (n = 160)	Enhanced recovery pathway (n = 146)	p Value
Type of colectomy, n (%)			0.19
Right colectomy	47 (29.4)	45 (30.8)	
Left colectomy	43 (26.9)	49 (33.6)	
Proctectomy	58 (36.2)	45 (30.8)	
Total abdominal colectomy	12 (7.5)	7 (4.8)	
Laparoscopic, n (%)			
Yes	112 (70.0)	119 (81.5)	0.02
No	48 (30.0)	27 (18.5)	
Ostomy creation, n (%)	66 (41.3)	39 (26.7)	<0.01
Loop ileostomy	24 (36.4)	19 (48.7)	0.22
End ileostomy	21 (31.8)	13 (33.3)	0.87
Loop colostomy	1 (1.5)	0 (0.0)	0.44
End colostomy	20 (30.3)	7 (18.0)	0.16
Operative time, min, mean ± SD	207.3 ± 77.5	188.7 ± 78.1	0.04
Estimated blood loss, mL, mean ± SD	201.8 ± 352.2	173.9 ± 294.0	0.45

of patients in our series. Although the daily pharmacy cost increased with the ERP, total pharmacy costs for the hospitalization were significantly reduced ($477 per day vs $318 per day; $p < 0.01$; $1534 vs $1,859; $p < 0.01$).

Propensity match

Because there were differences in key variables, such as the use of laparoscopy and ostomy creation between study groups, we conducted a 1:1 propensity score match on laparoscopy and type of colectomy. This yielded comparison groups of 119 patients with ERP and 119 patients with traditional pathway. There were no differences in patients for important variables, such as age, BMI, American Society of Anesthesiologists classification, indication for operation, type of colectomy, laparoscopic procedure, or ostomy creation. In this matched subset, median LOS was 3 days for ERP vs 5 days for traditional pathway ($p < 0.001$). Total direct cost for the index admission was $1,224 cheaper in the ERP group ($p = 0.029$). Pharmacy cost in the matched group was $253 cheaper, but this was not statistically significant ($p = 0.055$).

DISCUSSION

This study further expands on the topic of ERPs in elective colorectal surgery. To our knowledge, this is the first

Table 4. Postoperative Outcomes

Outcome	Traditional (n = 160)	Enhanced recovery pathway (n = 146)	p Value
Length of stay, d, median	5.0	3.0	<0.01
ICU admission, %	8	7	0.67
Days with patient-controlled analgesia, mean	3.3	1.3	<0.01
Total narcotic dosage, MEU, mean (95% CI)	720.2 (524–915)	211.7 (131–291)	<0.01
Days with Foley, median	2.0	1.0	0.04
Days until diet advanced, median	2.0	1.0	<0.01
30-d complication			
Surgical site infection, %	5.0	4.1	0.71
Anastomotic leak, %	4.1	4.8	0.65
Prolonged ileus, %	20.0	6.2	<0.01
Anemia, %	10.0	6.2	0.22
Units transfused, mean ± SEM	2.3 ± 0.4	1.8 ± 0.2	0.31
Dehiscence, %	0	1.4	0.14
30-d readmission, %	11.9	11.0	0.8
30-d reoperation, %	5.0	6.2	0.66
30-d mortality, %	0.6	0.7	0.94

MEU, morphine equivalent unit.

Table 5. Cost Data for Index Hospitalization

	Traditional (n = 160)		Enhanced Recovery Pathway (n = 146)		
Cost	**Total**	**Daily**	**Total**	**Daily**	**p Value**
Total direct cost, $, mean (95% CI)	11,508 (10,601−12,414)	2,115	9,791 (9,065−10,516)	3,088	0.004
Detail pharmacy cost, $, mean (95% CI)	1,859 (1,637−2,080)	318	1,534 (1,397−1,670)	477	0.016

study to publish detailed cost analysis specific to pharmacy costs after implementation of an ERP. One year after the universal implementation of an ERP at our institution, patient outcomes and cost data were compared with the previous year in which no universal pathway was used. We found that with the use of an ERP median hospital LOS decreased by 2 days, total narcotic use was drastically reduced, and patients were tolerating a diet 1 day earlier. The incidence of prolonged postoperative ileus was reduced, and there was no significant increase in 30-day readmissions, reoperations, and mortality. Despite a higher daily pharmacy cost, overall total cost for the hospitalization decreased. The decrease in narcotic administration was likely due to the preemptive analgesia model in the ERP group, as both the ERP and traditional pathway patients had the same use of transverse abdominis plane blocks.

Enhanced recovery pathways have been well studied in the past decade. Since their conceptualization, ERPs have consistently shown improvements in postoperative recovery by reducing LOS and shortening the time to advancement of diet.[20,21] Historically, many colorectal surgeons waited until resumption of full bowel function before resuming a diet. Enhanced recovery pathways have begun to shift this paradigm. In addition, this benefit is paired with reduction in prolonged postoperative ileus, and does not lead to an increase in surgical site infections, anastomotic leaks, or worse 30-day measures. A meta-analysis by Varadhan and colleagues[6] found that an ERP reduced surgical complication rates by 50%. A larger series by Greco and colleagues[5] has confirmed this finding as well. Our study shows similar outcomes to previously published data on ERPs. Because it is well established in the literature, reductions in LOS and postoperative ileus after elective colorectal surgery can be used as a quality-control measure to assure proper implementation of an ERP.

Unlike patient outcomes, there are few published data on the costs of implementing an ERP. To our knowledge, this study is the first study to publish a detailed cost analysis specific to pharmaceutical costs on the universal implementation of an ERP. In addition to reinforcing the clinical benefits of an ERP, our study shows the financial benefits to the hospital. One argument against an ERP is that pharmacy departments will see an increased cost with the routine use of expensive medications. Our study demonstrates that although the daily pharmacy cost increased with use of an ERP, the total cost seen by the pharmacy decreased by approximately $300 per patient, likely due entirely to the shorter LOS. Although the ERP required the use of more-expensive medications, a net reduction in hospital cost was observed. Although there are limited data on a full cost analysis surrounding ERP implementation, this finding expands on ERP cost data that are already published. A mathematical model of cost analysis of existing publications by Stone and colleagues[22] found that at The Johns Hopkins Hospital, an ERP implementation cost of $552,783 was offset by an annual savings of $948,500.[22] However, this study is based on the development of a theoretical cost analysis using a mathematically derived formula and does not report tangible cost savings. To our knowledge, none of the previously published studies have shown the breakdown of hospital costs.

With the relatively new Bundled Payments for Care Improvement Initiative, reducing hospital costs will become imperative. A study by Gani and colleagues[23] found that payments under the bundled payments system were lower than previous reimbursement models, and that postoperative complications and LOS were associated with a higher hospital cost. In addition, patient factors have been shown to be the driving force for hospital costs, and the use of an ERP can potentially optimize the cost of each procedure.[24] A study performed in Canada showed that implementation of an ERP over 6 hospitals reduced hospital costs by US$2,806 to US$5,898 per patient.[25] Although the medical insurance markets are different in Canada compared with the US, we have shown a similar reduction in total cost per patient of US$1,717.

There are several limitations to this study. The primary limitation is the retrospective analysis of nonrandomized patient cohorts, which led to differences in demographic characteristics. First, patients who received an ERP had a BMI 1.6 kg/m^2 greater than those who did not receive an ERP. Although obese patients are at increased risk for surgical site infections, prolonged postoperative ileus, and a longer recovery, this small increase is unlikely to manifest clinically. Second, the ERP group demonstrated

a nonsignificant trend toward higher American Society of Anesthesiologists classification. Although not statistically significant, the most common procedures before and after ERP implementation were different. Proctectomy was most common before the use of ERP, and left colectomy was most common with ERP use. This suggests that before ERP implementation, more patients presented with rectal cancer than colon cancer. Increased number of procedures performed for rectal cancer might explain the higher rate of ostomy creation in the traditional group, as rectal resections are more likely to require diverting loop ileostomies or end colostomies. Although only a randomized controlled trial could eliminate all of these differences, our propensity-matched analysis confirmed the benefits of reduced LOS and total direct cost. A final limiting factor is a possible Hawthorne effect. Surgeons performing the elective colon resections were not blinded to the type of pathway used. To the extent possible, this confounding effect was minimized by implementing ERP order sets to automate the recovery process.

Lastly, although excellent results were achieved using this protocol, we cannot be sure of which elements provide the most benefit. Although gabapentin and toradol were effective in our patient population, there are some concerns with dosing these medications, particularly in elderly patients. Because of this, alternative medications, such as pregabalin and IV ibuprofen, could be studied. Although alvimopan was useful in reducing ileus, our patients, particularly in the laparoscopic group, used such low doses of narcotics that additional study is warranted to validate the use of alvimopan in the laparoscopic subgroup. Although stoma closures were not included in this study to keep a uniform patient cohort, we now use this pathway in colostomy closure patients, with similar benefits. It is difficult to determine which patients would benefit from an ERP. Although not all patients are candidates for "fast track" discharge, we do believe that even the most difficult of cases can benefit from the improved pain control and earlier return of bowel function of an ERP. The final area of study is to determine how to best monitor patient compliance with individual elements of the protocol.

CONCLUSIONS

To our knowledge, this is the first published study that provides specific details of hospitalization costs for an ERP. Universal implementation of an ERP for all elective colorectal operations resulted in a significant decrease in hospital LOS, reduced the duration of postoperative ileus, and hastened diet tolerance. In addition, the ERP led to an overall decrease in medical costs. Although the costs of drugs alone increased, the detailed pharmacy cost for the entire hospitalization was reduced. Given these results, we suggest that cost should not be a factor in the decision to implement an ERP.

Author Contributions

Study conception and design: Jung, Snyder, Rafferty, Edwards, Paquette

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Discussion

DR SUSAN GALANDIUK (Louisville, KY): Drs Paquette, Edwards, and colleagues have presented a much-needed study detailing costs associated with enhanced recovery pathways in colorectal surgery. As has been stated, these pathways have been broadly adopted in the US, and the American Society of Colorectal Surgeons and Society of American Gastrointestinal and Endoscopic Surgeons jointly published practice guidelines earlier this year.

Much of the data presented in their paper are given as means with standard deviations, and I think it is always nice to see ranges of data to see the true breadth of the population being presented. This is especially important in 2 areas—age and BMI—and I was a bit envious to see the BMI of 28 kg/m^2 in the Cincinnati population.

Not all patients are fast-track patients, and I have several questions for the authors. First, you describe a routine use of preoperative gabapentin and also postoperative ketorolac and postdischarge ibuprofen. Do you also administer these drugs in elderly patients, and have you observed complications with these patients, particularly with respect to the sedating effects of gabapentin and renal effects of ketorolac? And is there a role for pre- or postoperative pregabalin, realizing again that this is a more expensive drug than gabapentin? Second, thoracic epidural blocks were not used in the study. Although I agree that these should not be used or are not necessary in laparoscopic cases, their use in open cases is often helpful, and this is actually suggested by the guidelines that I previously referred to. Can you comment on this?

Were the transversus abdominis plane (TAP) blocks performed with regular bupivacaine, which only lasts for about 24 hours, or were they performed using liposomal bupivacaine, which, again, is a more expensive drug?

Third, Foley catheters were removed on day 1 in laparoscopic cases and on day 2 in open cases, and also there was that same difference in the diet. Why was there a difference with the type of access? And with the day 1 Foley catheter removal, was that also done in cases of proctectomy? Fourth, why were stoma closures excluded from this study? Finally, coming back to my initial statements, which patients do you think are not suitable for a fast-track pathway?

DR JONATHAN EFRON (Baltimore, MD): Drs Edwards and Paquette have truly done an outstanding job of presenting their experience with implementing an enhanced recovery pathway. The authors not only examined the implementation, but looked at the financial implications of that implementation, which can be a significant barrier to starting these pathways at any institution. For instance, at Johns Hopkins, my institution, we have not incorporated many of the drugs used in this pathway because of the cost of the drugs and the lack of level I data proving their effectiveness.

I have 5 questions for the authors. First, the authors did not specify the number of surgeons who were included in this analysis. Colorectal resections are often performed by a variety of subspecialty surgeons at an institution. Can the authors tell us how many surgeons were part of the analysis, and was it the same number before and after implementation of the protocols? Are all patients who undergo colorectal surgical procedures at their institutions now enrolled in this pathway?

Second, as we have heard, the authors make no mention of epidural catheters, either before or after Enhanced Recovery After Surgery (ERAS) implementation. Because epidural catheters are commonly used in open procedures for pain management, were they used before implementation of the pathway, and could that have affected the difference in cost?