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GENERAL SURGERY NEWS

Special REPORT

Enhanced Recovery Pathways for Major Abdominal Surgery

This monograph is based on the 2nd Enhanced Recovery After Surgery (ERAS) USA Symposium held on October 10, 2014 in New Orleans, Louisiana.

Even in the absence of morbid events, patients undergoing major open colorectal surgery traditionally experience a significant decline in function requiring prolonged rehabilitation during the postoperative period. Additionally, despite improvements in surgical technology and perioperative care, complication rates of 30%,¹ and even as high as 45% to 50%,^{2,3} have been reported after major elective open colorectal surgery in the traditional perioperative care setting. A number of traditional interventions that are routinely used have been shown to be outdated, not evidence-based, and even harmful to patients.⁴⁻⁷ Long periods of physical inactivity and starvation perioperatively

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induce a loss of muscle mass and deconditioning, which in turn correlates with postoperative complications and fatigue.⁸

The geriatric population and individuals with limited physiologic reserve are least able to tolerate a decrease in functional status and are therefore at greater risk. If a perioperative complication occurs, the long-term sequelae and associated health care costs can be profound. The occurrence of a 30-day postoperative complication is more important than preoperative patient risk in determining survival after major surgery, and perioperative complications have been shown to decrease long-term median survival after surgery by 69% in a 10-year follow-up.⁹

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Enhanced recovery pathways (ERPs) are multimodal perioperative care pathways designed to attenuate the stress response during the patients' journey through a surgical procedure, facilitate the maintenance of preoperative bodily compositions and organ function, and in doing so achieve early recovery.¹⁰ ERPs integrate a range of perioperative interventions to maintain physiologic function and facilitate postoperative recovery.¹¹

ERPs in colorectal surgery were pioneered in the late 1990s by Professor Henrik Kehlet, who asked the fundamental question, "Why is the patient still in hospital?" Although the causes were multifactorial, the common end point that keeps patients in the hospital after uncomplicated major abdominal surgery is delay of the return of bowel function. This is influenced by several perioperative factors including the need for parenteral opioid analgesia, surgical approach, IV fluid management, and bed rest caused by lack of mobility. These factors often lead to delayed recovery and discharge from the hospital. The various elements of ERPs are aimed to address these issues, and the interventions that facilitate early recovery cover all 3 phases of the perioperative period (Table).

The essence of enhanced recovery after surgery (ERAS) or "fast-track" surgery pathways is to accelerate recovery by attenuating the stress response. With successful reduction in perioperative stress response, the hospital length of stay (LOS), the incidence of postoperative complications and overall mortality rate can be reduced. An observed added benefit of reducing health care costs also is associated with these improvements to clinical outcomes.^{10,11}

There are several elements of ERPs that are new and specific to this approach, bringing together 2 best practices: 1) organization of care and 2) clinical management, while ensuring that patients receive evidence-based care. In the 2000s, ERAS pathways in colorectal surgery were applied throughout Europe, and the first consensus guidelines were published in

2005.¹² Since then, ERAS pathways have been adopted worldwide, and pathways and guidelines have been published for other major procedures because the principles of ERPs apply to all patients undergoing major surgery.

Successful implementation of ERPs requires collaboration between surgery, anesthesia, and perioperative nursing to provide optimal perioperative care. Anesthesiologists play a vital role in facilitating recovery because they routinely carry out some of the key elements of ERPs (ie, preoperative assessment, perioperative fluid management, and optimal analgesia).

Preoperative Components

Preoperative components of an ERAS protocol involve patient education, preoperative evaluation and optimization, and techniques to minimize preoperative fasting. An informed, prepared, physiologically optimized, and fed-state patient is the goal.

Patient education is an essential part of any ERAS program. The aim is to educate the patient about the program, to set realistic expectations for postoperative recovery, and to psychologically prepare the patient, as well as family members, for the care program.

Written information at an appropriate literacy level should be provided, detailing explanations of the procedure along with goals for postoperative recovery. Detailed preoperative information given to patients may diminish fear and anxiety and aid postoperative recovery.¹³

Preoperative evaluation and optimization aim to optimize and risk-stratify patients, thus aiding with the consent process, choice of surgical procedure and anesthetic technique, and determination of the appropriate postoperative location. Recent cohort studies have reported that mortality and morbidity are still common after major surgery. Mortality ranges of 3% to 4% after major abdominal surgery have been reported,^{14,15} whereas overall morbidity is even more common (21%-30% after colorectal surgery¹⁴) and is often associated with a decline in functional

Table. Typical Elements in an Enhanced Recovery Protocol

Preoperative	Intraoperative	Postoperative
Identify patients	Minimally invasive surgery	Early feeding
Education about program	Goal-directed fluid therapy	Early mobilization
Screen for malnutrition	Regional anesthesia	Optimize fluid regimen
Carbohydrate drink	PONV prophylaxis	Optimize analgesic regimen
Selective bowel preparation	Antibiotics before incision	No NG tube or urinary catheter
Smoking cessation	Thromboprophylaxis	Multimodal analgesia

NG, nasogastric; **PONV**, postoperative nausea and vomiting

capacity and quality of life.¹⁶ In addition to evaluation and optimization of chronic diseases (eg, cardiovascular status, anemia, diabetes), preoperative evaluation should include help with smoking cessation and optimization of nutritional status (with oral supplements if needed). One month of abstinence from smoking is required to reduce the incidence of pulmonary complications.¹⁷ Additionally, prehabilitation to improve physical fitness before surgery is an emerging concept that is safe and effective, although evidence for improved outcomes is currently limited.¹⁸ Cardiopulmonary exercise testing (CPET) has been used to objectively evaluate exercise capacity preoperatively, and could be used to guide prehabilitation programs.¹⁹

There is no scientific evidence behind the dogma of fasting the night before elective surgery. Current preoperative fasting guidelines for adult patients undergoing elective surgery recommend a minimum fasting period of 2 hours for clear liquids and 6 hours for a light meal.²⁰ Examples of clear liquids include, but are not limited to, water, fruit juices without pulp, carbonated beverages, clear tea, and black coffee. Additionally, a preoperative 12.5% carbohydrate drink containing mainly maltodextrins (complex carbohydrates) has been shown to reduce preoperative hunger, thirst, and anxiety. There also are metabolic benefits in undergoing surgery in a metabolically fed state, with less protein loss, reduced postoperative insulin resistance (resulting in better glucose control), and better-maintained muscle strength.²¹ Current evidence suggests that a preoperative carbohydrate drink can be given safely to all patients, including those with diabetes.²²

There also is a lack of evidence for another dogma of surgical practice: the routine use of mechanical bowel preparation (MBP) for colonic and other major abdominal surgeries. There is no evidence that MBP decreases complications such as anastomotic leakage or wound infection.²³ Indeed, one study has shown that patients receiving MBP may have a tendency toward higher incidence of spillage of bowel contents and complications.^{24,25} Because MBP is associated with side effects such as dehydration and electrolyte disturbances, and is unpleasant for the patient, its routine use is not recommended in colon and other major abdominal surgeries.¹¹ Further trials are needed in rectal surgery, where MBP may be necessary. Additionally, some surgeons prefer the use of MBP for laparoscopic surgery to improve bowel handling.

Intraoperative Components

Intraoperative elements are the key to successful ERAS pathways, and lay the groundwork for early mobilization and feeding. Surgical and anesthetic factors should be considered in developing ERAS pathways.

Laparoscopic Surgery

Laparoscopic surgery for colon resections is recommended if the expertise is available.¹¹ Minimally invasive surgery in colon resection reduces the incidence of postoperative

complications and hospital LOS, while providing equivalent cancer outcomes.¹¹ Laparoscopic surgery within an ERAS protocol has shown superior recovery to all other combinations (ie, open surgery within an ERAS protocol, laparoscopic surgery with standard care).²⁶ There is less evidence from randomized controlled trials (RCTs) for the benefits of laparoscopic surgery in rectal surgery. However, it has been shown to be safe with equivocal disease-specific outcomes, and thus will undoubtedly be strongly driven by patients and surgeons.

Fluid Management

Fluid and pain management are the 2 major anesthetic factors to be considered when developing an ERAS protocol. Fluid management within ERAS should be viewed as a continuum through the preoperative, intraoperative, and postoperative phases. Each phase is important in improving patient outcomes, and suboptimal care in one phase can undermine best practices within the rest of the ERAS pathway.

The goals of intraoperative fluid management are to maintain central euvolemia and minimize salt and water excess. To achieve this, patients undergoing surgery within an ERP should have an individualized fluid management plan. As part of this plan, fluid excess should be avoided. Excess fluid administration will result in fluid shifting out of the circulation and into the interstitium.²⁷ The resulting interstitial edema can result in edema of the gut wall and prolonged postoperative ileus. Even a modest positive salt and water balance causing a weight gain of 3 kg after elective colon resection has been shown to delay recovery of gastrointestinal function, increased complications, and extended hospital LOS.⁵

Maintenance fluid requirements during surgery can be delivered with a 1 to 3-mL/kg per hour infusion of a balanced crystalloid solution, with the aim of maintaining preoperative body weight.^{28,29} The term *fluid restriction* should be abandoned because it implies causing deliberate hypovolemia. A better term to describe a low crystalloid therapy regimen is *zero-balance fluid therapy*.

For low-risk patients undergoing low-risk surgery, a zero-balance approach might be sufficient. However, during major surgery there also is a significant body of evidence supporting individualized goal-directed fluid therapy (GDFT).

GDFT refers to individualized fluid management using a minimally invasive cardiac output monitor. GDFT uses algorithms incorporating fluid challenges to optimize stroke volume (SV) and avoid episodes of hypovolemia and postoperative oxygen debt (Figure 1). This technique also has been referred to in the literature as SV optimization, and has been shown to reduce LOS and complications after major surgery.³⁰ In an ERP setting, the benefit of GDFT may be less than in older studies when crystalloid excess in the control group was the norm.³¹ Additionally, avoiding prolonged preoperative fasting has made intraoperative fluid management easier, with patients less likely to be fluid responsive upon arrival in the operating room.

However, a number of patients continue to receive preoperative bowel preparation, have significant comorbidities, and experience prolonged surgery with blood loss. Although ERAS programs may have raised the threshold for benefit, there will still be patients (some expected, some unexpected) for whom SV optimization will be beneficial. Ultimately, the additional benefit of GDFT should be determined based on surgical and patient risk factors.

Pain Management

Optimal pain management strategies should provide good pain relief, facilitate early mobilization and feeding, and avoid side effects and complications. This is best achieved by avoiding escalation of IV opioids as much as possible through the use of multimodal analgesia regimens and regional anesthesia (Figure 2).³² Opioid use leads to a host of undesirable side effects such as respiratory depression, postoperative nausea and vomiting (PONV), and delayed return of gastrointestinal function. That being said, rescue opioids should always be available if patients are in pain. All of the above opioid-related side effects are dose dependent, with minimization of opioid use being more important than avoidance: Limited use of IV opioids has little effect on outcome.³³

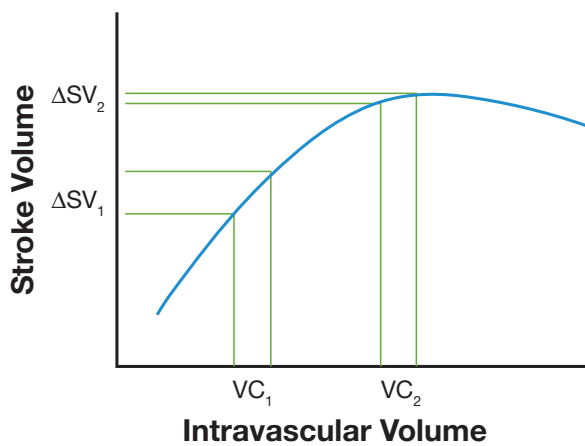


Figure 1. Frank-Starling-based stroke volume optimization.

When a patient is hypovolemic and on the steeper ascending part of the Frank-Starling curve, an IV fluid challenge (VC₁) will lead to a 10% increase in SV. Such a patient has “recruitable” SV, and is in a fluid-responsive state. When the patient is no longer hypovolemic (VC₂), the same fluid challenge will result in an increase of less than 10% in SV. The patient is now not fluid responsive and will not benefit from a further fluid challenge.

SV, stroke volume; **VC**, intravascular volume challenge

Multimodal analgesia should consist of regular acetaminophen and nonsteroidal anti-inflammatory drugs unless contraindicated; this should be initiated preoperatively and continued postoperatively as needed. Other drugs that can be used as part of a multimodal regimen include the gabapentinoids (gabapentin, pregabalin), N-methyl-D-aspartate receptor antagonists (ketamine), α_2 agonists (clonidine, dexmedetomidine), local anesthetic infiltration, and IV lidocaine.

Additionally, regional anesthesia should be used whenever possible as part of a pain management strategy. For open surgery, thoracic epidural anesthesia (TEA) is well established as the optimal regional analgesic technique. When functioning well, TEA offers excellent analgesia for the first 72 hours, and it is therefore considered the gold standard for open surgery.³⁴ However, TEAs have potential to cause harm. Patients with a poorly working TEA often are denied other analgesia and can be in considerable pain.³⁵ TEA also can cause hypotension (often treated with fluid) that complicates fluid management, as well as delayed mobilization and urinary catheter removal. Thus, it is essential that TEA be managed by a dedicated pain service.

For laparoscopic surgery, the advantages of TEA are less clear. Some studies support its use because patients undergoing laparoscopic surgery still experience a considerable amount of visceral pain¹⁰; yet, others suggest that it is unnecessary and that the disadvantages outweigh the advantages.³³ It is probably the case that there is no gold standard technique for laparoscopic surgery. For extensive laparoscopic surgery in a patient at high risk for pulmonary complications, TEA may offer advantages over other techniques.³⁶ For more routine laparoscopic surgery, alternative techniques should be considered such as intrathecal (spinal) analgesia, paravertebral blocks, transversus abdominis plane blocks, and local anesthesia in the wound, all combined with multimodal analgesia.

Postoperative Components

Successful implementation of the preoperative and intraoperative elements of an ERAS pathway enables mobilization and feeding to occur on the day of surgery. Patients are encouraged to sit on a chair for at least 6 hours on every postoperative day. Only evidence-based use of drains, catheters, or nasogastric tubes is applied. This intentionally directed early return to normal function reduces the complications associated with starvation and immobility.

Allowing early feeding decreases the incidence of ileus and negates the need for postoperative intravenous fluid. Avoiding postoperative fluid overload continues to be as important as fluid management intraoperatively; however, this can be a greater challenge on the surgical ward without monitors or fluid management strategies. Allowing for the responses to trauma of surgery and the natural normalization of these responses is an important postoperative management consideration. Some extent of permissive oliguria until decreases in antidiuretic

hormone or permissive relative hypotension (within 10-15 systolic points of baseline), while peripheral tone is decreased with a thoracic epidural, will allow for minimal fluid infusion when not needed.³⁷ These strategies are challenges with the multitude of care providers over the first 36 to 72 hours, emphasizing the need for enthusiastic teaching of all providers and involved learners.

The most enthusiastic early adopters of ERAS principles in the United States have been surgeons with aggressive rehabilitation postoperative protocols. These practitioners were predominantly early adopters of laparoscopic colorectal surgery and referred to their postoperative care pathways as “fast track.” These pathways have continued to evolve to include more elements as more interventions are studied. The majority of debated postoperative elements are related to bowel function, as the common end point of LOS is driven by return of bowel function.

Chewing gum, laxative use, and the peripheral mu-opioid inhibitor are used in many protocols. These individual components have been proven safe and variably effective. Of all the postoperative elements affecting outcomes, especially resource use and costs, preoperative education of discharge criteria and postoperative adherence to defined criteria is paramount. A patient that successfully tolerates the stress of surgery, due to all the implemented care elements, but is not successfully discharged at this time is subject to in-hospital complications and does not obtain the full benefit of the protocol.³⁸⁻⁴¹

The importance of team and patient education is essentially stressed in terms of discharge. One point of presumed failure of enhanced recovery care could be readmission. At times interpreted as being caused by premature discharge from the hospital, readmission following ERAS is usually due to complication(s); however, if patient education is lacking, the anxious or uneducated patient may use the postoperative clinic or emergency room for answers. These visits happen with greatest frequency in the first 30 days after index hospital stay and certainly affect the metrics of interest for ERAS programs. Of note, it has been shown that shorter hospital stays in an ERP are not associated with increased readmission. Rather, longer index stays are associated with greater readmission rates, confirming the etiology of readmission to be related to surgical complications.⁴²

Evidence of Benefit

The most recent meta-analysis of ERAS pathways in colorectal surgery included 2,376 patients in 16 RCTs, and showed that ERAS pathways were associated with a reduction of overall morbidity (relative risk [RR]=0.60; 95% confidence interval [CI], 0.46-0.76), particularly with respect to nonsurgical complications (RR = 0.40; 95% CI, 0.27-0.61).⁴³ The ERAS pathway also resulted in a shortened hospital LOS (weighted mean difference, -2.28 days; 95% CI, -3.09 to -1.47), without increasing the readmission rate.

Implementation of ERPs, however, is a complex process that affects multiple departments in a hospital and requires

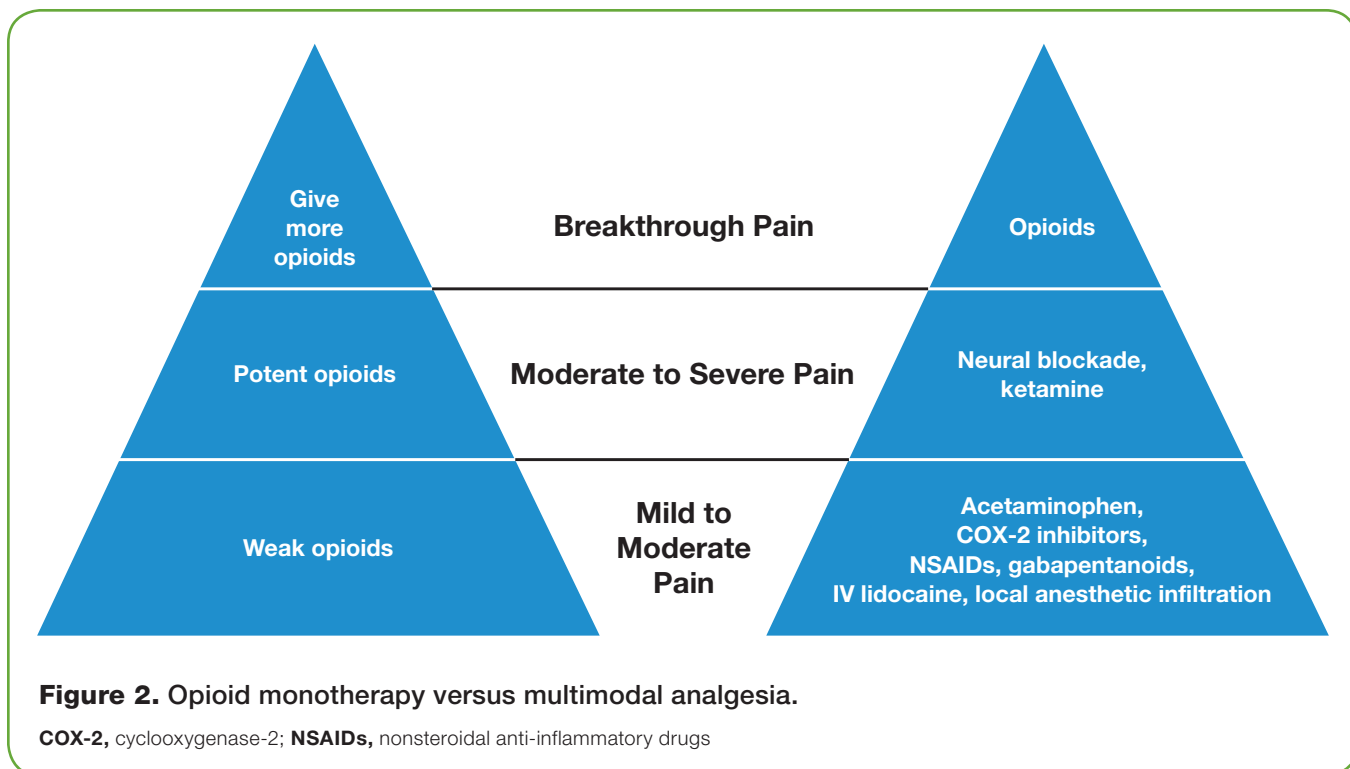


Figure 2. Opioid monotherapy versus multimodal analgesia.

COX-2, cyclooxygenase-2; **NSAIDs**, nonsteroidal anti-inflammatory drugs

collaboration between surgery, anesthesia, nursing, and hospital management. Most implementation cycles take 3 to 6 months and are multifaceted, and therefore are not ideally suited for an RCT. There also are a number of quality improvement projects showing similar benefits—the largest being the implementation of the NHS Enhanced Recovery Partnership Program in the United Kingdom.⁴⁴

It also is important to note that published studies to date that evaluate the outcome benefit of ERPs have focused on short-term benefits. Patients, however, do not define recovery as being healed physically; instead, they consider recovery as “the absence of symptoms and return of their ability to perform activities as they could prior to surgery.”⁴⁵ This rehabilitation period can last much longer than health care providers expect. In a study of patients older than age 60 years undergoing elective abdominal surgery, less than 50% of patients had recovered to baseline levels of physical performance 6 months after surgery, and 20% were still unable to perform basic activities of daily living (ADLs).⁴⁶ Thus, future studies should also examine long-term outcomes with return to normal function considered the benchmark for recovery after major surgery.⁴⁷

Moving Beyond Colorectal Surgery

The principles of ERPs apply to all patients undergoing major surgery, and probably all patients admitted to a hospital. There are now international guideline groups developing guidelines across all surgical specialties, and so far, evidence-based guidelines have been published or are being developed for pancreatotomy,⁴⁸ gastric resection,⁴⁹ cystectomy,⁵⁰ pelvic/rectal surgery,⁵¹ gynecologic procedures, and esophagectomy. In 2012, the United Kingdom’s Enhanced Recovery consensus statement stated that “enhanced recovery should now be considered standard practice for most patients undergoing major surgery across a range of procedures and specialties.”⁴⁴

Recent data suggest that at least 30% of patients over age 70 and hospitalized with a medical illness (eg, pneumonia) are discharged with a new hospitalization-associated disability (defined as a new loss of ability to perform at least one ADL) that was not present before the onset of illness⁵²; factors such as prolonged bed rest; malnutrition; and overuse of lines, monitors, urinary catheters, and sedating medications are thought to contribute significantly to loss of function.⁵³

The Economic Effect of ERPs

There is considerable economic benefit in the implementation of ERPs that is related to both the reduction in hospital LOS and complications.¹¹ The most recent meta-analysis showed that ERPs shorten hospital LOS by approximately 2.3 days.⁴³ This will result in a significant reduction in hospital costs, and also has added clinical and economic advantages to the institution by making hospital beds available for patients undergoing other procedures.

ERPs also reduce complications by approximately 40%,⁴³ and consequently reduced associated expenses. In a recent study of 74,140 patients undergoing major non-cardiac surgery, the average cost difference between patients with and without complications was \$29,876.⁵⁴ In an era of pay-for-performance programs and economic constraints, a program that improves the quality of health care while reducing costs is obviously very attractive to health care providers, administrators, and patients.

Conclusion

ERPs are multimodal perioperative care protocols that apply evidence-based medicine to every step of a patient’s perioperative period, and have been shown to reduce LOS and associated complications after colorectal surgery. ERPs should be considered as the new standard of care for patients undergoing elective colorectal resection. Additional studies are needed to support the use of ERPs in other major surgery.

The American Society for Enhanced Recovery (ASER) was officially founded in 2014. It is a nonprofit organization with an international membership, which is dedicated to promote the practice of enhanced recovery in the perioperative patients through education and research.

ASER’s mission is to advance the practice of perioperative enhanced recovery, and to contribute to its growth and influences by fostering and encouraging research, education, public policy discussion, and scientific progress.



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