CLINICAL PRACTICE GUIDELINES

Clinical Practice Guidelines for Enhanced Recovery After Colon and Rectal Surgery From the American Society of Colon and Rectal Surgeons and Society of American Gastrointestinal and Endoscopic Surgeons

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KEY WORDS: Colectomy; Enhanced recovery; Ileus; Proctectomy.

This clinical practice guideline represents a collaborative effort between the American Society of Colon and Rectal Surgeons (ASCRS) and the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES). The ASCRS Clinical Practice Guidelines Committee is composed of society members who are chosen because they have demonstrated expertise in the specialty of colon and rectal surgery. In a collaborative effort, the ASCRS Clinical Practice Guidelines Committee and members of the SAGES Surgical Multimodal Accelerated Recovery Trajectory Enhanced Recovery Task Force and Guidelines Committee have joined together to produce this guideline, written and approved by both societies. The combined ASCRS/SAGES panel worked together to develop the statements in this guideline and approved these final recommendations. Through this effort, the ASCRS and SAGES continue their dedication to ensuring high-quality perioperative patient care.

Previous guidelines on perioperative care for colon[1] and rectal[2] surgery included studies identified up to January 2012 with significant literature published since then. The combined ASCRS/SAGES committee was created to define current best-quality care for enhanced recovery after colon and rectal surgery. This clinical practice guideline is based on the best available evidence. These guidelines are inclusive and not prescriptive. Their purpose is to provide information on which decisions can be made rather than to dictate a specific form of treatment. These guidelines are intended for the use of all practitioners, healthcare workers, and patients who desire information about the management of the conditions addressed by the topics covered in these guidelines. It should be recognized that these guidelines should not be deemed in-

All supplemental tables for these guidelines are available at this link: https://tinyurl.com/CPG-Suppl-Tables.

Financial Disclosure: The funding bodies (ASCRS and SAGES) did not influence the content of this work and no other specific funding was received from other entities. Dr Keller is a member of the Pacira Pharmaceuticals speaker's bureau, and her institution has received unrestricted educational grants from Pacira. Dr Feldman has received grant support from Medtronic and Merck. Dr Carmichael's institution has received unrestricted educational grant support for his work with Medtronic and Johnson & Johnson.

Liane S. Feldman and Scott R. Steele contributed equally to this article.

This article is being published concurrently in *Surgical Endoscopy*. The articles are identical except for minor stylistic and spelling differences in keeping with each journal's style. Either citation can be used when citing this article.

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Dis Colon Rectum 2017; 60: 761–784
DOI: 10.1097/DCR.0000000000000883

clusive of all proper methods of care or exclusive of methods of care reasonably directed toward obtaining the same results. The ultimate judgment regarding the propriety of any specific procedure must be made by the physician in light of all of the circumstances presented by the individual patient.

STATEMENT OF THE PROBLEM

Contemporary colorectal surgery is often associated with long length of stay (8 days for open surgery and 5 days for laparoscopic surgery),[3] high cost,[3] and rates of surgical site infection approaching 20%.[4] During the hospital stay for elective colorectal surgery, the incidence of perioperative nausea and vomiting (PONV) may be as high as 80% in patients with certain risk factors.[5] After discharge from colorectal surgery, readmission rates have been noted as high as 35.4%.[6]

An enhanced recovery protocol (ERP) is a set of standardized perioperative procedures and practices that is applied to all patients undergoing a given elective surgery. In general, these protocols are not intended for emergent cases, but components of them certainly could apply to the emergent/urgent patient. Also known as fast-track protocols or enhanced recovery after surgery (ERAS)[1] protocols, the content of these specific protocols may vary significantly, but all are designed as a means to improve patient outcomes. Outcomes of interest to patients and providers include freedom from nausea, freedom from pain at rest, early return of bowel function, improved wound healing, and early hospital discharge.[7] Although numerous perioperative protocols currently exist, this clinical practice guideline will evaluate the strength of evidence in support of measures to improve patient recovery after elective colon and rectal resections.

A 2011 Cochrane review found that ERPs were associated with a reduction in overall complications and length of stay when compared with conventional perioperative patient management.[8] Subsequent studies have shown that ERPs are associated with reduced healthcare costs and improved patient satisfaction.[4] ERPs are also associated with improved outcomes regardless of whether patients undergo laparoscopic or open surgery.[9] Studies have also shown that ERPs cannot simply be implemented and forgotten but require a continued audit process in place to guide compliance and to continue to improve quality.[10–13]

There are many different preoperative, intraoperative, and postoperative components in a typical ERP, and it is difficult to identify which are the most beneficial components of the bundle of measures, because they are generally all implemented simultaneously. However, one retrospective review of 8 years of compliance with an ERP identified these items as the strongest predictors of shorter length of stay: no nasogastric tube, early mobilization, early oral nutrition (early discontinuance of intravenous fluids), early removal of epidural, early removal of urinary catheter, and nonopioid analgesia.[10] This clinical practice guideline will evaluate the evidence behind ERPs for colorectal surgery.

METHODOLOGY

Members of the SAGES and ASCRS Practice Guidelines Committee worked in joint production of these guidelines from inception to final publication. Final recommendations were approved by each society's committee and executive council. These guidelines were built following a standardized algorithm for the creation of all of our clinical practice guidelines, which included: search for existing guidelines, formulation of key questions, a systematic review of the literature, selection and appraisal of the quality of the evidence, development of clear recommendations, and drafting of the guideline. The details of specific search strategies, including search terms, inclusion criteria, exclusion criteria, total number of studies identified, and tables of evidence for each statement, are available in the supplements, but all of the search strategies involved an organized search of MEDLINE, PubMed, EMBASE and the Cochrane Database of Collected Reviews using a variety of key word combinations (for details on key words and search strategies see https://tinyurl.com/CPG-Suppl-Tables). Systematic searches were conducted from 1990 to 2016 and were restricted to English-language articles. Directed searches of the embedded references from the primary articles were also performed in certain circumstances. Prospective randomized controlled trials (RCTs) and meta-analyses were given preference in developing these guidelines. After all of the searches were complete, a total of 12,483 citations had been identified for title/abstract review, and 764 of those articles were selected for extensive review and placed into evidence tables with ranking of the evidence based on quality of the research by 2 independent reviewers (see Tables S1–S14, https://tinyurl.com/CPG-Suppl-Tables). The final grade of recommendation was performed using the modified Grading of Recommendations, Assessment, Development, and Evaluation system outlined previously by the American College of Chest Physicians (Table 1).[14] Previous guidelines on perioperative care for colon[1] and rectal[2] surgery included studies identified up to January 2012, with significant literature published since then.

PREOPERATIVE INTERVENTIONS

A. Preadmission Counseling

1. A preoperative discussion of milestones and discharge criteria should typically be performed with the patient before surgery. Grade of recommendation: strong recommendation based on low-quality evidence, 1C.

Standardized discharge criteria for patients undergoing colorectal surgery have been defined previously in an international consensus statement, which states that patients are fit for discharge when there is tolerance of oral intake, recovery of lower GI function, adequate pain control with oral analgesia, ability to mobilize, ability to perform self care, no evidence of complica-

TABLE 1. The Grading of Recommendations, Assessment, Development, and Evaluation system-grading recommendations[14]

	Description	*Benefit vs risk and burdens*	*Methodologic quality of supporting evidence*	*Implications*
1A	Strong recommendation, high-quality evidence	Benefits clearly outweigh risk and burdens or vice versa	RCTs without important limitations or overwhelming evidence from observational studies	Strong recommendation, can apply to most patients in most circumstances without reservation
1B	Strong recommendation, moderate-quality evidence	Benefits clearly outweigh risk and burdens or vice versa	RCTs with important limitations (inconsistent results, methodologic flaws, indirect or imprecise) or exceptionally strong evidence from observational studies	Strong recommendation, can apply to most patients in most circumstances without reservation
1C	Strong recommendation, low- or very low-quality evidence	Benefits clearly outweigh risk and burdens or vice versa	Observational studies or case series	Strong recommendation but may change when higher quality evidence becomes available
2A	Weak recommendation, high-quality evidence	Benefits closely balanced with risks and burdens	RCTs without important limitations or overwhelming evidence from observational studies	Weak recommendation, best action may differ depending on circumstances or patients' or societal values
2B	Weak recommendation, moderate-quality evidence	Benefits closely balanced with risks and burdens	RCTs with important limitations (inconsistent results, methodologic flaws, indirect, or imprecise) or exceptionally strong evidence from observational studies	Weak recommendation, best action may differ depending on circumstances or patients' or societal values
2C	Weak recommendation, low- or very low-quality evidence	Uncertainty in the estimates of benefits, risks, and burden; benefits, risks, and burden may be closely balanced	Observational studies or case series	Very weak recommendations; other alternatives may be equally reasonable

Adapted with permission from Chest. 2006;129:174–181.[14]
RCT = randomized controlled trial.

tions or untreated medical problems, adequate post-discharge support, and patient willingness to leave the hospital.[15]

Although there are few studies that look solely at the impact of preadmission counseling regarding milestones and defined discharge criteria, these concepts are a well-established cornerstone of ERPs.[1,16–21] Several single-center case series,[4,22–34] prospective cohort studies,[35] systematic reviews,[36,37] and RCTs[38–41] have supported the benefits of an ERP that includes defined discharge criteria on reducing hospital length of stay. Furthermore, compliance with an ERP that includes preoperative patient education and defined discharge criteria has been shown in prospective trials and national audits to be inversely associated with length of stay and complication rates.[10,42–46]

The time to meeting the defined discharge criteria (time to readiness for discharge) has been proposed as a measure of short-term recovery.[47] However, there are discrepancies between the time when patients are meeting defined discharge criteria and actually being discharged, with a reported 1 to 2 days of additional length of stay despite high ERP compliance.[48,49]

2. Ileostomy education, marking, and counseling on dehydration avoidance should be included in the preoperative setting. Grade of recommendation: strong recommendation based on moderate-quality evidence, 1B. The creation of an ostomy is an independent risk factor for a prolonged length of stay after colorectal surgery.[21,50–53] The benefit of structured patient stoma education to significantly improve quality of life and psychosocial adjustment, reduce hospital length of stay, and reduce hospital costs has been affirmed in several single-center and multicenter studies, as well as a systematic review.[54,55] Stoma education in general is beneficial before discharge, but a randomized trial demonstrated that patient education was most effective if undertaken in the preoperative period.[50] Case–control, registry, retrospective, and prospective descriptive studies have shown that preoperative evaluation by an enterostomal therapist (including marking of the skin site and patient education) was associated with significantly improved postoperative quality of life, reduced rates of postoperative complications, and improved patient independence regardless of stoma type.[56–61] Retrospective and prospective studies have confirmed the benefit of preoperative stoma education, specifically within an ERP.[56,62]

Counseling on dehydration avoidance is an important element of ERPs. Dehydration has been shown to be the most common cause of readmission after ileostomy creation, ranging from 40% to 43% of readmissions.[63,64] By implementing an ileostomy pathway in which patients were directly engaged in ostomy management and avoiding dehydration within an enhanced recovery pathway, Nagle et al[6] reduced overall readmissions from 35.4% to 21.4% and readmissions for dehydration from 15.5% to 0%. Stoma education, including dehydration avoidance, within a perioperative care pathway has been included in a systematic and expert review of process measures to reduce postoperative readmission.[65]

B. Preadmission Nutrition and Bowel Preparation

1. A clear liquid diet may be continued <2 hours before general anesthesia. Grade of recommendation: strong recommendation based on high-quality evidence, 1A.

Patients should be encouraged to drink clear fluids <2 hours before the induction of anesthesia, because it has been shown to be safe and to improve patients' sense of well-being.[66] Since 1986, multiple randomized controlled clinical trials[67–74] have supported the ingestion of clear liquids <2 hours before elective surgery. These studies have shown that ingestion of clear liquids within 2 to 4 hours of surgery versus >4 hours is associated with smaller gastric volume and higher gastric pH at the time of surgery. The current practice guidelines of the ASA[66] and European Society of Anaesthesiology support this recommendation.[75]

2. Carbohydrate loading should be encouraged before surgery in nondiabetic patients. Grade of recommendation: weak recommendation based on moderate quality evidence, 2B.

The use of preoperative carbohydrate-rich beverages should be encouraged, with the purpose to attenuate insulin resistance induced by surgery and starvation.[76] A Cochrane review in 2014[76] identified 27 trials conducted in Europe, China, Brazil, Canada, and New Zealand, involving 1976 participants. Most beverages contained complex carbohydrates (eg, maltodextrin), as opposed to the monosaccharides (eg, fructose) or disaccharides (eg, sucrose) found in fruit juice or sports drinks. The conclusion of the review was that carbohydrate treatment was associated with a small reduction in the length of hospital stay when compared with placebo or fasting in adult patients undergoing elective surgery. Preoperative carbohydrate loading was not associated with increased or decreased perioperative complications when compared with placebo or fasting. Several studies were susceptible to bias because of a lack of blinding. A meta-analysis of 21 randomized studies including 1685 patients showed no overall difference in length of stay across all of the included studies; however, when considering the subgroup of patients undergoing major abdominal surgery, there was a benefit in terms of length of stay.[77] A network meta-analysis of 43 trials evaluated whether the dose of carbohydrate was influential and found that both low and high doses of carbohydrate before surgery improved length of stay when compared with fasting.[78] However, when compared with water or placebo, carbohydrate loading did not show a benefit in the length of stay. Carbohydrate loading failed to influence the rate of complications regardless of the dose or comparator group. Based on this most recent analysis, allowing clear liquids before surgery may provide similar clinical results as formal carbohydrate loading.

3. Mechanical bowel preparation plus oral antibiotic bowel preparation before colorectal surgery is the preferred preparation and is associated with reduced complication rates. Grade of recommendation: weak recommendation based on moderate-quality evidence, 2B.

A 2013 guideline[1] for perioperative care in elective colonic surgery stated that mechanical bowel preparation (MBP) should not be used routinely in colonic surgery based on the distress it causes patients, and a 2011 Cochrane review[79] showed no benefit to MBP in randomized trials. However, recent evidence regarding the addition of oral antibiotic preparation (OBP) to MBP should be taken into account.

Although there appear to be no meaningful benefits of MBP alone in terms of complications, a meta-analysis of seven RCTs (1769 patients) comparing MBP with OBP versus MBP alone showed a reduction in total surgical site infection and incisional site infection, with no difference in the rate of organ/space infection after elective colorectal surgery.[80] These trial findings are consistent with population-level data. In a retrospective analysis of a large nationwide database in the United States, MBP plus OBP in left colonic resection was associated with decreased overall morbidity, superficial surgical site infection, anastomotic leakage, and intra-abdominal infections.[81] Similar retrospective studies in different populations (Veterans Administration database[82] and a large Polish hospital database[83]) showed a reduction in surgical site infection with the addition of OBP to MBP. The Michigan Surgical Quality Collaborative database showed a reduction in surgical site infection and a reduction in postoperative *Clostridium difficile* colitis in patients who received MBP with OBP versus patients who received no bowel preparation.[84] When OBP was added as part of a larger perioperative care bundle at Duke University, a significant drop in surgical site infection was seen.[85]

C. Preadmission Optimization

1. Prehabilitation before elective surgery may be considered for patients undergoing elective colorectal surgery with multiple comorbidities or significant deconditioning. Grade of recommendation: weak recommendation based on moderate-quality evidence, 2B.

Prehabilitation, defined as enhancement of the preoperative condition of a patient, has been proposed as a possible strategy for improving postoperative outcomes.[86] Prehabilitation aims to augment functional (exercise) capacity before a surgical procedure with the intent to minimize the postoperative morbidity and accelerate postsurgical recovery.[87,88]

The quality of existing data is poor. Several systematic reviews were performed, using both controlled and noncontrolled data.[86,89–98] These studies were of moderate to poor methodologic quality. Some of these meta-analyses and RCTs reported on the effects of exercise training only in patients who had completed colorectal cancer treatment, not prehabilitation.[91–94] The applicable studies inconsistently showed physical improvement with prehabilitation. Meta-analyses including diverse patient populations had conflicting evidence for the effect of prehabilitation on function, quality of life, length of stay, and pain.[89,97,98] Studies focusing on colorectal and abdominal oncologic surgery were highly heterogeneous in terms of exercise interventions studied, duration, outcome measures, follow-up period of the interventions, and compliance rates with these programs, which limited the power of comparisons and the ability to draw conclusions.[99–106] However, these studies did support the feasibility of prehabilitation to improve or preserve physical function before surgery. There were additional retrospective reviews, observational and case–control studies, and longitudinal analyses that reported improvement in physical function, peak exercise capacity, mental health, vitality, self-perceived health, and quality of life with prehabilitation.[101,105–111] Patients at lower baseline functional capacity may have the most to gain with prehabilitation.[106] However, inherent biases in the study design, lack of control group or randomization of participants, small sample sizes, wide variances in compliance with protocols, and limited generalizability limited these studies. When looking at postoperative quality outcomes, small, single-center studies report no differences in postoperative complication rates and hospital length of stay with prehabilitation compared with control subjects or postoperative rehabilitation[103,106,109] or results have been discordant.[100,109]

D. Preadmission Orders

1*. *Preset orders should be used as a part of the enhanced care pathway. Grade of recommendation: weak recommendation based on low-quality evidence, 2C

ERPs are complex and require collaboration between many different stakeholders to ensure the optimal care of the surgical patient. Common to all of these protocols are preset orders, which include preoperative, intraoperative, and postoperative sections that standardize care between all surgeons and for all patients. The current number of elements has not yet been clearly elucidated, but all of the randomized studies comparing enhanced recovery versus conventional care have included preset order sets as part of the pathway. However, it is not merely the presence of standardized order sets that contribute to improved outcomes, because a study by Li et al[112] reported improved outcomes for patients undergoing esophagectomy who were managed by enhanced recovery compared with a conventional care group that already included standardized preset orders. Complete protocol implementation is recommended over piecemeal implementation.[113]

The presence of standardized orders within an ERP is not enough to ensure optimal outcomes. Maessen et al[48] demonstrated in a multi-institutional study that adherence to protocol elements was high in the preoperative and intraoperative phases but low postoperation. Patients met predefined recovery criteria at a median of 3 days, but median length of stay was 5 days. Only 31% of patients in that study were discharged on functional recovery, and institutions that had long-standing ERPs were more likely to delay discharge. A larger multi-institutional collaborative from the ERAS Society reported that patients with <50% protocol compliance experienced longer length of stay and more complications than patients with ≥75% compliance throughout all of the perioperative phases.[114] A national clinical audit reported that compliance with an ERP was weakly associated with shorter length of stay.[46] However, this has not been an unequivocal finding, because a single-center retrospective study reported decreased ERP compliance in routine clinical practice compared to within a randomized clinical trial, yet the study did not demonstrate any differences in length of stay, complications, or mortality between the 2 groups.[115]

PERIOPERATIVE INTERVENTIONS

A. Surgical Site Infection

1*. *A bundle of measures should be in place to reduce surgical site infection. Grade of recommendation: strong recommendation based on moderate-quality evidence, 1B.

A care bundle is a small set of evidence-based practices that have been proven to improve patient outcomes. In 2014, Keenan et al[85] reported a reduction in superficial surgical site infections (SSIs) from 19.3% to 5.7% after implementation of a preventative SSI bundle. Preoperative measures included a chlorhexidine shower, MBP with oral antibiotics, ertapenem within 1 hour of incision, and standardization of preparation of the surgical field with chlorhexidine. Operative measures included use of a wound protector, gown and glove change before fascial closure, use of a dedicated wound closure tray, and limited operating room traffic. Postoperative measures included removal of the sterile dressing within 48 hours and daily washings of the incision with chlorhexidine. Patient education, euglycemia maintenance, and perioperative maintenance of normothermia were also components of the bundle. No significant difference was observed in deep SSIs and organ-space SSIs.

A recent systematic review and cohort meta-analysis including 16 studies concluded that use of an evidence-based, surgical care bundle for patients undergoing colorectal surgery significantly reduced the risk of SSI (7.0% in bundle group vs 15.1% in the standard care group). Although none of the studies in this analysis used the identical SSI care bundles, all included elements from a core group of interventions, including appropriate antibiotic prophylaxis, normothermia, appropriate hair removal, and glycemic control for hyperglycemic patients.[116]

Other measures that have been included in SSI bundles are a reduction in intraoperative intravenous fluid use, supplemental oxygen, double gloving, smoking cessation, MBP omission, Penrose drains for high BMI, pulse lavage of subcutaneous tissue, and silver dressings for 5 days postoperation. Bundles vary between different protocols, and the degree to which each plays a role in reducing SSI remains difficult to determine.

B. Pain Control

1. A multimodal, opioid-sparing, pain management plan should be used and implemented before the induction of anesthesia. Grade of recommendation: strong recommendation based on moderate-quality evidence, 1B.

Multiple prospective studies have demonstrated that minimizing opioids is associated with earlier return of bowel function and shorter length of stay.[4,10,41,117] One of the simplest techniques to limit opioid intake is to schedule narcotic alternatives, such as oral acetaminophen, nonsteroidal anti-inflammatory drugs (NSAIDs), and gabapentin, rather than giving them on an as-needed basis.[38]

The scheduled use of nonselective or selective NSAIDs (and cyclooxygenase 2 inhibitors),[118] when not contraindicated, and of acetaminophen[119–121] (by mouth or intravenously) have been shown to improve postoperative analgesia and reduce systemic opioid consumption and some of their dose-dependent adverse effects[120,122–125] that have been shown to delay surgical recovery.[126] Experimental and observational clinical studies have shown that NSAIDs may increase the risk of anastomotic leakage[127–132]; however, one recent meta-analysis demonstrated that, in patients receiving ≥1 dose of NSAIDs in the first 48 hours after surgery, the risk of anastomotic leakage was not significantly increased.[133] This potential effect on leak rates appears to be molecule[131] and class specific[132] and more pronounced in patients receiving NSAIDs for a period >3 days after surgery. Another recent meta-analysis has demonstrated a higher risk of anastomotic leakage exclusively in patients undergoing emergency but not elective colorectal surgery (OR = 1.70 (95% CI, 1.11–2.68)).[130] The evidence is inconclusive and does not support the avoidance of NSAIDs in patients with low cardiovascular risk.[134,135]

Systemic perioperative gabapentinoids,[136] ketamine,[137,138] and α2-agonists[139–141] have also been administered to improve analgesia and reduce systemic opioid consumption and postoperative hyperalgesia, but psychotropic adverse effects,[142] dizziness, and sedation may impair immediate recovery. Moreover, the optimal gabapentinoids regimen (dose, timing, and duration of administration) still needs to be determined. High doses of systemic steroids have also been shown to attenuate systemic inflammatory response and improve pulmonary function and postoperative analgesia without increasing the risk of wound dehiscence or infection.[143–146] However, additional safety data are needed. Wound infiltration and abdominal trunk blocks with liposomal bupivacaine have shown promising results in patients undergoing open and laparoscopic colorectal surgery.[147–150] In addition, limited data demonstrate that the transversus abdominis plane (TAP) block with a local anesthetic has been associated with decreased length of stay compared with systemic opioids in laparoscopic colorectal surgery.[151] TAP blocks performed before surgery appear to provide better analgesia than TAP blocks performed at the end.[152] Although many centers start a multimodal analgesic regimen preoperatively, the efficacy of preemptive analgesia remains controversial[153–158] and mainly limited to epidural blockade and TAP blocks.[152,159–161]

2. Thoracic epidural analgesia is recommended for open colorectal surgery, but not for routine use in laparoscopic colorectal surgery. Recommendation: strong recommendation based on moderate-quality evidence, 1B.

Although thoracic epidural analgesia (TEA; T6–T12) is considered the gold standard (versus patient controlled analgesia or simple parenteral opioids) to control pain in patients undergoing open colorectal surgery,[162,163] the modest analgesic benefits provided by TEA do not support a faster recovery in laparoscopic surgery. Trials and meta-analyses have shown that TEA has no impact on[164,165] or may even delay[166] hospital discharge in laparoscopic surgery. This delay is probably related to the higher incidence of hypotension and urinary tract infections requiring additional postoperative care.[164–168] TEA might still be valuable in patients at high risk of pulmonary complications,[169] in whom postoperative pain management could be challenging (eg, patients chronically using opioids), with a high risk of conversion to midline laparotomy.[170]

When an epidural is used, an infusion of a mixture of a small dose of local anesthetic and lipophilic opioids has been shown to provide better analgesia than an epidural infusion of local anesthetic or opioids alone.[162,163,171] Epidural hydrophilic opioid combined with small doses of local anesthetic can provide better analgesia for long midline incisions.[172] The addition of adjuvants such as epidural adrenaline[173–175] or clonidine[160,161,176] can be considered to improve segmental analgesia and reduce certain opioid adverse effects. Because epidural failure rates have been reported ranging from 22% to 32%,[177,178] alternative methods to increase the specificity of the conventional loss-of-resistance technique (ie, method of placement used to identify the epidural space), such as neurostimulation and waveform analysis, can be used to increase the success rate of epidural blocks.[177–190]

C. Perioperative Nausea and Vomiting

1. Antiemetic prophylaxis should be guided by preoperative screening for risk factors for postoperative nausea/vomiting. Grade of recommendation: strong recommendation based on moderate-quality evidence, 2B.

The incidence of postoperative nausea and vomiting (PONV) across all of the patients in a postanesthesia care unit is ≈30%,[181] whereas patients with documented risk factors for PONV may have an incidence of PONV as high as 80%.[5] PONV increases hospital costs and significantly reduces patient satisfaction.[182] Control of PONV has been shown to significantly improve patient satisfaction.[183]

One existing guideline supports preoperative risk assessment of all patients undergoing anesthesia and subsequent tailored multimodal therapy to prevent and treat PONV[184]; however, the most recent practice guideline from the ASA does not address risk assessment.[185] Several validated scoring systems have been developed to help identify patients at high risk for PONV.[186] Although preoperative assessment of PONV and prevention makes intuitive sense, some experts argue for the liberal use of a multimodal antiemetic protocol for all patients (regardless of risk), because antiemetics tend to be low cost and low risk.[187]

A recent single-center, cluster-randomized trial of 12,032 elective surgical patients showed that the simple implementation of a PONV prediction model (without specific recommendations for antiemetic prophylaxis) did not reduce the PONV incidence despite increased antiemetic prescriptions in high-risk patients.[188] However, a prospective study by the same group in which risk assessment was combined with a specific recommendation for antiemetic intervention showed a significant reduction in PONV in all patients, with an even greater reduction in high-risk patients.[189] A significant reduction in PONV has been seen with this type of strategy (pairing risk assessment with a specific antiemetic strategy recommendation) in several other prospective, nonrandomized trials.[190–192]

2. Preemptive, multimodal antiemetic prophylaxis should be used in all at-risk patients to reduce PONV. Grade of recommendation: strong recommendation based on high-quality evidence, 1A.

Although many interventions have been developed to help prevent postoperative nausea, vomiting, and the need for rescue medications, it appears that combination therapy is the best approach in high-risk patients. One prospective series of 900 patients revealed that a multimodal antiemetic approach reduced the predicted risk of PONV (79%–87%) in the high-risk group to just 7% and that patients actually had a high willingness to pay for such preventative treatment.[5] Prospective data demonstrate that use of ≥3 prophylactic antiemetics had the most positive impact on the prevention of PONV in high-risk patients.[193]

A common intervention for patients determined to be high risk for PONV is the administration of dexamethasone at induction of anesthesia and ondansetron (or another 5-hydroxytryptamine 3 antagonist) at emergence from anesthesia.[191] RCT data show that the combination of ondansetron with dexamethasone is superior to single-agent therapy in the prevention of PONV in moderate- to high-risk patients undergoing abdominal surgery.[194] A meta-analysis of 9 RCTs including 1089 patients clearly demonstrated that dexamethasone combined with other antiemetics provided significantly better prophylaxis than single antiemetics with decreased PONV and the use of rescue therapy.[195] In addition to its antiemetic properties, dexamethasone provides some analgesic effects. A recent meta-analysis of 45 RCTs involving 5796 patients receiving dexamethasone alone showed that dexamethasone patients used fewer opioids, required less rescue analgesia for pain, and had lower pain scores at 2 hours.[144] Although some have stated concerns regarding hyperglycemia associated with steroid administration in diabetic patients, an RCT has shown that preoperative administration of 8 mg of dexamethasone did not lead to a significant intraoperative hyperglycemic response when compared with nondiabetic patients.[196]

Additional strategies to control PONV include the use of total intravenous anesthesia, intravenous acetaminophen, and gabapentin. There is RCT evidence that the addition of total intravenous anesthesia with propofol to a multimodal antiemetic regimen is superior to a multimodal antiemetic regimen with inhaled anesthetics.[183] A meta-analysis of 30 RCTs including 2364 patients showed that the use of intravenous acetaminophen given either before surgery or before arrival in the postanesthesia care unit reduced the risk of nausea and pain; however, it was not effective in preventing PONV if given after the onset of pain.[122] There have now been 17 randomized controlled clinical trials evaluating the efficacy of preoperative gabapentin as prophylaxis for PONV in abdominal surgery, and a quantitative meta-analysis shows that the pooled relative risk of nausea and vomiting is lower in patients who receive preoperative gabapentin.[197] Interestingly, the benefits of gabapentin appeared reduced in the presence of the use of propofol, and it remains unclear how gabapentin fits into a multimodal PONV prevention plan. Although the meta-analysis included studies using varying doses of gabapentin and a variety of abdominal surgeries were included, the level of evidence is strong in support of gabapentin.

D. Intraoperative Fluid Management

1. Maintenance infusion of crystalloids should be tailored to avoid excess fluid administration and volume overload. Grade of recommendation: strong recommendation based on moderate-quality evidence, 1B.

Intravenous fluid overload or excessive fluid restriction can significantly impair organ function, increase postoperative morbidity, and prolong hospital stay.[198,199] Intraoperative infusion regimens based on definitions such as liberal, restrictive, or supplemental should be avoided, because a large variability in the volume of fluid infused exists between different studies using the same definitions.[200] Over the years, traditional physiologic principles leading to a large volume of fluids have been revised and challenged. Insensible fluid losses during surgery have been significantly overestimated, and even if the bowel is fully exteriorized from the abdominal cavity, insensible fluid losses do not exceed 1 mL/kg/h.[201] The neuroendocrine response induced by surgical trauma leads to a physiologic reduction of urine output that, in the absence of other signs of hypovolemia, should not trigger additional fluid administration. Moreover, trying to restore normal urine output by administering fluids does not prevent acute renal failure[202,203] but in contrast might offset the benefits of hemodynamic optimization strategies by creating complications such as volume overload.[203] However, oliguria should not be neglected, and it should be monitored over time.

Crystalloid or colloid preloading does not prevent hypotension induced by neuraxial blockade, because total blood volume is unchanged after neuraxial blockade.[204] Moreover, a low dose of vasopressors, not intravenous fluids, restores colonic perfusion in normovolemic hypotensive patients after epidural blockade.[205] In these patients, hypotension should be treated with vasopressors after ensuring that the patient is normovolemic.

Based on these considerations, a maintenance infusion of 1.5 - 2 mL/kg/h of balanced crystalloid solution is sufficient to cover the needs derived from salt–water homeostasis during major abdominal surgery[206,207] while limiting substantial postoperative weight gain (>2.5 kg/d), which is associated with increased morbidity and prolonged hospital stay.[208]

2. Balanced chloride-restricted crystalloid solutions should be used as maintenance infusion in patients undergoing colorectal surgery. Grade of recommendation: strong recommendation based on low-quality evidence, 1C.

Results from studies conducted in healthy volunteers[209] and from meta-analyses of small RCTs indicate that balanced chloride-restricted crystalloid solutions should be preferred to normal saline to decrease the risk of hyperchloremic metabolic acidosis.[210] Large propensity-matched observational studies have observed an association between the use of normal saline and an increased incidence of renal dysfunction, postoperative morbidity, and mortality in surgical patients.[211,212]

3. In high-risk patients and in patients undergoing major colorectal surgery associated with significant intravascular losses, the use of goal-directed fluid therapy is recommended. Grade of recommendation: strong recommendation based on moderate-quality evidence, 1B.

Infusing intravenous fluid based on more objective measures of hypovolemia, such as cardiac output, stroke volume, oxygen delivery, oxygen extraction, or mixed venous oxygen saturation or based on dynamic indices of fluid responsiveness (pulse pressure variation or stroke volume variation) can guide physicians to more accurately decide whether to administer intravenous fluids. Several meta-analyses of RCTs have shown that goal-directed fluid therapy (GDFT) reduces postoperative morbidity and length of hospital stay, especially in high-risk patients undergoing major surgery.[213–216] High-risk patients have been variably defined but have been noted to include patients with a history of severe cardiorespiratory illness (acute myocardial infarction, chronic obstructive pulmonary disease, stroke, etc), planned extensive surgery (>8 h), age >70 years with evidence of limited physiologic reserve of one or more vital organs, respiratory failure, and aortic vascular disease.[217] However, it must be acknowledged that the amount of fluids infused in patients of the control group of the included studies was significantly higher than what is currently recommended. Trials comparing GDFT with a more judicious and evidence-based fluid regimen in the context of an ERP have failed to demonstrate the same results.[218–220] In patients treated with ERPs, advancements in perioperative and surgical care seem to have offset the previously demonstrated benefits of GDFT. The results of the largest multicenter RCT, including 734 high-risk patients undergoing major abdominal surgery (45% colorectal surgery, and the majority in the context of an ERP), has shown a nonstatistically significant decrease of complications and mortality in patients treated with GDFT (relative risk = 0.84 (95% CI, 0.71–1.01); $p = 0.07$).[221]

RCTs evaluating the efficacy of GDFT are extremely heterogeneous. They differ in the type of GDFT algorithm used, timing of the intervention (intraoperative GDFT vs intraoperative and postoperative GDFT), hemodynamic targets, type of fluids, use of inotropes, fluid regimen used in the control group, and perioperative care. GDFT algorithms can be classified in 2 types, GDFT aiming at preemptively maximize stroke volume or GDFT aiming at optimizing stroke volume when clinically deemed. An optimal GDFT algorithm cannot be recommended, because only a few studies have compared different types of GDFT. These studies mainly focused on the impact of different intravenous solutions used to optimize stroke volume (GDFT with colloid vs GDFT with crystalloids). Their results demonstrate that patients treated with GDFT with crystalloid solutions received more fluids than patients treated with GDFT with colloid solutions and that postoperative complications or length of hospital stay were similar.[222,223] Data from RCTs conducted in critically ill patients have raised concerns about the use of hydroxyethyl starch colloids because of the increased risk of acute kidney injury, the need for renal replacement therapy, and mortality. However, 3 recent meta-analyses[224–226] and 1 large propensity-matched retrospective study[227] failed to demonstrate these findings in surgical patients. It is advisable to use crystalloid solutions rather than hydroxyethyl starch colloids in surgical patients at risk of acute kidney injury or with pre-existing renal dysfunction.

E. Surgical Approach

1. A minimally invasive surgical approach should be used whenever the expertise is available and appropriate. Grade of recommendation: strong recommendation based on high-quality evidence, 1A.

There is high-quality evidence that, in appropriate cases, when performed by properly trained personnel, laparoscopic treatment of colorectal conditions is beneficial compared with open surgery. Two separate multicenter RCTs of patients with colon cancer, the Australasian Laparoscopic Colon Cancer Study trial from Australia and the Colon Cancer Laparoscopic or Open Resection Study trial from the Netherlands, both showed laparoscopy to be superior to open resection in terms of short-term outcomes (quicker return of bowel function, less blood loss, less postoperative pain, and shorter hospital lengths of stay).[228,229] Several other RCTs have shown reduced perioperative morbidity, including total morbidity, wound morbidity, and nonsurgical morbidity, following laparoscopic compared with open colonic resection.[230–233] Additional RCTs showed that patients undergoing laparoscopy have decreased time to pulmonary recovery, reduced use of narcotics,[234,235] and improved short-term quality of life.[236] Furthermore, despite early concerns that laparoscopic resection would not provide adequate oncologic outcomes, the Medical Research Council Short-Term Endpoints of Conventional Versus Laparoscopic-Assisted Surgery in Patients With Colorectal Cancer trial showed equivalent margin resection rates in colon cancer.[237] Short-term results from RCTs of rectal cancer are similar and also show reduced blood loss and shorter ileus and length of stay.[238,239]

The results seen in these RCTs are consistent with large database studies, including the National Surgical Quality Improvement Program and the National Inpatient Sample, as well as single-institution studies.[240–243] The evidence has been synthesized in 3 high-quality Cochrane reviews, evaluating short-[244] and long-term[245] results of laparoscopic resection in colon cancer and in rectal cancer.[246] These studies support the generalization of results of the early RCTs.

Some have concerns that oncologic outcomes may be compromised with the laparoscopic approach, especially for rectal cancer. Two recent randomized clinical trials failed to show that laparoscopy was noninferior to open surgery in a composite score of immediate oncologic outcomes.[247,248] One of these 2 trials reported short-term benefits for laparoscopy in terms of intraoperative blood loss and time to first flatus.[247] Until the 3-year oncologic data are available from these 2 trials, the true oncologic outcomes are unclear. Data from 2 other robust RCTs have shown that short-term outcomes are superior for laparoscopic resection of rectal cancer, and long-term oncologic outcomes are equivalent to open surgery.[238,239,249,250] In addition, multiple other RCTs of colon and rectal cancer with several years of follow-up show equivalent rates of local recurrence, disease-free survival, and overall survival.[251–254] Opponents of laparoscopy have also expressed concern about the potential for increased costs; but RCTs and large-scale national database studies have often shown laparoscopy to be associated with comparable or lower overall cost, mostly attributable to reduced length of stay and reduced complication rates.[243,255–257] The optimal approach is likely the combination of laparoscopy with an ERP, as demonstrated in the 4-arm Laparoscopy and/or Fast Track Multimodal Management Versus Standard Care trial.[258]

2. The routine use of intra-abdominal drains and nasogastric tubes for colorectal surgery should be avoided. Grade of recommendation: strong recommendation based on moderate-quality evidence, 1B.

Nasogastric tubes should not be routinely used in colorectal surgery and should be reserved for patients who develop postoperative ileus refractory to more conservative management. RCTs have unequivocally demonstrated that patients who do not receive nasogastric tubes in the immediate postoperative period have no difference in nausea, vomiting, time to return of bowel function, or increased length of stay when compared with patients who do receive nasogastric tubes.[259–261] Patients who do not receive nasogastric tubes also tolerate oral intake 2 days earlier than patients who receive nasogastric tubes, suggesting that nasogastric decompression may unnecessarily delay important nutrition in the postoperative period.[262,263] Additionally, the use of nasogastric tubes was associated with a significantly higher risk of associated complications, notably pharyngolaryngitis.[259]

Similarly, there are no data to support the routine use of intra-abdominal drains to identify and prophylactically treat anastomotic leaks. RCTs have been uncommon in recent literature, yet all have demonstrated no significant difference in mortality, leak, or a composite of postoperative complications in patients who receive intra-abdominal drainage.[264–267] Meta-analyses of published studies similarly demonstrate no added benefit to prophylactic drainage in patients with benign or malignant colorectal disease.[268–271] The location of the anastomosis in relation to the peritoneal reflection does not appear to impact the use of drainage: patients with cancer or benign colorectal disease who receive drainage for anastomoses below the peritoneal reflection have similar rates of leak, mortality, and other complications when compared with patients in which a drain was not left.[264,265] Retrospective analysis of the prospectively collected Dutch total mesorectal excision data suggest that intra-abdominal drainage may be beneficial for selected patients[272]; however, a recent large randomized controlled clinical trial of 494 patients with rectal cancer (Drainage After Rectal Excision for Rectal Cancer 5) suggested that the use of pelvic drains after rectal resection did not confer any benefit to patients.[273] Furthermore, the use of abdominal drains has also been associated with drain-related complications, including enterocutaneous and colocutaneous fistulas, as well as skin ulceration.[265,266]

POSTOPERATIVE INTERVENTIONS

A. Patient Mobilization

1. Early and progressive patient mobilization is associated with shorter length of stay. Grade of recommendation: strong recommendation based on low-quality evidence, 1C.

Complications of prolonged immobility include skeletal muscle loss and weakness, atelectasis, insulin resistance, thromboembolic disease,[274] and decreased exercise capacity.[275] The deconditioning associated with bedrest can be reduced with physical activity.[275]

Within enhanced recovery programs (ERPs) for colorectal surgery, definitions of early mobilization vary, from any mobilization at all within 24 hours[10] to 8 hours per day by postoperative day (POD) 2.[276] Patients in ERPs meet mobilization targets sooner compared with conventional care.[8,277,278] In observational studies, adherence with various mobilization targets, if reported, ranged from 28%[279] to 69%[276] and was a significant predictor of earlier discharge in most studies[10,276,277] but not all.[279]

Although increased mobilization is associated with shorter hospital stays within ERPs, few studies investigate the impact of specific strategies to increase mobilization compared with allowing early ambulation ad libitum. A systematic review identified 8 comparative studies, 4 in thoracic and 4 in abdominal surgery, including 6 randomized trials. None of the studies were done in the context of an ERP, and overall quality was poor. There was significant variability between the different protocols. None of the 5 studies assessing complications found any differences, and only 1 of 4 studies reported a decrease in length of stay in favor of the intervention group. The review concluded that there is little evidence to guide clinicians on best practices to increase mobilization and improve outcomes.[280]

Several randomized trials investigate interventions to increase postoperative walking after a variety of procedures, with little impact on outcomes. Liebermann et al[281] randomly assigned gynecologic patients to usual care or a specific ambulation goal, including self-monitoring with pedometers, and found no differences in the number of steps taken or length of stay. In patients having roux-en-y gastric bypass, those receiving gradually increasing daily step goals (1000 on POD1 to 4000 on POD7) walked more than control subjects who did not receive the goals; however, there were no differences in length of stay, GI function, or patient-reported outcomes.[282] Silva et al[283] randomly assigned open upper abdominal surgery patients to physiotherapy-supervised early mobilization (POD1), early mobilization plus breathing exercises, or delayed mobilization (POD3). Patients in the early mobilization group alone had the shortest hospital stay, but there was no significant difference in distance walked. A recent randomized trial investigating the impact of personnel to facilitate walking after colorectal surgery within an ERP found that, when time out of bed and activity were increased, there was no effect on hospital stay or complications in the recovery of walking capacity 1 month postoperation. The authors concluded that additional personnel to increase adherence with mobilization goals were not required in an established ERP.[284]

Using a formal exercise program in addition to walking, Ahn et al[285] randomly assigned 31 patients having colon cancer surgery to a supervised in-patient exercise program including core, stretching, and resistance exercises or to conventional care. The exercise group had shorter hospital stay (7.8 (1.0) vs 9.9 (2.7) d) and shorter time to flatus (52 (22) vs 72 (29) h). There were no differences in functional tests, body composition, or walking distance between the groups.

B. Ileus Prevention

1. Patients should be offered a regular diet immediately after elective colorectal surgery. Grade of recommendation: strong recommendation based on moderate-quality evidence, 1B.

Multiple randomized studies,[21,263,269,286–296] meta-analyses,[297–302] and observational studies[31,269,303–306] demonstrated that early (<24 h) feeding accelerated GI recovery and decreased the hospital length of stay. The rate of complications[298,300,301] and mortality (OR = 0.41; 95% CI, 0.18–0.93) were also decreased with early feeding.[297] One randomized trial in open surgery reported no significant differences in any outcomes, including rates of vomiting, nasogastric tube insertion, length of ileus, length of stay, or overall complications.[307] Several studies demonstrated the benefits specifically in laparoscopic surgery with an ERP.[308,309] The factor related to failure of early feeding was identified as blood loss during the operation in open cases,[310] whereas age <50 years, surgery performed by colorectal surgeons, and use of laparoscopic surgery were associated with early postoperative feeding success.[311]

Based on the evidence, both the French guidelines and ERAS consensus guidelines supported early feeding in patients undergoing enhanced recovery.[16,312] However, with early oral feeding, providers must be cognizant that the risk of vomiting increases.[269,293]

2. Sham feeding (ie, chewing sugar-free gum for ≥10 minutes 3 to 4 times per day) after colorectal surgery is safe, results in small improvements in GI recovery, and may be associated with a reduction in the length of hospital stay. Grade of recommendation: strong recommendation based on high-quality evidence, 1B.

Chewing gum after elective colorectal surgery resection was first proposed as a mechanism for sham feeding and gastric stimulation in 2002.[313] Conflicting results have been reported. Multiple systematic reviews and meta-analyses have been published, reporting that adding chewing gum to standard postoperative care was associated with significantly earlier time to flatus and bowel movement than those having ordinary postoperative treatment, with no significant improvement in postoperative complications, readmission, or reoperation rates.[314–322] Some reported a significantly shorter hospital length of stay,[314,317,318,321,323] whereas others had no significant impact on length of stay.[315,316,319,320,322] One systematic review reported an uncertain effect of gum chewing on bowel motility.[299] All of the studies experienced limitations, including small sample sizes, as well as heterogeneity of methodology, procedures, and operative approach, thereby limiting the conclusions.

A recent Cochrane review of 81 relevant studies and >9000 abdominal surgery patients found some evidence that people who chewed gum after an operation had faster return of bowel sounds and were able to pass flatus and have bowel movements sooner than people who did not chew gum. There was a small difference in hospital length of stay but no differences in complications or overall cost of care between people who did or did not chew gum. However, the studies were generally of poor quality and described abdominal surgery broadly, including cesarean section, and results were not limited to adult patients; thus, their results are less reliable.[324] Given the limited risk and potential benefit, the French guidelines for enhanced recovery after elective colorectal surgery recommended gum chewing after surgery.[312]

3. Alvimopan is recommended to hasten recovery after open colorectal surgery, although its use in minimally invasive surgery remains less clear. Grade of recommendation: strong recommendation based on moderate-quality evidence, 1B.

The results of Alvimopan in open abdominal surgery have been generally supportive. Several RCTs and pooled post hoc analyses showed accelerated time to recovery of GI function with alvimopan 6- and 12-mg doses compared with placebo and a significantly shorter hospital length of stay in the alvimopan 12-mg group compared with placebo for patients undergoing open laparotomy.[325–334] In the RCT by Ludwig et al,[335] the benefit of the alvimopan 12-mg dose in GI recovery, actual hospital discharge, and reduced postoperative ileus-related morbidity versus placebo was validated in the setting of an ERP. A small, retrospective review of 50 patients showed that patients who did not receive the preoperative dose of alvimopan also had the benefits of faster GI recovery, shorter time to hospital discharge, and reduction in postoperative ileus compared with nonalvimopan patients.[336] One large RCT (n = 911) did not report a significant advantage with alvimopan; however, post hoc analysis did demonstrate that alvimopan was effective in patients receiving patient-controlled analgesia after open abdominal surgery compared with the nonpatient-controlled analgesia group.[337] Two meta-analyses have also supported the role of alvimopan; however, the studies were limited in that there were no randomized trials of alvimopan after laparoscopic surgery.[338–340] A Cochrane review of 9 studies affirmed that alvimopan was better than placebo in reversing opioid-induced increased GI transit time and constipation and that alvimopan was safe and efficacious in treating postoperative ileus, but the studies were in open laparotomy, and no ERP was noted in place.[341]

In laparoscopic colorectal surgery, the majority of reports are from smaller studies yielding conflicting results. Several observational studies found significantly faster return of GI function and shorter length of stay in the alvimopan group.[342–348] Other authors found a lower incidence of postoperative ileus but no difference in length of hospital stay with or without alvimopan after laparoscopic resections.[349] The Michigan statewide collaborative study had similar findings, with significantly decreased rates of postoperative ileus in laparoscopic colectomy patients who received alvimopan but no significant decreases in length of stay.[350] A meta-analysis of 5 laparoscopic abdominal surgery studies by Nguyen et al[351] supported a 75% relative risk reduction in the development of postoperative ileus, with no impact on length of hospital stay or readmission. Additional studies have reported that alvimopan added no benefit in the rates of postoperative ileus or length of stay to laparoscopic colorectal surgery with an ERP,[352,353] leading to the conclusion that the addition of alvimopan to an established ERP will lead to improvement in clinical outcomes in patients after open or hand-assisted colectomy but does not have a benefit after laparoscopic colorectal resection.[353]

It may be difficult to justify the cost of alvimopan in laparoscopic surgery in the setting of an ERP. A case-matched retrospective review of >600 patients undergoing laparoscopic colorectal surgery did not show added benefit to patient outcomes with a potential cost savings if alvimopan was eliminated in this large cohort.[352] In other retrospective reviews of open and laparoscopic patients, cost savings were seen.[346,354,355]

C. Postoperative Fluid Management

1. Intravenous fluids should be discontinued in the early postoperative period after recovery room discharge. Grade of recommendation: strong recommendation based on moderate-quality evidence, 1B.

Few small and heterogeneous RCTs evaluated different fluid regimens in the postoperative period. Because of the negative impact of fluid excess on clinical outcomes,[208] intravenous fluids should be discontinued in the early postoperative period (after recovery room discharge) and clear fluids (≥1.75 L/d of water)[200] encouraged as tolerated soon after surgery.[356] Intravenous fluids should be administered only when deemed clinically necessary. To prevent excessive fluid administration, daily postoperative weight gain should be monitored and weight gain >1 to 2 kg avoided.[208] It is advisable to measure fluid responsiveness before volume expansion, because the results from studies conducted in critically ill patients show that only 46% of patients are fluid responders when bolus intravenous fluids are given based on clinical signs of hypovolemia.[357] Although measuring fluid responsiveness before volume expansion also seems appropriate in the postoperative period, because several clinical scenarios like oliguria, hypotension, and tachycardia frequently trigger the infusion of bolus of intravenous fluids, studies evaluating its feasibility and efficacy in surgical patients admitted on surgical wards are lacking. Hypotension induced by epidural analgesia should be managed by reducing the epidural infusion rate and with small doses of vasopressors after ensuring that the patient is normovolemic.[205]

D. Urinary Catheters

1. Urinary catheters should be removed within 24 hours of elective colonic or upper rectal resection when not involving a vesicular fistula, irrespective of TEA use. Grade of recommendation: strong recommendation, based on moderate-quality evidence, 1B.

Urinary catheterization is routinely used in abdominal colorectal surgery for intraoperative bladder decompression and monitoring of urinary output. Patients who undergo urinary catheterization for >2 days have twice the risk of a postoperative urinary tract infection (UTI).[358] Furthermore, among patients who develop a UTI, an estimated 3.6% will develop urosepsis, a condition that adds significantly to hospital stay and risk of mortality.[359,360]

Several prospective studies have assessed the impact of urinary catheter removal on the first postoperative day as part of an ERAS protocol.[38,361] In a prospective study of 113 patients who underwent right colectomy without epidural analgesia, a 5% risk of urinary retention was observed with early bladder catheter removal.[362] In another prospective study of colectomies with epidural analgesia, 7 (12%) of 60 patients with urinary catheters removed on the first postoperative day developed urinary retention, successfully managed by single in-and-out catheterization in all patients.[363] A small RCT comparing early removal of urinary catheters (<48 h) versus removal of urinary catheters at the time of cessation of epidural analgesia after colon and rectal surgery found that urinary retention was not associated with early urinary catheter removal; however, male sex and rectal resection increased the risk of urinary retention irrespective of epidural analgesia use.[364] This trial was not powered to detect differences in rates of UTI. Another RCT including 215 patients with epidural analgesia after abdominal or thoracic surgery showed a significantly decreased rate of UTI among patients randomly assigned to early catheter removal (POD1) compared with removal after discontinuation of epidural analgesia (1.9% vs 13.6%). No significant differences in urinary retention rates between early and late catheter removal were identified in this trial.[365]

A recent study highlighted the impact of urinary retention on early postoperative functional recovery using a retrospective analysis of a prospectively maintained ERP database. The rate of urinary retention after early urinary catheter removal in 513 patients who underwent elective colorectal surgery was 14%.[366] Patients with urinary retention were significantly less mobile in the early postoperative period and gained more weight because of fluid overload. Furthermore, these patients reported significantly more pain on a visual analog scale. In this study, rates of UTI were not significantly different between patients with and without urinary retention (14% vs 10%).

It is plausible that urinary catheterization may be avoided altogether during select colon resections. A prospective single cohort study of 65 patients who underwent elective segmental colon resection on an ERP completely avoided urinary catheterization unless it was required for fluid management or to facilitate dissection, and then it was removed at the end of the operation. In this cohort, sigmoid colectomy was the most common procedure, the average duration of anesthesia was <5 hours, and epidural analgesia was used in half of the patients. Urinary retention occurred in 9.0% of patients and UTI occurred in 1.5%.[367]

2. Urinary catheters should be removed within 48 hours of midrectal/lower rectal resections. Grade of recommendation: strong recommendation based on moderate-quality evidence, 1B.

Direct retraction on the bladder and close proximity of dissection to the lateral pelvic nerves during proctectomy may increase the risk of postoperative urinary retention. Several retrospective studies have identified a significantly increased risk of urinary retention after early catheter removal in rectal surgery,[368] whereas other retrospective studies have observed equivalent urinary retention rates.[369] An RCT comparing urinary catheter removal after rectal resections on PODs 1, 3, and 5 found that the rates of urinary retention were 14.6%, 5.3%, and 10.5% without reaching statistical significance. This study was not powered to identify differences in UTI.[370] Another RCT with 126 patients compared day 1 and 5 urinary catheter removal after rectal resection and found that rates of urinary retention were significantly greater after day 1 catheter removal (25% vs 10%).[371] Furthermore, rates of UTI were significantly lower in the day 1 catheter removal group (20% vs 42%). A post hoc subgroup analysis excluding the low rectal resections demonstrated urinary retention rates of 14% and 7% for day 1 and 5 catheter removal (although this did not reach statistical significance likely because of an underpowered analysis). However, the observed rate of urinary retention in the day 1 group was comparable to published urinary retention rates for early catheter removal after colectomies. In this subgroup, rates of UTI were significantly lower with early removal (12% vs 40%). These data suggest that patients who undergo upper rectal surgery may have urinary catheter removal on the first postoperative day, as would patients who undergo a colectomy. Patients who undergo low rectal resections are at an increased risk of UTI with longer duration of urinary catheterization. Selective late urinary catheter removal should be used for patients with extensive pelvic dissection, male sex, and increased intraoperative fluids (>2 L).[368]

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