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Early outcomes of an enhanced recovery protocol for open repair of ventral hernia

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Abstract

Background Enhanced recovery after surgery (ERAS) protocols are evidence-based quality improvement pathways reported to be associated with improved patient outcomes. The purpose of this study was to compare short-term outcomes for open ventral hernia repair (VHR) before and after implementation of an ERAS protocol.

Methods After obtaining IRB approval, surgical databases were searched for VHR cases for two years prior and eleven months after protocol implementation for retrospective review. Groups were compared on perioperative characteristics and clinical outcomes using chi-square, Fisher's exact, or Mann–Whitney U test, as appropriate.

Results One hundred and seventy-one patients underwent VHR (46 patients with ERAS protocol in place and 125 historic controls). Age, gender, ASA Class, comorbidities, and smoking status were similar between the two groups. Body mass index was lower among ERAS patients ($p = .038$). ERAS patients had earlier return of bowel function (median 3 vs. 4 days) ($p = .003$) and decreased incidence of superficial surgical site infection (SSI) (7 vs. 25%) ($p = .008$) than controls.

Conclusion An ERAS protocol for VHR demonstrated improved patient outcomes. A system-wide culture focused on enhanced recovery is needed to ensure improved patient outcomes.

Keywords Enhanced recovery · Clinical outcomes · Ventral hernia repair · Process evaluation · Surgical site infection

Ventral incisional hernia is the most common complication of laparotomy, and has been reported to occur in nearly 20% of patients [1–4]. Although not all patients that develop incisional hernia will undergo repair, the operative repair of incisional hernias places patients at risk for further complications. Surgical site infection (SSI), the most commonly reported complication following open ventral hernia repair (VHR) [2, 4–6], is a frequent cause of hospital readmission [4, 7] and contributes to increased costs [8]. Furthermore, SSI is a major predictor of hernia recurrence [9]. Other complications, such as urinary tract infection, venous thromboembolism (VTE), and pneumonia also may complicate VHR recovery [7]. While complications are multifactorial and may not be entirely preventable, preventive measures, when used in a standardized manner, would be expected to reduce their incidence.

Enhanced recovery after surgery (ERAS) protocols are evidence-based quality improvement pathways reported to be associated with improved patient outcomes, specifically shortened length of hospital stay (LOS) and decreased incidence of postoperative complications for several types of surgery [10–14]. ERAS protocols incorporate many similar evidence-based components of care across surgical specialties, such as optimization of risk factors, avoidance of fasting, carbohydrate loading, multimodal pain management, and early removal of nasogastric and/or urinary catheters [13, 15]. In order to facilitate recovery and decrease the stress associated with abdominal surgery, ERAS protocols are being utilized on a more widespread basis. While institutional working groups or providers are well able to define

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specific measures to include in a protocol, barriers to implementation of ERAS protocols have been reported [16].

Enhanced recovery protocols for VHR previously have been described [17–19]. Because of the success in terms of improved patient outcomes of ERAS protocols for colorectal surgery, VHR, and other procedures, a comprehensive ERAS protocol for VHR was developed at our institution. We hypothesized that patients cared for after protocol implementation would have improved clinical outcomes as compared to patients cared for prior to protocol implementation.

The purpose of this study was to compare short-term outcomes for patients having undergone open VHR before and after implementation of an ERAS protocol.

Materials and methods

The ERAS for VHR protocol was developed over a 6-month time period at our institution by a working group composed of general surgeons, anesthesiologists, and nurses. Clinical pharmacists also were instrumental in protocol implementation. Using the framework as reported by Fayezizadeh, which detailed guidelines for enhanced intestinal recovery and multimodal pain management for patients undergoing abdominal wall reconstruction (AWR), our comprehensive ERAS for VHR protocol included standards for 15 aspects of care integral to caring for patients undergoing open VHR (Table 1) [17]. With the primary goals of prevention of postoperative complications and hastened recovery, active involvement of the patient and a multitude of health care providers across the spectrum of care are critical to success. The first key element, Preoperative Risk Stratification, stipulated preoperative weight optimization, smoking and alcohol cessation, and glucose optimization, all of which were required prior to surgical planning. Additional evidence-based perioperative guidelines, with similarities to previously reported protocols, provided standardized measures for patient care taking into account the particular needs of patients undergoing VHR. Multimodal pain management involving minimization of opioid use, which is intricately involved in hastened bowel recovery, included epidural pain control, intravenous transitioning to oral non-narcotic analgesics, and oral gabapentin and muscle relaxants (See Table 1).

After obtaining IRB approval, surgical databases at the University of Kentucky were searched for consecutive open VHR cases performed by one surgeon for two years prior to protocol implementation (August 1, 2013 through July 30, 2015) and for 11 months after protocol implementation (August 1, 2015 through June 30, 2016). Cases studied included only those who had undergone open VHR (initial or recurrent). Cases that included planned ostomy reversals were excluded.

Conducted as a retrospective review of hospital and ambulatory electronic health records, preoperative characteristics including age, gender, body mass index, smoking status at time of surgery scheduling (defined as non-smoker, former smoker, active smoker), history of common comorbidities (diabetes, chronic obstructive pulmonary disease, cancer, coronary artery disease, and/or hypertension), and American Society of Anesthesiologists' (ASA) Class for each case were recorded. Whether or not a patient had a previous hernia repair, previous abdominal wall infection, previous mesh infection, and/or an open wound on the abdomen at the time of surgery also were recorded. Operative details obtained from the medical records included duration of the procedure, estimated blood loss, Center for Disease Control and Prevention (CDC) Wound Class, whether or not component separation was performed, and the mesh type, size, and location. Elements of ERAS protocol as were in place for historical control patients are noted in Table 1.

Short-term clinical outcomes including LOS, number of days postoperatively of return of bowel function, hospital readmission within 30 days, and any complication, including wound events, that occurred within 30 days of surgery also were obtained by medical record review and entered into the study database. Wound complications were defined as infected seroma/seroma requiring drainage, superficial SSI, and/or deep SSI. Perioperative variables were compared for the two groups (pre- and post-ERAS implementation) using chi-square, Fisher's exact, or Mann–Whitney U test, as appropriate. Significance was set at $p < .05$.

In an effort to understand the level of adherence to ERAS protocol details, retrospective tracking of compliance occurred. Through detailed review of electronic medical records, specifics of care as related to the ERAS protocol were entered into the study database for each case. Based on the information recorded for each variable, the adherence per ERAS protocol element for each patient was categorized as protocol completed, protocol failure that was justified, or protocol failure that was not justified. As this was a pilot project of one surgeon's cases in a large academic institution that previously had no experience with implementation of an ERAS protocol, successful adherence by element of care was established to be 85% compliance.

Results

The total cohort was made up of 171 patients who had undergone VHR via an open approach, with 46 patients having had surgery with ERAS protocol in place and 125 patients serving as historical controls. All procedures were performed by a single surgeon at our institution during the time period described. Across all patients, the median age was 54 years (interquartile range [IQR] 46–64), median

Table 1 Key care components of ERAS for VHR protocol and historical controls experience

No.	Key element	Historical controls	ERAS expectations/guidelines
1	Preoperative risk stratification/preoperative counseling	BMI < 40 kg/m^2 while preferred was not systematically required Smoking cessation was not systematically expected No routine A1c testing preoperatively No protocol counseling	BMI no greater than 40 kg/m^2 For smokers, notation that patient has ceased smoking × 4 weeks prior to surgery For diabetic patients and/or patients with BMI ≥ 30 kg/m^2 A1c ≤ 8.0% Counseling about protocol was provided
2	Preoperative bowel preparation	Generally was followed in historical control patients	Bowel preparation (clear liquids × 2 days prior to surgery) recommended only to patients with colostomy
3	Prophylaxis against thromboembolism	VTE prophylaxis was hospital policy prior to ERAS implementation	Preoperative and postoperative prophylaxis and intraoperative and postoperative sequential compression devices ordered and utilized
4	Methicillin resistant *Staphylococcus Aureus* (MRSA) prophylaxis	Not done with control patients	Mupirocin intranasal ointment BID × 5 days preoperatively
5	Nutritional preparation	Not done with historical control patients	Three servings of Impact AR™ to be taken for 5 days preoperatively
6	Preoperative fasting and carbohydrate treatment	Not done with historical control patients	Gatorade (or diabetic alternative) 400 mL 4 h prior to arrival time. No solid foods after midnight
7	Perioperative fluid management	Not done with historical control patients	< 5 cc/kg/h or < 2 l of IVFs intraoperatively
8	Postoperative nausea and vomiting	No systematic plan	Use of prophylactic antiemetics as appropriate
9	Nasogastric intubation	No systematic plan	NG tube placed in the OR removed prior to leaving OR
10	Urinary drainage	No systematic plan	Removal of Foley catheter by POD #2
11	Prevention of intraoperative hypothermia	Historical control patients had warmers in the OR	Temperature ≥ 36 °C intraoperatively
12	Multimodal pain management	Some patients had epidurals, generally relied on opioids. Little multimodal therapy in place	No scheduled narcotics Multimodal therapy (Epidural with hydromorphone and bupivacaine, scheduled acetaminophen (IV transitioning to po), ketorolac transitioning to ibuprofen, and oxycodone prn after discontinuation of epidural)
13	Acceleration of intestinal recovery	Not in place for historical control patients	Alvimopan, preoperatively as appropriate, and BID postoperatively until bowel function Clear liquids with quick advancement to regular diet
14	Early mobilization	While it was expectation, not systematically followed or enforced	Patient to be out of bed evening of surgery and ambulating by POD #1
15	Postoperative glucose control	Hospital policy prior to protocol implementation	Blood glucose checked and sliding scale insulin utilized per hospital protocol

body mass index (BMI) was 33.5 kg/m^2 (IQR 28–37), and there were nearly equal numbers of males (49%) and females (51%).

In comparing preoperative features, the groups (pre- and post-protocol implementation) were similar for the characteristics of age, gender, ASA class, smoking status, and common comorbidities (see Table 2). ERAS patients had lower median BMI (30 kg/m^2, IQR 27–34) than controls (34 kg/m^2, IQR 29–38), as weight optimization was a protocol specification. BMI was categorized as < 30, 30–39, and ≥ 40 kg/m^2, with a statistically significant difference demonstrated between BMI groups ($p = .038$).

All cases were that of open repair of ventral hernia, initial or recurrent. Median operative time was similar between the groups, as was amount of estimated blood loss and median hernia defect size (Table 3). Component separation was performed in 31 (67%) of the ERAS cases and in 52 (42%) of the historical control cases ($p = .003$). Most often transversus abdominis muscle release (TAR) was the method of component separation performed (78 of 83 or 94% of component

Table 2 Patient preoperative characteristics in historical controls and applied ERAS protocol groups

Characteristic	Historical control ($n=125$)	ERAS protocol applied ($n=46$)	p value[†]
Median age (IQR) (years)	54 (45–64)	58 (47–66)	.312
Female (%)	50%	52%	.837
ASA class > II (%)	67%	59%	.175
Diabetes (%)	28%	22%	.410
COPD (%)	10%	9%	1.000
Cancer (%)	18%	28%	.161
CAD (%)	14%	13%	.821
Hypertension (%)	64%	59%	.525
Smoking status (%)			.826
Never smoked	45%	46%	
Former smoker	43%	45%	
Current smoker	12%	9%	
BMI (kg/m^2)			.038
< 30 (%)	30%	46%	
30–39 (%)	56%	52%	
≥ 40 (%)	14%	2%	
Prior hernia repair (%)	58%	48%	.255
2 + Prior repairs (%)	17%	22%	.457
Previous infected mesh (%)	17%	11%	.338
Preoperative open wound (%)	10%	7%	.762
Previous abdominal wall infection (%)	32%	33%	.940

IQR interquartile range, 25th–75th percentiles

[†]χ^2 or Fisher's exact test for group proportions; Mann–Whitney U test for continuous variables

Table 3 Patient Intraoperative characteristics in historical controls and applied ERAS protocol groups

Characteristic	Historical control ($n=125$)	ERAS protocol applied ($n=46$)	p value[†]
Wound class (%)			.298
I-Clean	81%	76%	
II-Clean/contaminated	4%	11%	
III-Contaminated	6%	9%	
IV-Dirty/infected	8%	4%	
Mesh type (%)			< .001
Synthetic	36%	67%	
Biologic	14	0%	
Bioresorbable	49%	33%	
Concomitant procedure (%)	30%	39%	.237
Component separation technique (%)	42%	67%	.003
Complex ventral hernia repair	52%	74%	.010
Median operative duration [min (IQR)]	184 (147–231)	189 (141–231)	.875
Median EBL [cm^2 (IQR)]	150 (100–200)	100 (50–225)	.340
Median defect size [cm^2 (IQR)]	135 (76–233)	190 (68–282)	.379
Median mesh size [cm^2 (IQR)]	600 (400–800)	875 (502–1200)	.001

IQR interquartile range, 25th–75th percentiles

[†]χ^2 or Fisher's exact test for group proportions; Mann–Whitney U test for continuous variables

separation cases). The vast majority of cases were CDC Wound Class I (76 and 81%, ERAS vs. control). Whereas complex VHR is defined as that which involves a component separation technique and/or contamination, 34 (74%) ERAS

cases and 65 (52%) control cases were complex ($p = .01$). Type of mesh implanted varied by group ($p < .001$); ERAS patients were more likely to have had synthetic mesh implanted than control patients (67 vs. 36%), most likely due to a change over time in practice patterns. Median size of mesh implanted varied by group, with larger pieces of mesh having been placed for the ERAS patients ($p = .001$). Mesh was implanted in the retrorectus space for 94% of cases from each group. Mesh was placed either intraperitoneally or as an onlay for the remainder of the cases.

With respect to short-term clinical outcomes, patients in the ERAS group experienced earlier return of bowel function (median 3 vs. 4 days, $p = .003$) and overall decreased incidence of any wound complication compared to control patients (11 vs. 32%, $p = .006$) (Table 4). More specifically, ERAS patients were significantly less likely than control patients to experience superficial SSI (7 vs. 25%, $p = .004$). Length of hospital stay was similar between groups, as was percentage of patients readmitted to the hospital within 30 days. Of the 19 patients in the control group that were readmitted to the hospital within 30 days of surgery, 13 (68%) of the readmissions were attributed to wound complications, compared to 3–6 patients (50%) in the ERAS group. Two patients in the control group were readmitted due to VTE issues compared to 1 patient in the ERAS group.

Across all study subjects, the likelihood of any wound occurrence was greater among patients with BMI ≥ 30 kg/m^2 than for those patients with BMI < 30 kg/m^2 ($p = .017$). In an attempt to analyze the impact of obesity on wound occurrences between groups, outcomes by group were compared for those patients with BMI greater than or equal to 30 kg/m^2. Among only those patients with BMI greater than or equal to 30 kg/m^2, no differences between ERAS and historical controls in overall wound occurrences (20 vs. 36%, $p = .155$) or superficial SSI (12 vs. 28%, $p = .183$) were noted.

A total of 59 patients across the study were non-obese with a BMI < 30 kg/m^2. When comparing SSI pre- and post-ERAS implementation among this cohort of patients, we found that seven of 38 (18%) developed superficial SSI in the pre-ERAS group compared to no patient (0%) in the ERAS group ($p = .043$ based on Fisher's exact test.) In comparing SSO in the BMI < 30 kg/m^2 cohort, nine patients (24%) developed SSO pre-ERAS compared to no patient (0%) in the ERAS group ($p = .20$).

In terms of adherence to protocol specifications, compliance varied from 54% (acceleration of intestinal recovery) to 100% (postoperative glucose control). For the eight aspects of care for which the compliance was less than the set standard of 85%, the percent compliance attained with explanations of reasons for determination of lack of compliance without justification are shown in Table 5. On a case-by-case basis, protocol adherence varied from 55% for one patient to 94% for four patients. For the eight elements for which compliance did not meet the standard, adherence for the eight components by patient varied from two for one patient to eight for four patients with a mode of four. Clinical outcomes were compared based on the number met of the eight key elements for which standard was not reached across subjects. While mean number of key elements adhered to was greater among patients with better outcomes, none reached statistical significance.

Discussion

ERAS protocols have been shown to demonstrate benefits to patient recovery for colorectal surgery [13, 20], liver surgery [21], VHR [18], and gynecological surgery [22]. Decreased length of hospital stay is one of the most frequently reported improvements associated with ERAS protocols. A recent meta-analysis of 42 randomized controlled trials across a variety of procedures reported a reduction in LOS of 2.35 days for patients with an ERAS program in place compared to standard care [12]. While ERAS protocols have been reported for more than 20 years, more

Table 4 30-day postoperative clinical outcomes in historical controls and applied ERAS protocol groups

Characteristic	Historical control ($n = 125$)	ERAS protocol applied ($n = 46$)	p value[†]
Median length of hospital stay [days (IQR)]	5 (4–7)	5 (4–6)	.569
Return of bowel function [Median days (IQR)]	4 (3–5)	3 (2–4)	.003
Wound complication [n (%)]	40 (32%)	5 (11%)	.006
Infected seroma or seroma requiring drainage [n (%)]	11 (9%)	1 (2%)	.185
Superficial surgical site infection [n (%)]	31 (25%)	3 (7%)	.009
Deep surgical site infection [n (%)]	2 (2%)	1 (2%)	1.000
Non-wound complication [n (%)]	18 (14%)	4 (9%)	.442
Readmission	19 (15%)	6 (13%)	.723

IQR interquartile range, 25th–75th percentiles

[†] χ^2 or Fisher's exact test for group proportions; Mann–Whitney U test for continuous variables

Table 5 Protocol adherence for any key element with adherence less than standard set (85%)

Key protocol element	Percent adherence to protocol across patients	Reasons for determination of non-compliance
Acceleration of intestinal recovery	54%	Orders not placed and/or medication and/or dietary orders not administered/carried out
Prevention of intraoperative hypothermia	56.5%	> 1 recording of intraoperative temperature < 36 °C, no documentation of warmer placed in the OR
Preoperative fasting and carbohydrate treatment	57%	Notations in day of surgery anesthesia/nursing records of time of last oral liquids not corresponding to protocol requirements
Early mobilization	61%	No documentation of ambulation at least by end of day POD#1
Urinary drainage	70%	Urinary catheter left in place past POD#2 without justification
Prophylaxis against thromboembolism	78%	All preoperative doses of anticoagulant were ordered and provided, but there were postop missing doses on one or more occasions due to patient refusal/unjustified holding of medication
Perioperative fluid management	80%	Greater than 5 cc/kg/h or > 2 l IV fluids given intraoperatively
Multimodal pain management	54% (no scheduled opioids) 87% (multimodal pain control)	Either no documentation of multimodal efforts with pain management or patient had order for scheduled opioids

recently, authors have reviewed comprehensive institutional protocols to try to determine specific ERAS factors predictive of optimal outcomes [15, 23]. Factors found to be predictive of success include perioperative fluid management, early mobilization, early removal of tubes, and early oral nutrition [15, 23]. While some factors may, for example, have a stronger association with expedited hospital discharge than others, the interaction between the different elements of care within protocols likely contribute to the overall improvement of outcomes.

Enhanced recovery protocols for VHR have not been extensively studied, but early reports have been encouraging. Majumder et al. have shown an ERAS protocol to have positively affected hospital length of stay, return of bowel function, and readmission rates [18]. The current study did not demonstrate a decrease in hospital length of stay, and in retrospect, many factors likely were involved in the inability to have reduced length of hospital stay among the current cohort of patients that were cared for with the ERAS protocol in place. These factors include patient and staff expectations, and use of epidural catheters for pain management, which routinely were being removed on the third day postoperatively for any patient that was not experiencing nausea/vomiting/ileus. As a means to decrease median LOS, based on the current study data, earlier removal of epidural catheters, particularly for patients who undergo less musculoskeletal dissection, is being considered. Additionally, in part because of the information gained from our evaluation concerning less than ideal adherence for some aspects of care, we have added additional education to clinical staff (resident and nurses) involved in preoperative and postoperative care which together would be expected to positively impact median LOS over time.

Patients cared for with the ERAS for VHR protocol in place had significantly decreased incidence of superficial SSI compared to the historical control patients. As SSIs are a major player in increased costs and hernia recurrence, a reduction in incidence of SSIs of this magnitude would potentially be associated with decreased costs in the short term and decreased incidence of hernia recurrence in the long term. Superficial SSI following VHR has been shown to be associated with tripled hernia repair hospital costs as well as significantly increased 90-day post-discharge costs [8]. While prior to protocol implementation, our practice was to avoid repair of patients with BMI ≥ 40 kg/m^2, with the ERAS protocol in place, the surgical practice more rigorously followed strict BMI criteria for offering elective repair based upon local and other published outcomes' data [24, 25]. In comparing clinical outcomes based solely on BMI, patients with BMI equal to or greater than 30 kg/m^2 had increased incidence of wound occurrences than non-obese patients (32 vs. 15%). When comparing groups only among patients with BMI greater than 30 kg/m^2, no significant differences were found in wound occurrences in general or in superficial SSI more specifically. Given the increased complexity of repairs among the ERAS group and the lack of significance between groups for wound events for patients with BMI greater than or equal to 30, BMI alone is unlikely to account for the improved outcomes between groups.

Prior to implementation of ERAS for VHR, some elements of the protocol were performed although not standardized for all patients. Elements such as deep venous thrombosis prophylaxis and antibiotic prophylaxis were

routine, whereas other elements such as multimodal pain management, the use of bowel-enhancing medications, preoperative MRSA eradication, preoperative nutritional supplements and goal-directed intraoperative fluid management were not routinely employed. Once the protocol was commenced, attempts were made to adhere to all steps of the enhanced recovery pathway for all patients. As this study represents contiguous patients by the same surgeon at the same institution, we feel the improvement in outcomes following implementation of ERAS is most likely attributable to the protocol. Discerning the benefits of each element of the protocol is not feasible from the current study design. While it is possible that some elements are more beneficial than others, we feel that the culmination of implementation of all elements is responsible for the improved clinical outcomes in the ERAS group.

Protocol elements, standardized ordering for VTE prophylaxis and postoperative glucose control, were hospital policy at our institution prior to protocol implementation. Even though it is well understood that surgical patients are at risk for thrombus formation and prophylaxis is highly efficacious, there were instances noted from the current study in which the patient was noted to have refused one or more doses of postoperative subcutaneous heparin, a failure not only at the patient level, but also at the provider level for not further educating the patient about the risk involved. However, preoperative patient education is an important element of the enhanced recovery protocol; patients are provided detailed information preoperatively regarding all elements of the protocol and the importance of their compliance.

Improving the health of Americans and the performance of the health care system was the overriding intention of the Health Information Technology for Economic and Clinical Health (HITECH) Act which was passed by the United States Congress in 2009 as part of the stimulus bill (the American Recovery and Reinvestment Act) [26]. Standards and certification criteria were developed for the electronic health records (EHRs) that were created in order to help health care providers and hospitals comply with the provisions of the new guidelines. Based on the inherent technology of the systems, EHRs were built and continue to be upgraded to have the ability to record, track, and demonstrate the degree to which the underlying objectives are being met and ultimately the impact on patient care, safety, and efficiency [27]. Although EHRs are no doubt a dramatic improvement over paper-based systems, on the system level, informational technology has played a key role in difficulties encountered with implementation of some aspects of our ERAS protocol. For example, there is a lack of interface ability between the ambulatory EHR and the separate hospital EHR at our institution, leading to many opportunities for failure. Additionally, the ERAS postoperative order set has not been placed into the hospital system presenting particular challenges for the surgical providers in placing orders for postoperative pain control measures and other care elements. Despite these challenges, we remain optimistic that compliance will improve as implementation is adopted across our facility for ventral hernia and subsequently other specialties.

In addition to informational technology barriers to protocol implementation, other implementation difficulties have been described [28–30]. Resistance to change, concern of cost constraints, and communication deficits were identified as potential barriers based on interviews with multidisciplinary providers at an academic medical center planning system-wide implementation [30]. Due to fewer than desired number of protocol elements applied per patient, authors of a 2007 study concerning a colorectal surgery fast-track program conveyed a need for thorough and repeated education of hospital staff as a potential means of improvement of compliance [28]. Another early study noted that while implementation during the intraoperative period occurred with little difficulty, challenges to application were particularly evident in the early postoperative period [29].

The Centers for Medicare and Medicaid Services (CMS) has planned that 50% of traditional Medicare payments will flow through alternative payment models (APMs) by 2018 [31]. Because of the imminent shift toward APMs, in which reimbursement will be based on quality measures rather than quantity, it likely would be in the best interest of surgeons and hospitals to seek means of improving patient outcomes while avoiding unnecessary expense, such as with ERAS protocols. While some expense is involved in implementing enhanced recovery care pathways, improved outcomes would be expected to lead to early and late decreased costs under payment through APMs.

A primary limitation of this study was its retrospective nature. For any aspect of care that had not been documented, it was not possible to obtain the information. While the electronic medical records provide little opportunity for data loss, review nonetheless lacks the opportunity to be certain about some data points. However, missing data elements occurred minimally across this study. Another study limitation is that there was no indicator of patient satisfaction available in the medical records.

The purpose of this study was to assess the effectiveness of an ERAS protocol for VHR on short-term patient clinical outcomes. Because of the finding of substantially decreased rate of wound complications among the ERAS group compared to the historical control group, it is conceivable that the comprehensive nature of the described protocol was instrumental in improved outcomes for the patients cared for with the ERAS protocol in place.

Conclusions

A comprehensive ERAS protocol for VHR was associated with quicker return of bowel function and decreased incidence of SSI, which is the most prevalent postoperative complication following VHR. A system-wide culture focused on enhanced recovery is needed to ensure improved patient outcomes. Implementation of ERAS protocols in ventral hernia may enhance value by reducing perioperative complications. Further studies assessing the economic impact of ERAS protocols are ongoing.

Compliance with ethical standards

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