Fast-Track Pathways in Colorectal Surgery

Paul J. Chestovich, MD[a], Anne Y. Lin, MD[b], James Yoo, MD[c,*]

KEYWORDS

• Fast-track • Enhanced recovery after surgery • ERAS • Colorectal surgery

KEY POINTS

- Enhanced recovery after surgery (ERAS) or "fast-track" pathways are a multimodal approach to the perioperative management of patients undergoing colorectal surgery designed to improve the overall quality of care.
- Typical fast-track management includes proper patient selection, avoidance of bowel preparation unless indicated, multimodal pain management including epidural catheters, use of a laparoscopic approach when possible, avoidance of excessive fluid administration, early diet advancement and ambulation, and adherence to Surgical Care Improvement Project (SCIP) measures.
- Fast-track protocols are safe for patients and offer improvement in intestinal recovery and hospital discharge.
- A higher rate of hospital readmissions should be expected, although the overall hospital days will be lower than in standard perioperative management.

INTRODUCTION

Fast-track pathways, also known as ERAS pathways, were first introduced in the mid-1990's and are a more recent addition to the care of patients undergoing colorectal procedures.[1] The purpose of these pathways is to use current evidence in a streamlined multidisciplinary manner with the aim of minimizing surgical pain and enhancing recovery, leading to fewer complications, more rapid hospital discharge, and improved overall outcomes. These pathways encompass all facets of perioperative care, including preoperative planning, intraoperative management, and postoperative

[a] Department of Surgery, David Geffen School of Medicine, University of California Los Angeles, 757 Westwood Plaza, B711, Los Angeles, CA 90095, USA; [b] Department of Surgery, David Geffen School of Medicine, University of California Los Angeles, 10833 Le Conte, 72-247 CHS, Los Angeles, CA 90095, USA; [c] Department of Surgery, David Geffen School of Medicine, University of California, Los Angeles, 10833 Le Conte Avenue, 72-253 CHS, Los Angeles, CA 90095, USA
* Corresponding author.
E-mail address: jayoo@mednet.ucla.edu

Surg Clin N Am 93 (2013) 21–32
http://dx.doi.org/10.1016/j.suc.2012.09.003 **surgical.theclinics.com**
0039-6109/13/$ – see front matter

care. Success is achieved by making evidence-based management decisions aimed to expedite recovery and minimize complications after surgery, which ultimately decreases the use of hospital resources and health care costs.

Several small trials have been performed in the past several years comparing traditional perioperative management with a fast-track approach in colorectal surgery.[2–8] These studies demonstrated more rapid return of bowel function, shorter inpatient hospital stays, and fewer complications, although 2 studies[3,8] noted an increased rate of readmissions after fast-track surgery. Systematic review and meta-analysis has supported these findings with decreased hospital stay and no change in mortality, complications, or readmissions.[9] From this information, fast-track protocols are a safe useful tool for any surgeon performing colorectal procedures.

PREOPERATIVE EVALUATION AND PATIENT SELECTION

Proper patient selection is the first and perhaps most important component of a fast-track pathway. Not all patients should be considered for this type of management. The best candidates for fast-track protocol are primarily healthy individuals requiring straightforward procedures for diverticulitis, polyps, or nonobstructive malignancy (**Box 1**). Generally, any patient with American Society of Anesthesiologists (ASA) score 1 or 2 and select ASA 3 patients may be included. Finally, the patient should be well informed and amenable to fast-track management because active patient participation will directly affect the success of the program. In ideal circumstances, the protocol should be discussed with the patient in a preoperative clinic visit, and the goals, advantages, and risks discussed in detail.

Box 1
Indications and contraindications to fast-track management in colorectal surgery

Ideal patients for fast-track management

Straightforward elective procedures

ASA 1, 2, possibly 3

Ambulatory preoperatively

Good nutritional status

No prior abdominal surgery

Compliant, reliable, and amenable to fast-track management

Relative contraindications—use fast-track management with caution

Contraindication to epidural analgesia

Psychiatric issues

Poor social support

Difficult or unconventional procedure

Absolute contraindications to fast-track management

Emergent procedures (obstruction, perforation, ischemia)

ASA 4 or higher

Patients who are nonmobile or have limited mobility

Severe malnutrition

Noncompliant or reluctant to participate in the fast-track program

There are also several patient groups in which fast-track management is inadvisable. These include patients who are malnourished, immobile, or minimally mobile. Patients requiring emergent procedures should also be avoided, such as for ischemia, obstruction, or perforation. Medical comorbidities should be considered, and all patients with ASA 4 or higher and some ASA 3 patients would not be well suited for fast-track management. The specific procedure should be considered in the decision, and difficult procedures, such as those requiring extensive dissection or lysis of adhesions, would be best managed via standard postoperative protocols. Owing to the higher readmission rates after discharge from fast-track protocols, a patient's social support and psychiatric history should be considered, and patients who may be unreliable, or may have difficulty returning for complications or follow-up, should be fast-tracked with caution.

BOWEL PREPARATION

Mechanical bowel preparation before elective colorectal surgery was previously considered the standard of care for decades. It was thought to decrease infectious complications and anastomotic dehiscence by decreasing intraluminal fecal mass and bacterial load. Although tolerated by most patients, cathartic bowel preparation may cause dehydration and potentially severe electrolyte toxicities, especially in elderly patients with renal insufficiency,[10] and should not be treated lightly.

Recently, use of bowel preparation has been extensively studied. Meta-analyses of multiple trials have concluded that bowel preparation is unnecessary and fails to decrease infectious complications or improve outcomes after colorectal surgery.[11–13] Many surgeons continue using bowel preparation for patients requiring a low rectal anastomosis because of concern that the column of stool may cause anastomotic disruption. Detailed subgroup analysis comparing patients with and without bowel preparation has failed to find a difference in anastomotic leakage, infectious complications, mortality, peritonitis, or reoperation in both colon and rectal procedures. Furthermore, no difference was found between oral bowel preparation and enemas.[11] However, in patients receiving cathartic bowel preparation, the addition of oral antibiotics may reduce infectious complications compared with prep alone.[14]

Current clinical practice guidelines from the Canadian Society of Colon and Rectal surgeons endorses omitting bowel preparation for open left-sided and right-sided colon surgery but has found insufficient evidence for patients undergoing laparoscopic or low anterior resection procedures. Some surgeons may prefer a bowel preparation in certain scenarios, such as resection of a small nontattooed lesion (<2 cm), or if there may be a need to perform an intraoperative colonoscopy. This preference is particularly relevant to laparoscopic procedures when the location of a lesion is uncertain and manual palpation is not possible. Some surgeons may also prefer to use a bowel preparation in all laparoscopic procedures to make colon manipulation easier, and guidelines published by the Society of Alimentary Gastrointestinal Endoscopic Surgeons (SAGES) have endorsed the use of bowel preparations in laparoscopic colorectal surgery.[15]

At present there is no study specifically investigating the use of cathartic bowel preparation in a fast-track pathway, although some studies investigating fast-track protocols omitted bowel preparation,[6,16] whereas others included a standard bowel preparation.[4,8] It is up to the specific surgeon as to the inclusion of a bowel preparation, but the general recommendation is to avoid routine use unless specifically indicated.[2]

LAPAROSCOPIC VERSUS OPEN PROCEDURES

Laparoscopy has revolutionized the modern practice of surgery and has become a standard method for performing colon resection. Properly performed laparoscopic colon surgery achieves appropriate surgical margins, accurate staging, and equivalent survival when compared with open surgery.[17] A meta-analysis of long-term outcomes comparing laparoscopic to open colorectal surgery for cancer resection found no difference in tumor recurrence, cancer-related mortality, as well as reoperations for hernia or adhesions.[18]

When considering inclusion in a fast-track protocol, the laparoscopic approach to colon resection offers several advantages. In trials comparing laparoscopic and open colon surgery, patients undergoing laparoscopic colon resection have less postoperative pain, fewer wound infections, shorter time to return of bowel function, and shorter hospital stays. There is no difference in reoperation rate or postoperative complications, but the procedure time is longer in laparoscopic procedures.[19] Of note, this difference in operative time between the 2 approaches has steadily decreased as further experience with minimally invasive techniques has accrued over time.

For these reasons, a laparoscopic approach should be preferred in the establishment of a fast-track pathway, provided the patient is suitable for laparoscopy. However, some groups have successfully implemented a fast-track pathway using both open and laparoscopic techniques, with similar outcomes in bowel recovery, hospital stay, morbidity, and mortality.[20] Thus, although the laparoscopic approach will likely yield more rapid return to normal activity and hospital discharge, an open surgical approach should not exclusively preclude inclusion in a fast-track protocol.

FLUID MANAGEMENT

Standard fluid management in colorectal surgery involves liberal fluid administration during both intraoperative and postoperative periods. However, this practice has been challenged recently because excess intravenous (IV) fluid is suspected to increase interstitial volume and total body weight, leading to ambulation difficulty, cardiopulmonary dysfunction, and impaired tissue oxygenation. These effects are suspected to contribute to anastomotic breakdown and wound infections.[21] For this reason, some institutions have adopted a protocol of fluid restriction in the perioperative management of colorectal procedures.

Several randomized clinical trials have addressed the issue of fluid administration in surgical patients. Two trials of patients undergoing colorectal surgery comparing "standard" and "restricted" fluid administration found fewer complications in fluid-restricted patients,[22,23] whereas another found no difference in complications, discharge time, and diet advancement.[24] An additional trial comparing "restricted" with "excess" fluid administration found no difference in hospital stay or complications, but fluid-restricted patients had less hypoxia and improved pulmonary function.

Unfortunately, the specific definition of "standard," "excess," and "restricted" fluid administration is rather nebulous. A detailed description of perioperative fluid management is beyond the scope of this article, but in general, "standard" perioperative fluid management is divided into intraoperative and postoperative periods. Intraoperatively, insensible fluid losses are replaced 2 mL/kg/h and third-space losses are replaced 1 to 3 mL/kg/h for minor surgical trauma (eg, hernia repair) and up to 6 to 8 mL/kg/h for major surgical trauma (including colon resection procedures). Patients who are nil per os (NPO) preoperatively without hydration have a fluid deficit at the start of the procedure, which is replaced according to maintenance fluid rates. In

patients receiving bowel preparations, this deficit may be even greater. Blood loss is replaced at 3 mL of crystalloid for every 1 mL of blood lost. Postoperatively, maintenance fluid is administered at 4 mL/kg/h for the first 10 kg of body weight, 2 mL/kg/h for the next 10 kg, and 1 mL/kg/h for each kg beyond 20 kg. Vital signs are monitored, with a urine output goal of 0.5 to 1 mL/kg/h.[25] Fluid administration is then altered as clinically necessary.

Owing to the differences in fluid administration in different trials, 1 meta-analysis[26] defined "standard" fluid management using calculated estimates of fluid requirements based on the patient weight, length, and type of procedure. A range was defined as the mean value $\pm$10%. Fluid "restriction" was any amount more than 10% beneath the low limit of this range, and "excess" fluid administration was any amount more than 10% above the upper limit. This study failed to find any significant differences in mortality, anastomotic leakage, or wound infection, but overall morbidity was decreased when intraoperative fluids were restricted. Decreases in morbidity were also found in patients using intraoperative esophageal Doppler-guided fluid management, although this method is experimental and not in widespread use.

Although it is impossible to devise a universal fluid administration protocol that is satisfactory for all patients, the avoidance of excessive fluid administration is a prudent strategy, with fluid boluses reserved for clinical indications of hypovolemia. This strategy will decrease perioperative third spacing, likely facilitate a more rapid hospital discharge, and would thus be advocated in a fast-track protocol. It is imperative that any fluid administration protocol be developed in conjunction with the anesthesia team because the intraoperative fluid volume given seems to have the greatest effect on morbidity. Furthermore, the patient's specific health status should be considered, and fluid restriction should be used with caution or avoided completely in patients with renal dysfunction, diabetes mellitus, history of alcohol overconsumption, and inflammatory bowel disease. Similarly, a careful approach should ensue in patients who may not tolerate bolus fluid administration well, such as those with underlying congestive heart failure, although admittedly, both strategies involve inherent risks in this population.

PAIN MANAGEMENT

Pain management is another significant element of surgical perioperative care and is best accomplished through cooperation between patients, nurses, anesthesiologists, pain specialists, and surgeons. There are several methods available for pain control, but most patients who undergo colorectal surgery receive either patient-controlled opioid analgesia (PCA) techniques or indwelling continuous epidural analgesia (CEA) with opioid or local anesthesia infusion for pain control. PCA has the benefit of providing systemic delivery of opioids, which acts on opiate receptors in the brain and body, and yields immediate pain relief. It also allows patients to self-titrate to their individual pain level, and its use is associated with high levels of patient satisfaction.[27] However, disadvantages include systemic opioid effects including respiratory depression, sedation, nausea and vomiting, and prolongation of postoperative ileus.

Continuous epidural anesthesia, also known as neuraxial anesthesia, has the benefit of delivering a combination of local and opioid analgesia directly to the dorsal horn of the spinal cord, thus delivering pain relief without systemic opioid effects.[28] Negative side effects of CEA include pruritis, urinary retention, and arterial hypotension, often necessitating additional fluid administration. CEA also requires placement of a catheter in the epidural space, an additional invasive procedure that can be associated with rare complications of neuraxial bleeding or hematoma (approximately 1 in

150,000 cases).[29] CEA may be used safely in conjunction with pharmacologic deep venous thrombosis (DVT) prophylaxis, and practice guidelines for proper use are available from the American Society of Regional Anesthesia.[29]

Several trials have investigated the potential benefits of PCA and CEA in patients undergoing colorectal surgery with regard to pain control, resumption of diet, resolution of ileus, and hospital discharge. Most trials have found a benefit with CEA for the end points pain control, diet resumption, and ileus resolution but have failed to demonstrate a decrease in hospital stay.[30,31] One study demonstrated a higher rate of prolonged ileus[32] in CEA patients while showing superior pain control, diet advancement, and resolution of ileus with spinal anesthesia. Two different meta-analyses[33,34] and one systematic review[35] found significant improvement in pain control with CEA compared with PCA. Only 1 meta-analysis found improvement in ileus resolution with CEA,[33] although it was also associated with a higher incidence of urinary retention, pruritis, and hypotension.

Although a definitive decrease in hospital stay has yet to be demonstrated, CEA use does improve pain control when compared with PCA, and there is reasonable evidence to suggest that it hastens resolution of ileus and helps diet advancement. We would advocate for CEA use in fast-track pathways in patients without contraindications. Superiority of CEA seems to be greatest in the first 2 to 3 postoperative days (PODs), so routine removal of CEA after POD 2 or 3 may be a useful strategy in a fast-track pathway.[30,32] If not anticipated, waiting for catheter removal could actually delay discharge by an additional day, thereby nullifying any benefit achieved by earlier resumption of diet and resolution of ileus.

Other modalities of pain control include local control by wound infiltration with local anesthesia. This is an easy step with low morbidity and may help decrease doses of CEA or PCA required to achieve adequate pain control. Nonsteroidal antiinflammatory drugs (NSAIDs) such as ibuprofen (Motrin) or ketorolac (Toradol) are also useful in controlling postoperative pain and have the added benefit of not worsening postoperative ileus. Ketorolac is parenterally administered and particularly useful in the immediate postoperative period. It acts through prostaglandin inhibition and has a similar time to onset as IV morphine but has longer duration (6–8 h) and minimal central nervous system effects of respiratory depression, sedation, nausea, and vomiting. Side effects include inhibition of platelet aggregation, gastrointestinal (GI) ulceration, and renal toxicity and so should be avoided or used cautiously in patients with increased risk of bleeding or renal dysfunction. Acetaminophen can also be used and is available in both oral and IV formulation. It is particularly useful as an adjunct to oral narcotic pain medication. Because many oral preparations already contain acetaminophen, the total daily dose should be monitored to avoid liver toxicity.

DIET ADVANCEMENT

A central tenet of a fast-track protocol is diet advancement to the patient's preoperative regimen. All patients considered for fast-track management should have a functional nonobstructed GI tract immediately before their colorectal procedure. Gastric drainage tubes have been shown to increase pulmonary complications, delay bowel function, and increase length of stay without any difference in anastomotic breakdown and so should not be used without evidence of ileus or obstruction.[36] If they are used intraoperatively for technical purposes, they should be removed as soon as the surgery is completed.

Specific protocols for advancement of diet vary, and no protocol will be perfect for all patients and procedures. Early enteral feeding has been studied extensively, and

multiple trials[37–40] and a meta-analysis[41] have shown it to be safe and possibly beneficial for patient recovery from colorectal surgery. Most fast-track protocols allow at least some liquids immediately after surgery, some with addition of protein shakes for added nutrition. Patients will then advance to their regular diet by POD 2 to 3, some with a soft or blenderized diet in between, whereas other protocols allow for discharge when tolerating a full liquid diet. The addition of alvimopan (Entereg), a highly selective μ-receptor antagonist, has been shown to improve recovery of intestinal function without adversely affecting postoperative analgesia[42] and may be useful in a fast-track protocol.[43,44]

DRAINAGE

Anastomotic drainage is a long-standing controversial topic, and many studies have been conducted investigating its merits. Meta-analyses of trials in this topic have failed to show a benefit for routine drainage,[45,46] and routine anastomotic drainage is not typically part of a fast-track pathway. However, if clinically indicated, drain placement should not interfere with a standard fast-track protocol.

READMISSIONS

Readmission after discharge after colorectal surgery has been a significant drawback to adoption of fast-track pathways. Several studies comparing fast-track to conventional pathways have demonstrated higher readmission rates for patients in the fast-track group when compared with the conventional group.[3–5,8] Importantly, despite the increased readmissions, the total hospital days are still lower for patients managed by fast-track pathways. It is generally difficult to predict readmissions after colorectal surgery,[47] and most readmissions occur after POD 5 to 7, indicating that a longer hospitalization may not have prevented the readmission.[3,5] However, a slightly higher readmission rate should be anticipated when adopting a fast-track protocol. It is prudent to notify patients of this preoperatively and verify that patients are reliable, have good social support structure, and are able to return to the hospital should concerns or complications arise.

SCIP MEASURES

SCIP is a widely publicized initiative by the Center for Medicare and Medicaid Services (CMS) and Centers for Disease Control (CDC) to reduce the number of postoperative complications.[44] Targeted events include surgical site infections (SSI), adverse cardiac events, DVT and thromboembolism, and postoperative pneumonia. All applicable measures currently recommended and recorded through SCIP can be incorporated into a fast-track protocol.

- SSI prevention—Appropriate hair clipping, appropriate antibiotic administration within 1 hour before skin incision and discontinued within 24 hours, and immediate postoperative normothermia (T >98.6°F within 1 hour of leaving operating room).
- Adverse cardiac events—Patients on preoperative beta-blockade should be continued throughout the operation and perioperative period.
- DVT—Appropriate thromboembolism prophylaxis (low-dose unfractionated heparin 5000 units twice or thrice daily or low-molecular-weight heparin combined with intermittent pneumatic compression or graduated compression stockings).

PROTOCOL MODIFICATIONS

No perioperative management protocol is perfect for all patients. The guidelines presented in this article are simply meant to act as a framework to standardize the postoperative management, minimize complications, and decrease hospital stays, and protocol deviations are expected. Each patient should be closely followed throughout his or her hospitalization, and protocol changes should be made for proper clinical indications. For example, patients with more severe pain may require an epidural or PCA for a longer time and those with nausea and abdominal distension may have prolonged ileus and will thus require longer hospitalization. The fast-track protocol should not usurp good clinical judgment. Even accounting for protocol deviations and hospital readmissions, the overall number of hospital days will likely decrease when a fast-track protocol is instituted.

SUMMARY

Fast-track protocols were developed to use current evidence to streamline perioperative management for patients undergoing colorectal surgery, decrease complications, reduce hospital resource use, and improve the overall quality of care. Most fast-track protocols include careful patient selection and preoperative planning, avoidance of bowel preparation, avoidance of excessive fluid, laparoscopic approach to surgery, multimodal pain management, early ambulation, and rapid diet advancement. Despite the faster return to normal function and discharge, a higher readmission rate is expected, although the overall hospital days are still fewer than with standard management techniques.

Sample fast-track pathway
Preoperative
Medical risk stratification and workup.
Lesion marked with tattoo, if possible.
Bowel preparation for small lesions or anticipating intraoperative colonoscopy.
Review the surgical procedure, plan of care, and milestones with patients, their families, and the anesthesia and nursing teams.
NPO after midnight before surgery.
Place epidural catheter for postoperative pain control.
Appropriate DVT and antibiotic administration.
Intraoperative
Prefer laparoscopic approach when feasible and safe.
Place Foley catheter for bladder drainage.
Appropriate antibiotic and thromboembolism prophylaxis.
Avoid excessive fluid; boluses for clinical indications.
Proper blood glucose level control.
Remove orogastric tube placed for technical purposes at the end of case.
No routine drainage unless clinically indicated.
POD 0
Maintenance IV fluids.

Return to normothermia within 1 hour of leaving operation room.

Restricted liquid diet (30–60 mL/h).

Begin ambulation out of bed to chair.

Begin incentive spirometry.

POD 1

Unrestricted liquid diet.

Heplock IV when tolerating liquids (>500 mL intake).

Monitor urine output for 0.5 mL/kg/h; bolus if clinically indicated.

Continue incentive spirometry and ambulation out of bed in hallway.

Discontinue bladder catheter.

Discontinue prophylactic antibiotics within 24 hours.

Consider scheduled acetaminophen or NSAIDS (ketorolac, ibuprofen) or for pain control if indicated.

POD 2

Advance to soft or regular preoperative diet.

Continue ambulation, incentive spirometry, and other perioperative care.

Schedule epidural catheter removal in the early morning.

Start oral pain regimen.

POD 3 to 4

Remove epidural catheter.

Discharge home if afebrile with stable vital signs, tolerating diet, urinating spontaneously, and pain controlled on oral regimen and if the patient is amenable to discharge.

REFERENCES

1. Kehlet H. Fast-track colorectal surgery. Lancet 2008;371:791–3.
2. Kehlet H, Wilmore DW. Evidence-based surgical care and the evolution of fast-track surgery. Ann Surg 2008;248:189–98.
3. Jakobsen DH, Sonne E, Basse L, et al. Convalescence after colonic resection with fast-track versus conventional care. Scand J Surg 2004;93:24–8.
4. Feo CV, Lanzara S, Sortini D, et al. Fast track postoperative management after elective colorectal surgery: a controlled trial. Am Surg 2009;75:1247–51.
5. Basse L, Thorbøl JE, Løssl K, et al. Colonic surgery with accelerated rehabilitation or conventional care. Dis Colon Rectum 2004;47:271–8.
6. Muller S, Zalunardo M, Hubner M, et al. A fast-track program reduces complications and lengths of hospital stay after open colonic surgery. Gastroenterology 2009;136:842–7.
7. Wichmann MW, Eben R, Angele MK, et al. Fast-track rehabilitation in elective colorectal surgery patients: a prospective clinical and immunological single-centre study. ANZ J Surg 2007;77:502–7.
8. Khoo CK, Vickery CJ, Forsyth N, et al. A prospective randomized controlled trial of multimodal perioperative management protocol in patients undergoing elective colorectal resection for cancer. Ann Surg 2007;245:867–72.
9. Wind J, Polle SW, Fung Kon Jin PH, et al. Systematic review of enhanced recovery programmes in colonic surgery. Br J Surg 2006;93:800–9.

10. Barkun A, Chiba N, Enns R, et al. Commonly used preparations for colonoscopy: efficacy, tolerability and safety – a Canadian Association of Gastroenterology position paper. Can J Gastroenterol 2006;20:699–710.
11. Guenaga KF, Matos D, Wille-Jorgensen P. Mechanical bowel preparation for elective colorectal surgery [review]. Cochrane Database Syst Rev 2011;(9):CD001544.
12. Pineda CE, Shelton AA, Hernandez-Boussard T, et al. Mechanical bowel preparation in intestinal surgery: a meta-analysis and review of the literature. J Gastrointest Surg 2008;12:2037–44.
13. Slim K, Vicaut E, Launay-Savary MV, et al. Updated systematic review and meta-analysis of randomized clinical trials on the role of mechanical bowel preparation before colorectal surgery. Ann Surg 2009;249:203–9.
14. Englesbe MJ, Brooks L, Kubus J, et al. A statewide assessment of surgical site infection following colectomy: the role of oral antibiotics. Ann Surg 2010;252: 514–20.
15. Society of American Gastrointestinal and Endoscopic Surgeons. Guidelines for laparoscopic resection of curable colon and rectal cancer. 2005. Available at: http://www.sages.org/publication/id/32/.
16. Vlug MS, Wind J, Hollmann MW, et al. Laparoscopy in combination with fast track multimodal management is the best perioperative strategy in patients undergoing colonic surgery: a randomized clinical trial (LAFA-study). Ann Surg 2011;254: 868–75.
17. Clinical Outcomes of Surgical Therapy Study Group. A comparison of laparoscopically assisted and open colectomy for colon cancer. N Engl J Med 2004; 350:2050–9.
18. Kuhry E, Schwenk W, Gaupset R, et al. Long-term results of laparoscopic colorectal cancer resection. Cochrane Database Syst Rev 2008;(4):CD003432.
19. Schwenk W, Haase O, Neudecker JJ, et al. Short term benefits for laparoscopic colorectal resection. Cochrane Database Syst Rev 2008;(4):CD003145.
20. Basse L, Jakobsen DH, Bardram L, et al. Functional recovery after open versus laparoscopic colonic resection: a randomized, blinded study. Ann Surg 2005; 241:416–23.
21. Holte K, Sharrock NE, Kehlet H. Pathophysiology and clinical implications of perioperative fluid excess. Br J Anaesth 2002;89:622–32.
22. Abraham-Nordling M, Hjern F, Pollack J, et al. Randomized clinical trial of fluid restriction in colorectal surgery. Br J Surg 2012;99:186–91.
23. Brandstrup B, Tønnesen H, Beier-Holgersen R, et al. Effects of intravenous fluid restriction on postoperative complications: comparison of two perioperative fluid regimens. A randomized assessor-blinded multicenter trial. Ann Surg 2003;238: 641–8.
24. MacKay G, Fearon K, McConnachie A, et al. Randomized clinical trial of the effect of postoperative intravenous fluid restriction on recovery after elective colorectal surgery. Br J Surg 2006;93:1469–74.
25. Morgan GE, Mikhail MS, Murray MJ. Fluid management and transfusion. In: Morgan GE Jr, Mikhail MS, Murray MJ, editors. Clinical anesthesiology. 4th edition. vol. 29. New York: The McGraw-Hill Companies; 2005. p. 690–707.
26. Rahbari NN, Zimmermann JB, Schmidt T, et al. Meta-analysis of standard, restrictive and supplemental fluid administration in colorectal surgery. Br J Surg 2009; 96:331–41.
27. Morgan GE, Mikhail MS, Murray MJ. Pain management. In: Clinical anesthesiology. 4th edition. vol. 18. p. 359–411.

28. Kleinman W, Mikhail M. Spinal, epidural, and caudal blocks. In: Clinical anesthesiology. 4th edition. vol. 16. p. 289–323.
29. Horlocker TT, Wedel DJ, Rowlingson JC, et al. Regional anesthesia in the patient receiving antithrombotic or thrombolytic therapy. American Society of Regional Anesthesia and Pain Medicine evidence-based guidelines (Third edition). Reg Anesth Pain Med 2010;35:64–101.
30. Carli F, Trudel JL, Belliveau P. The effect of intraoperative thoracic epidural anesthesia and postoperative analgesia on bowel function after colorectal surgery: a prospective, randomized trial. Dis Colon Rectum 2001;44: 1083–9.
31. Taqi A, Hong X, Mistraletti G, et al. Thoracic epidural analgesia facilitates the restoration of bowel function and dietary intake in patients undergoing laparoscopic colon resection using a traditional, nonaccelerated, perioperative care program. Surg Endosc 2007;21:247–52.
32. Levy BF, Scott MJ, Fawcett W, et al. Randomized clinical trial of epidural, spinal, or patient-controlled analgesia for patients undergoing laparoscopic colorectal surgery. Br J Surg 2010;98:1068–78.
33. Marret E, Remy C, Bonnet F. Meta-analysis of epidural analgesia versus parenteral opioid analgesia after colorectal surgery. Br J Surg 2007;94:665–73.
34. Werawatganon T, Charuluxananan S. Patient controlled intravenous opioid analgesia versus continuous epidural analgesia for pain after intra-abdominal surgery [review]. Cochrane Database Syst Rev 2005;(1):CD004088.
35. Levy BF, Tilney HS, Dowson HM, et al. A systematic review of postoperative analgesia following laparoscopic colorectal surgery. Colorectal Dis 2010;12: 5–15.
36. Verma R, Nelson RL. Prophylactic nasogastric decompression after major abdominal surgery [review]. Cochrane Database Syst Rev 2007;(3):CD004929.
37. Zhou T, Wu XT, Zhou YJ, et al. Early removing gastrointestinal decompression and early oral feeding improve patients' rehabilitation after colorectostomy. World J Gastroenterol 2006;12:2459–63.
38. Dag A, Colak T, Turkmenoglu O, et al. Randomized controlled trial evaluating early versus traditional oral feeding after colorectal surgery. Clinics 2011;66: 2001–5.
39. Han-Geurts IJ, Hop WC, Kok NF, et al. Randomized clinical trial of the impact of early enteral feeding on postoperative ileus and recovery. Br J Surg 2007;94: 555–61.
40. Reissman P, Teoh TA, Cohen SM, et al. Is early oral feeding safe after elective colorectal surgery? Ann Surg 1995;222:73–7.
41. Andersen HK, Lewis SJ, Thomas S. Early enteral nutrition within 24h of colorectal surgery versus later commencement of feeding for postoperative complications [review]. Cochrane Database Syst Rev 2011;(2):CD004080.
42. Curran MP, Robins GW, Scott LJ, et al. Alvimopan. Drugs 2008;68:2011–9.
43. Barletta JF, Asgeirsson T, El-Badawi KI, et al. Introduction of Alvimopan into an enhanced recovery protocol for colectomy offers benefit in open but not laparoscopic colectomy. J Laparoendosc Adv Surg Tech A 2011;21:887–91.
44. Jones RS, Brown C, Opelka F. Surgeon compensation: "Pay for performance," the American College of Surgeons National Surgical Quality Improvement Program, the Surgical Care Improvement Program, and other considerations. Surgery 2005;138:829–36.
45. De Jesus CE, Karliczek A, Matos D, et al. Prophylactic anastomotic drainage for colorectal surgery [review]. Cochrane Database Syst Rev 2008;(4):CD002100.

46. Urbach DR, Kennedy ED, Cohen MM. Colon and rectal anastomoses do not require routine drainage: a systematic review and meta-analysis. Ann Surg 1999;2:174–80.
47. Azimuddin K, Rosen L, Reed JF III, et al. Readmissions after colorectal surgery cannot be predicted. Dis Colon Rectum 2001;44:942–6.