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Guidelines for Perioperative Care in Elective Rectal/Pelvic Surgery: Enhanced Recovery After Surgery (ERAS®) Society Recommendations

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Abstract

Background This review aims to present a consensus for optimal perioperative care in rectal/pelvic surgery, and to provide graded recommendations for items for an evidenced-based enhanced recovery protocol.

Methods Studies were selected with particular attention paid to meta-analyses, randomized controlled trials and large prospective cohorts. For each item of the perioperative treatment pathway, available English-language literature was examined, reviewed and graded. A consensus recommendation was reached after critical appraisal of the literature by the group.

Results For most of the protocol items, recommendations are based on good-quality trials or meta-analyses of good-quality trials (evidence grade: high or moderate).

Conclusions Based on the evidence available for each item of the multimodal perioperative care pathway, the Enhanced Recovery After Surgery (ERAS) Society, European Society for Clinical Nutrition and Metabolism (ESPEN) and International Association for Surgical Metabolism and Nutrition (IASMEN) present a comprehensive evidence-based consensus review of perioperative care for rectal surgery.

This study was conducted on behalf of the ERAS® Society, the European Society for Clinical Nutrition and Metabolism and the International Association for Surgical Nutrition and Metabolism.

The guidelines are published as a joint effort between the Enhanced Recovery After Surgery (ERAS) Society, for Perioperative Care, The European Society for Clinical Nutrition and Metabolism (ESPEN) and The International Association for Surgical Metabolism and Nutrition (IASMEN) and copyrights for this publication is shared between the three societies. The guidelines are published jointly in World Journal of Surgery (IASMEN) and Clinical Nutrition (ESPEN), and will also be available on the ESPEN (http://www.espen.org) and ERAS Society website (http://www.erassociety.org).

Introduction

Until quite recently, patients undergoing colorectal resection were counselled to accept a 20–25 % risk of complications and a 7–10-day postoperative stay in hospital. As

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studies throughout the 1980s to 1990s showed, length of stay in hospital (LOSH) and complication rates improved even if a single component of care was changed [1]. With this, the idea of incorporating many of these elements into a comprehensive perioperative care pathway developed.

Enhanced Recovery After Surgery (ERAS®) is a dynamic culmination of upon perioperative care elements. The strongest evidence for ERAS implementation is in the care of patients undergoing open colonic resection. Many interventions previously shown to benefit outcomes in this population have now been successfully applied to laparoscopic colon resections, as well as to other surgical specialties such as urology, orthopedics, and gynecology [2].

Investigators studying the application of ERAS principles to colonic resections have acknowledged the difference between intra-abdominal large-bowel resections and pelvic surgery. Pelvic intestinal resections are fraught with higher complication rates, longer LOSH, and unique complications not seen in abdominal surgery. Because of this and a need to address the more common lower-bowel resections, the authors of ERAS studies have excluded patients undergoing rectal resection or treated pelvic resections as a subgroup. In several studies, rectal resections are included in the overall analysis of an ERAS protocol or component implementation, only to be excluded or discounted as a 'special consideration' group.

In the present work, the authors have specifically considered the application of ERAS principles to a special population of rectal resection patients. We define pelvic bowel procedures to include resections of the last 12–15 cm of the large bowel as measured from the anus, and/or those resections defined intraoperatively to be below the pelvic reflection. Through the application of these definitions, we have included resections that encompass the increased: difficulty of pelvic surgery compared with segmental colonic resections; operative times and use of retraction known to increase perioperative morbidity; risk to the pelvic structures (e.g., hypogastric nerves, ureters). Although all indications for pelvic resections were included in the literature search, mention of specific recommendations relative to the diagnosis is made if appropriate. For example, the use of laparoscopy for pelvic bowel malignancy is not as readily applied outside of a trial as opposed to commonly accepted laparoscopic resection for pelvic inflammatory bowel disease.

With recognition of the aspects of pelvic bowel surgery that are known to be more difficult and moribund than abdominal surgery, we critically reviewed and graded the evidence. These guidelines are a literature review with summary expert opinion regarding the application of ERAS principles to rectal resection. Many (but not all) ERAS protocol elements, as defined in colonic resection, have been applied successfully to rectal resection. Table 1 is an overview of the individual components of ERAS for colonic resection with explanations as to the applicability in rectal resection. While practical, a discussion of application of the individual elements may not be as important as the consideration of a paradigm shift. The true focus of ERAS, whether the application of interventions is to rectal resection or orthopedics, is the understanding and prevention of the causative factors of perioperative stress and loss of homeostasis. By considering the specific stress factors associated with rectal resection during our review of the literature, we have created guidelines to shift the paradigm of care of rectal resection patients and stimulate more studies to further this effort.

Methods

Literature search

The authors met in April 2011, and the topics for inclusion were agreed and allocated. The principal literature search utilised MEDLINE, Embase and Cochrane databases to identify relevant articles published between January 1966 and January 2012. Medical Subject Headings terms were used, as well as the accompanying entry terms for the patient group, interventions and outcomes. The selected key words were "rectum", "perioperative care", "enhanced recovery" and "fast track". There was no language restriction. Reference lists of all eligible articles were checked for other relevant studies. Conference proceedings were not searched. Expert contributions came from within the ERAS Society Working Party on Systematic Reviews.

Study selection

Titles and abstracts were screened by individual reviewers to identify potentially relevant articles. Discrepancies in judgement were resolved by the senior author and during committee meetings of the ERAS Society Working Party on Systematic Reviews. Reviews, case series, non-randomised and randomised control studies, meta-analyses and systematic reviews were considered for each individual topic.

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Table 1 Guidelines for perioperative care in elective rectal/pelvic surgery: Enhanced Recovery After Surgery (ERAS®) Society recommendations and difference to protocol in colonic resection

ERAS intervention	As recommended in colon resection	As recommended in rectal resection	Difference in protocol
Preoperative counseling and education	Essential discussion between surgeon and patient regarding activity, drains/tubes/lines, and expectations regarding hospital discharge	Identical but with the addition of specific education for the marking and management of stomas	Increased (stoma)
Preoperative medical optimisation	Addressing anaemia, malnutrition, and deconditioning Smoking cessation and moderation of alcohol consumption.	Identical with consideration of possibly higher blood loss, longer operative time, open surgery more often that laparoscopy, and more aggressive preoperative therapy in the case of preoperative pelvic radiation and chemotherapy	Increased evaluation, though no specific optimisation
Oral mechanical bowel preparation	Should be avoided	Some cleansing of diverted bowel indicated	Specific indications with diversion of stomas
Preoperative carbohydrate drink, no overnight fasting	Indicated	Indicated	None
Preanaesthesia medications	Avoidance of long-acting sedation	Avoidance of long-acting sedation	None
Laxative use	Encouraged to minimise postoperative ileus	Avoid with creation of an end ileostomy or diverting ileostomy	Specific indications with stoma creation
Postoperative nausea and vomiting	Treatment as indicated.	Treatment as indicated	None
Nasogastric tube	Avoid	Avoid	None
Anaesthesia management	General anaesthesia plus use of epidural in cases of longer operative time and open surgery	Identical, may be lower epidural insertion in APR or additional narcotics Consider adjuvant multimodal for neuropathic pain	None, though recommended mid-thoracic epidural may not cover perineal wound pain
Laparoscopic approach	Recommended	Recommended in benign disease. Laparoscopic resection of rectal cancer currently only in selected cases or within a trial	Specific to disease
Resection-site drainage	Avoid	Not sufficient evidence if considering pelvic drainage after rectal resection Expert opinion is avoidance except with specific indications, such as excessive intraoperative blood loss or tenuous anastomosis	Specific to procedure without guiding evidence
Immediate postoperative diet	Recommended	Recommended	None
Early removal of urinary catheter	Recommended removal on first postoperative day	Recommended in selected patients and in pelvic surgery Higher re-insertion rates due to direct retraction on the bladder and close proximity to/occasional *en bloc* resection of the lateral pelvic nerves May be indication for supra-pubic catheter if planned postoperative drainage is >4 days.	Specific consideration of procedure and expected urinary retention risks Recognized increased catheter-associated infection risk in cases requiring prolonged catheterisation

Table 1 continued

ERAS intervention	As recommended in colon resection	As recommended in rectal resection	Difference in protocol
Immediate mobilisation	Recommended	Recommended, though possible need for specific guidelines for patients with perineal flap closure after APR may be indicated	Specific consideration of procedure without guiding evidence, except general guidelines for plastic-surgery care

Quality assessment and data analyses

The methodological quality of the included studies was assessed using the Cochrane checklist [3]. The strength of evidence and conclusions were assessed and agreed by all authors in May 2012. Quality of evidence and recommendations were evaluated according to the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) system [4–7]. Quoting from the GRADE guidelines [4], the recommendations are given as follows: "Strong recommendations indicate that the panel is confident that the desirable effects of adherence to a recommendation outweigh the undesirable effects". "Weak recommendations indicate that the desirable effects of adherence to a recommendation probably outweigh the undesirable effects, but the panel is less confident". Recommendations were based on quality of evidence ("high", "moderate", "low", "very low") but also on the balance between desirable and undesirable effects; and on values and preferences [4]. The latter implies that, in some cases, strong recommendations could be reached from low-quality data and vice versa.

Evidence base and recommendations

ERAS items

Preoperative counselling

Preoperative counselling targeting expectations about surgical and anaesthetic procedures may diminish fear and anxiety and enhance postoperative recovery and discharge [8–10]. Personal counselling, leaflets or multimedia information containing explanations of the procedure along with tasks that the patient should be encouraged to fulfil may improve perioperative feeding, early postoperative mobilisation, pain control, and respiratory physiotherapy; and hence reduce the prevalence of complications [11–13]. Ideally, the patient should meet with the surgeon, anaesthetist and nurse. Patients destined for a diverting or permanent stoma should have a preadmission nursing visit regarding enterostomal therapy to better prepare them for the procedure and to reduce postoperative LOSH [14].

Summary and recommendation	Patients should receive routine dedicated preoperative counselling.
Evidence level	Low.
Recommendation grade	Strong.

Preoperative optimisation

Preoperative optimisation is a crucial step in major abdominal surgery and physiological preparation for surgery is important. Preoperative evaluation should be used to identify medical conditions and risk factors for postoperative morbidity and mortality. Optimisation of anaemia, diabetes mellitus (DM) and hypertension improves outcomes (Preoperative Assessment and Patient Preparation, AAGBI Guidelines, January 2010. Available at: http://www.aagbi.org/publications/guidelines/docs/preop2010.pdf) [15]. Malnourished patients have limited nutritional stores, and benefit from preoperative nutritional supplementation with fewer infectious complications and anastomotic leaks [16].

Before surgery, patients should be advised to stop smoking or drinking excessive amounts of alcohol. A recent review over 11 randomised controlled trials (RCTs) involving 1,194 patients concluded that smoking cessation in the perioperative period (initiated 4 weeks before surgery) appeared to be beneficial in improving surgical outcomes [17]. Several studies have described the association between hazardous intake of alcohol and an increase in postoperative morbidity with a higher risk of postoperative infections, cardiopulmonary complications and bleeding episodes [18].

A recent RCT [19] showed that 'pre-habilitation' (a programme designed to increase functional capacity in anticipation of an upcoming stressor) addresses the impact that physical exercise might have on postoperative functional exercise capacity. The effect of such programmes regarding outcome remains to be evaluated [20].

Summary and recommendation	Preoperative optimisation of medical conditions (e.g., anaemia), cessation of

	smoking and alcohol intake 4 weeks before rectal surgery is recommended. Increasing exercise preoperatively may be of benefit. Preoperative specialised nutritional support should be considered for malnourished patients.
Evidence level:	Medical optimisation: Moderate; Prehabilitation: Very low; Cessation of smoking: Moderate; Cessation of excess consumption of alcohol: Low
Recommendation grade	Medical optimisation: Strong; Prehabilitation: No; Cessation of smoking: Strong; Cessation of excess consumption of alcohol: Strong

Preoperative bowel preparation

Mechanical bowel preparation (MBP) is associated with dehydration and changes in electrolyte balance (particularly in the elderly) [21]. A meta-analysis from studies focusing on colonic surgery show no clinical benefit from MBP [22].

A recent update of the Cochrane review on MBP in colorectal surgery included 18 studies (n = 5,805) [22]. Comparisons were made between MBP versus no preparation and MBP versus rectal enema only. Anastomotic leakage was assessed in patients undergoing restoration of bowel continuity, and showed no difference between MBP and no preparation/enema. Patients undergoing low anterior resection were also analysed separately (7 studies, n = 846). In this group of patients, bowel preparation was not associated with a changed prevalence of anastomotic leakage (7.4 vs. 7.9 %). The authors concluded (as was shown before) that routine bowel preparation before colonic surgery was of no value, and should not be recommended. However, if intraoperative colonoscopy might be carried out due to a small lesion or for any other reason, MBP should be initiated.

Patients undergoing pelvic surgery with restoration of bowel continuity frequently receive a proximal diversion. Although this has not been studied in detail, this group of patients will probably need oral MBP. A recent multicentre, single-blind, RCT included 178 patients undergoing low anterior resection for rectal cancer. Patients were randomised to preoperative MBP versus no preparation [23]. In this study (in which >80 % of subjects had a diverting stoma), overall and infectious morbidity were higher in the no MBP group. A non-significant trend to a twofold higher risk for overall and clinical anastomotic leak (19 vs. 11 %) and peritonitis (7 vs. 2 %) was also found in the no MBP group. In the latter study, >80 % underwent laparoscopic low anterior resection. It is necessary to conduct further trials comparing MBP with no preparation/enema in patients undergoing laparoscopic surgery (especially in pelvic surgery).

Summary and recommendation	In general, MBP should not be used in pelvic surgery. However, when a diverting ileostomy is planned, MBP may be necessary (although this needs to be studied further.
Evidence level	Anterior resection: (do not use MBP) High; Total mesorectal excision (TME) with diverting stoma: (use MBP) Low
Recommendation grade	Anterior resection: (do not use MBP) Strong; *TME with diverting stoma*: (use MBP) Weak

Preoperative fasting

Fasting from midnight has been standard practice in the belief that this reduces the risk of pulmonary aspiration in elective surgery. However, a Cochrane review of 22 RCTs showed that fasting from midnight did not reduce gastric content, increase the pH of gastric fluid, or affect the prevalence of complications compared with patients allowed free intake of clear fluids up until 2 h before anesthesia for surgery [24]. Thus, most national anesthesia societies now recommend intake of clear fluids up until 2 h before the induction of anesthesia as well as a 6-h fast for solid food [25]. Although diabetic patients with neuropathy may have delayed gastric emptying (thereby possibly increasing the risk of regurgitation and aspiration), patients with uncomplicated type-2 DM have been reported to have normal gastric emptying [26].

Summary and recommendation	Intake of clear fluids up until 2 h before the induction of anaesthesia is allowed. Intake of solids should be withheld at ≥6 h before anaesthesia.
Evidence level	Moderate
Recommendation grade	Strong

Preoperative treatment with carbohydrates

By providing a clear fluid containing a defined (12 %) concentration of complex carbohydrates up until 2 h before anesthesia, patients can undergo surgery in a metabolically fed state [27]. This treatment reduces the prevalence of preoperative thirst, hunger, and anxiety [24]. In addition, postoperative insulin resistance is reduced by ≈50 % as shown in several placebo-controlled randomised studies in

various surgical procedures (e.g., major abdominal surgery, orthopedic surgery) [27]. The treatment (avoiding preoperative fasting) also results in less postoperative nitrogen and protein losses [28, 29] as well as better-maintained lean body mass [30] and muscle strength [31]. Data from RCTs indicated accelerated recovery, and preliminary data from a meta-analysis showed 1-day shorter LOSH in patients receiving preoperative carbohydrate loading in major abdominal surgery [32]. Studies have indicated that the relative reduction in insulin sensitivity after a specific surgical procedure is related to the degree of surgery, and that more pronounced surgical stress results in a more advanced insulin resistance [27]. Thus, patients undergoing pelvic surgery suffer from significant and severe insulin resistance, and will benefit from avoiding preoperative fasting using this metabolic preparation. In addition, in a large prospective cohort of patients undergoing colorectal surgery (n = 953), including 419 patients undergoing pelvic surgery, preoperative carbohydrate loading was an independent predictor of postoperative clinical outcome, including postoperative nausea and vomiting (PONV) [33]

Summary and recommendation	Preoperative oral carbohydrate loading should be administered to all non-diabetic patients.
Evidence level	Reduced postoperative insulin resistance: Moderate
Improved clinical outcomes	Low
Recommendation grade	Strong

Preanaesthetic medication

Patients undergoing rectal surgery are anxious about the surgery and outcome. Education and reassurance can allay anxiety, but pharmacological interventions to reduce anxiety can be indicated, particularly in younger patients before procedures such as insertion of an epidural or arterial catheter. Anxiolytics such as clonidine, have been shown to have opioid-sparing capacity but clonidine is associated with hypotension and sedation [34].

Short-acting benzodiazepines can be given to facilitate patient positioning and insertion of an epidural catheter. Long-acting benzodiazepines are discouraged because they cause psychomotor impairment during the postoperative period, which can impair mobilisation and direct participation [35]. These medications are not indicated in the elderly (age >60 years) because they have been associated with cognitive dysfunction and delirium after surgery [36, 37].

Summary and recommendation	No advantages in using long-acting benzodiazepines. Short-acting benzodiazepines can be used in young patients before potentially painful interventions (insertion of spinal or epidural, arterial catheter), but they should not be used in the elderly (age >60 years).
Evidence level	Moderate
Recommendation grade	Strong

Prophylaxis against thromboembolism

It has been shown that pharmacological prophylaxis against venous thrombosis (VT) reduces the prevalence of symptomatic venous thromboembolism (VTE) without increasing side effects such as bleeding [38]. In addition, use of compression stockings reduces the incidence of VTE [39]. Patients with extensive comorbidity, malignant disease, who are taking corticosteroids preoperatively, who have undergone previous pelvic surgery, and those in hypercoagulable states have an increased risk of VTE [40].

In a recent Cochrane report based on 4 RCTs (n = 1,021), it was concluded that prolonged (4 weeks postoperatively) VTE prophylaxis as compared with in-hospital prophylaxis was associated with a significantly reduced prevalence of VTE (14.3 vs. 6.1 %, $p < 0.0005$), as well as symptomatic VTE (1.7 vs. 0.2 %), without an increase in postoperative bleeding complications or other side effects [38]. It is also demonstrated that compliance with prolonged treatment with low-molecular-weight heparin (LMWH) was high (>97 %). It is not known if early recovery, with the use of laparoscopic surgery and/or enhanced recovery protocols, reduces the risk of VTE. In addition, there are no controlled data available in patients undergoing major abdominal or pelvic surgery within enhanced recovery protocols. Until such data are available it is recommended that patients undergoing major abdominal or pelvic surgery with increased risk for VTE receive a prolonged treatment with LMWH up to 4 weeks postoperatively even if early recovery and early discharge from hospital is achieved.

Summary and recommendation	Patients should wear well-fitting compression stockings, and receive pharmacological prophylaxis with LMWH. Extended prophylaxis for 28 days should be considered in patients with colorectal cancer or other patients with increased risk of VTE.
Evidence level	High
Recommendation grade	Strong

Antimicrobial prophylaxis and skin preparation

Prophylactic antibiotics Prophylactic antibiotics are effective against aerobes and anaerobes; they have been shown to reduce the prevalence of infectious complications in colorectal surgery [41, 42]. A single dose is as effective as multidose regimens [42], but further doses should be given in prolonged cases (>3 h) depending on the pharmacokinetics of the antibiotics used [41]. The first intravenous dose should be administered before skin incision but ≤1 h before surgery [41]. A Cochrane meta-analysis concluded that a combination of intravenous and oral administration is more effective than intravenous alone or oral alone [42]. However, none of the included studies compared a similar combination of antibiotics administered orally and intravenously versus orally alone or intravenously alone. Hence, the revealed effect may just be the effect of adding another antimicrobial drug in the oral/intravenous groups and not an effect of the route of administration. The optimal combination of antibiotics has not been established, but a combination of metronidazole and a relevant aerobic antibiotic is often suggested. New generations of antibiotics have been reserved for infectious complications. However, in a 2006 multicentre prospective study in the USA, Itani et al. [43] showed an absolute difference in infection rate of nearly 15 % lower in a group randomised to single preoperative dose of ertepenem versus a cephalosporin. The greatest difference was seen in the subgroup of rectal resections. Whether improved effectiveness is sufficient reason to change the "dogma" of not using new antibiotics for prophylaxis remains to be proven.

Summary and recommendation	Patients should receive antimicrobial prophylaxis before skin incision in a single dose. Repeated doses may be necessary depending on the half-life of drug and duration of surgery.
Evidence level	High
Recommendation grade	Strong

Skin preparation

Summary and recommendation	A recent randomized trial has shown that skin preparation with a scrub of chlorhexidine-alcohol is superior to povidone-iodine in preventing surgical-site infections [44].
Evidence level	Moderate
Recommendation grade	For skin preparation in general: Strong; Specific choice of preparation: Weak

Standard anaesthetic protocol

Laparotomy with resection of the rectum requires a longer abdominal incision and more extensive dissection in the pelvic area. A laparoscopic approach to rectal dissection requires longer periods of time but is less invasive. A 5–7-cm surgical incision (horizontal or vertical) is used to facilitate extraction of the specimen. Mobilization of the viscera and excision of the colon and rectum requires the Trendelenburg position for better access. There are no randomized controlled trials comparing the impact of intravenous versus inhalational anaesthesia on postoperative outcome in rectal surgery. The considerations mentioned below should be taken into account if surgical stress needs to be attenuated.

Induction and maintenance of anesthesia can be guided by the bispectral index (BIS) monitor, thereby avoiding deep levels of anesthesia (BIS < 30), particularly in the elderly [45].

Insertion of a thoracic epidural catheter is recommended for open and assisted laparoscopic procedures to attenuate the stress response and provide better postoperative pain relief. Long-acting local anesthetics can be administered as a bolus or by continuous infusion throughout the procedure. If an epidural is not feasible or contraindicated, intravenous lidocaine can be administered due to its anti-inflammatory and opioid-sparing properties. It can be given at induction (1.5 mg/kg) followed by a continuous infusion of 2 mg/kg/h during surgery [46]. Spinal local anesthetics and opioids have been used successfully for colonic and colorectal resection [47]. Attention should be paid to the opioid doses because postoperative respiratory depression in the elderly can occur. A reduced dose of opioid is advised in those aged >70 years.

Short-acting potent opioids such as remifentanil can also be used to attenuate the stress response [48]. There is no evidence that induction of acute hyperalgesia associated with high doses of remifentanil can be reduced by ketamine, magnesium or other N-methyl D-aspartate (NMDA) antagonists [49]. Adequate relaxation of muscle is indicated to facilitate extensive resection in the pelvic area, especially during laparoscopic surgery. However, reversal of profound muscle relaxation can leave incomplete reversal. The use of sugammadex to counteract the action of large doses of muscle relaxants has proven to facilitate recovery [50]. But no data are available with the ERAS programme. Adequate lung ventilation with low tidal volumes to limit peak airway pressure is suggested to reduce the risk of barotraumas [51, 52]. However, if patients are in the Trendelenburg position, the risk of atelectasis is greater and therefore lung recruitment is required. Inspired oxygen concentration >80 % has been shown to decrease the

prevalence of surgical-site infection [53]. There is insufficient evidence for the use of positive-end expiratory pressure (PEEP) to prevent postoperative pulmonary complications and the impact on mortality [54]. Increased insulin resistance as a result of surgery causes hyperglycemia [55], and this should be avoided because it can lead to postoperative complications [56–58]. The optimal level of blood glucose is not known, so effort should be made to measure blood sugar during surgery and to keep it <10 mmol/l using intravenous insulin when needed.

Maintenance of adequate gut perfusion is of paramount importance for the integrity of the anastomosis. Because of the lack of vascular autoregulation in the splanchnic area, gut perfusion is dependent upon mean arterial pressure and cardiac output [59]. Satisfactory gut perfusion can be achieved by providing adequate amounts of intravascular fluids and more specifically goal-directed fluid therapy using minimally invasive cardiac output monitoring [60]. Intraoperative hypotension should be avoided because it can impact negatively on perfusion of the gut and anastomosis. Appropriate use of vasopressors such as neosynephrine or low doses of norepinephrine is strongly recommended [61].

Summary and recommendation	To attenuate the surgical stress response, intraoperative maintenance of adequate hemodynamic control, central and peripheral oxygenation, muscle relaxation, depth of anesthesia, and appropriate analgesia is strongly recommended.
Evidence level	Epidural: Moderate; IV Lidocaine: Low; Remifentanil: Low; High oxygen concentration: High
Recommendation grade	Epidural: Strong; IV Lidocaine: Weak; Remifentanil: Strong; High oxygen concentration: Strong

PONV

PONV is a major cause of delay in recommencement of oral food intake and can be more stressful than pain [62–64]. Risk factors include being female and a non-smoker, history of motion sickness (or PONV), and postoperative administration of opioids. PONV is a well-known side effect of some routine perioperative drugs, such as opioids or neostigmine, which should be avoided if possible. In fact, the prevalence of PONV after a standard anesthetic procedure of inhalational anesthetics and opioids and no PONV prophylaxis is ≤30 %. PONV can be minimised with the use of effective anti-emetic regimens. Multimodal prevention may represent a more simple approach and a more reliable strategy. The addition to these regimens of higher doses of perioperative glucocorticoids may further reduce the incidence of PONV. Without any clear evidence from RCTs, it seems reasonable to include in any ERAS protocol a multimodal anti-emetic prophylaxis regimen to eliminate (or substantially reduce) the incidence of PONV.

Summary and recommendation	Prevention of PONV should be included as standard in ERAS protocols. More specifically, a multimodal approach to PONV prophylaxis should be adopted in all patients with ≥2 risk factors undergoing major colorectal surgery. If PONV is present, treatment should be via a multimodal approach.
Evidence level	High-risk patients: (use multimodal prophylaxis) High; In all patients: Low
Recommendation grade	Strong

Surgical techniques

Laparoscopic rectal resection Though not yet supported with strong evidence from RCTs, the laparoscopic approach to pelvic surgery has been shown to decrease the inflammatory response to surgery relative to open approaches. It therefore merits mention in this review of multimodal interventions for enhanced recovery.

Minimally invasive surgery has become the standard against which other surgical approaches are now compared. The impetus for this worldwide change in surgical approach to procedures such as cholecystectomy and nephrectomy reflect impressively better short-term recovery. The improvement in short-term recovery in colon resection relative to open is less dramatic, but it is certainly 'physiologically rational and definitely will be an important component in future accelerated recovery programs' according to Kehlet and Wilmore in their review in 2008 [2]. Three diagnoses eligible for minimally invasive approaches are familial adenomatous polyposis (FAP), inflammatory bowel disease (IBD) and neoplasms.

Laparoscopic rectal resection for benign disease Laparoscopic proctocolectomy for FAP or IBD has been defined as 'safe' and 'feasible' at specialist centers, though some reports have raised concerns of under-studied functional outcomes and increased costs. Nevertheless, retrospective reviews, prospectively collected cohort studies, and the one RCT have consistently shown a decreased LOSH as well as the same or decreased: time to bowel function; time to oral nutrition tolerance; and wound complications [65, 66]. Additionally, the Washington University review showed that the laparoscopic ileal pouch group came to ileostomy closure sooner than the open group, presumptively because

of fewer complications and more expedient return to normal activities and recovery [65]. Given that these procedures are often undertaken in young patients, a study documenting better female fecundity after laparoscopic versus open proctocolectomy is an important addition to the evidence of safety and applicability of laparoscopy for the resection of benign tumours [67]. The only meta-analysis in this area involves one RCT and 15 studies; all included studies had mixed populations relative to the preoperative risk factors of immunosuppression and immunomodulator use, as well as medically refractory or complicated IBD. Laparoscopic resection in the included studies was "at least as safe" and seemed to confer decreased postoperative ileus and LOSH in combination with a decreased overall complication rate [68]. Necessary RCTs are unlikely to follow because the use of laparoscopy in IBD is strongly driven by the surgeon and patient.

Summary and recommendation	With proven safety and at least equivocal disease-specific outcomes, laparoscopic proctectomy and proctocolectomy for benign disease can be carried out by an experienced surgeon within an ERAS protocol with the goals of reduced perioperative stress (manifested by decreased postoperative ileus), decreased LOSH, and fewer overall complications.
Evidence level	Low
Recommendation grade	Strong

Laparoscopic resection of rectal cancer Laparoscopic, laparoscopic-assisted, and robotic rectal resection for neoplastic disease is controversial. A recent meta-analysis identified 9 RCTs addressing this topic, but a consensus is pending after reporting of the European-based Randomized Clinical Trial Comparing Laparoscopic and Open Surgery for Rectal Cancer (COLOR II) and the American College of Surgeons Oncology Group (ACOSOG Z6051) studies is complete [69]. This international debate regarding the adequacy of oncologic resection of rectal cancer by laparoscopy has led to brilliant discussions in the literature and at surgical meeting forums regarding the definition of resection, the risks of inadequate resection, the expected short-term and long-term oncologic outcomes and, to a lesser extent, the possible physiological benefits of laparoscopy. In relation to this review, there is little doubt about the physiological benefits of laparoscopic rectal resection over open resection [70, 71]. This discussion though, will be null, should the evidence prove inferiority with respect to oncology.

The UK-based Conventional Versus Laparoscopic-Assisted Surgery In Colorectal Cancer (CLASICC) trial supports a laparoscopic approach for rectal cancer but included a high conversion rate and unexpected higher rate of TME in the laparoscopic group. This was in combination with a slightly higher positive circumferential resection margin in the laparoscopic group. This brings into question the pathological standardization and the surgeon experience in both groups. At 3-year follow-up, however, no higher cancer recurrence than the open group was noted [72, 73]. Poon and Huang reviewed the topic separately, and concluded the greatest concern was the quality of the TME. Both concluded that, if proven to be oncologically equivalent, laparoscopic proctectomy offers benefits of improved short-term outcomes similar to laparoscopic colon resection as well as better visualization of the pelvic nerves and easier dissection between the visceral and parietal fascia with pneumoperitoneum [71, 74].

Summary and recommendation	Laparoscopic resection of rectal cancer is currently not generally recommended outside of a trial setting (or specialized centre with ongoing audit) until equivalent oncologic outcomes are proven.
Evidence level	Moderate
Recommendation grade	Strong

Nasogastric intubation

A meta-analysis [75] in 1995 showed that routine nasogastric decompression should be avoided after colorectal surgery because fever, atelectasis, and pneumonia are reduced in patients without a nasogastric tube. A Cochrane meta-analysis [76] of 33 trials with >5,000 patients undergoing abdominal surgery confirmed this finding, and also found earlier return of bowel function in patients if nasogastric decompression was avoided. Gastroesophageal reflux is increased during laparotomy if nasogastric tubes are inserted [77]. A recent meta-analysis of randomised trials including 1,416 patients undergoing colorectal surgery showed that pharyngolaryngitis and respiratory infection occurred less frequently if postoperative nasogastric decompression was avoided but that vomiting was more common if a nasogastric tube was inserted in 15 % of subjects [78] In a Dutch study with >2,000 patients found that the use of nasogastric decompression after elective colonic surgery declined from 88 to 10 % without increases in patient morbidity or mortality [79]. There is no *rationale* for routine insertion of a nasogastric tube during elective colorectal surgery except to evacuate air that may have entered the stomach during ventilation by the facial mask prior to endotracheal intubation. Nasogastric tubes placed during surgery should be removed before the reversal of anesthesia.

Summary and recommendation	Postoperative nasogastric tubes should not be used routinely.
Evidence level	High
Recommendation grade	Strong

Preventing intraoperative hypothermia Patients undergoing rectal surgery can become hypothermic as a result of prolonged exposure of the body and the abdominal cavity to cold ambient air and anesthesia-induced impaired thermoregulation. There is sufficient evidence that mild hypothermia is associated with postoperative complications such as wound infections, cardiac ischemia and bleeding, and increased pain sensitivity. Warming patients before surgery keeps the high core temperature [80] but might not be practical. Monitoring core temperature during surgery is essential.

Summary and recommendation	Patients undergoing rectal surgery need to have their body temperature monitored during and after surgery. Attempts should be made to avoid hyothermia because it increases the risk of perioperative complications.
Evidence level	High
Recommendation grade	Strong

Perioperative fluid management

Most of the literature on fluid management in colorectal surgery does not separate the colon from the rectum. Compared with the colon, rectal surgery leads to more fluid shift as a result of bowel preparation, bowel handling and blood loss from the pelvic area. In addition, the use of epidural local anesthetics, pneumoperitoneum, hypothermia and vasodilatation-induced by anesthetic drugs can cause changes in vascular tone. Whether a restrictive fluid regimen is better to a liberal one is controversial, but a recent review [81] concluded that fluid excess was associated with worse outcome.

Goal-directed fluid therapy using the oesophageal Doppler system has been shown to reduce the LOSH and the rate of postoperative complications [82, 83]. Minimising intravascular fluid shift is achieved by avoiding bowel preparation, adequate oral preload up until 2 h prior to surgery, and minimising blood loss. However, goal-directed fluid therapy has never been compared with restrictive fluid management.

The same results were not confirmed when the ERAS protocol was applied in laparoscopic surgery [84]. The *rationale* of using this device is that the intravenous fluids are titrated to optimize cardiac output (a better indicator of oxygen delivery and haemodynamic status than systolic blood pressure and pulse). Other minimally invasive cardiac output monitors that use arterial waveform analysis can provide useful information not only during but also after surgery.

Fluid requirement is decreased in laparoscopic surgery, and no difference has been shown between colloids and crystalloids [85]. It appears that balanced crystalloid solutions are more physiological than 0.9 % sodium chloride [86].

Summary and recommendation	Fluid balance should be optimised by targeting cardiac output and avoiding overhydration. Judicious use of vasopressors is recommended with arterial hypotension. Targeted fluid therapy using the oesophageal Doppler system is recommended.
Evidence level	Moderate
Recommendation grade	Strong

Drainage of the peritoneal cavity or pelvis

The use of a suction drain in the pelvic cavity after rectal surgery has been traditionally advocated to evacuate potential blood or serous collections and prevent anastomotic leakage.

In 2004, a Cochrane systematic review was published with the aim to compare the safety and effectiveness of routine drainage and no-drainage regimens after elective colorectal surgery. The primary outcome was clinical anastomotic leakage [87]. This study included 6 RCTs enrolling 1,140 patients, but only 2 RCTs (191 patients) separated low rectal anastomoses. The authors could not find a significant difference in outcomes (odds ration (OR) = 0.85).

In 2005, Bretagnol and coworkers undertook a meta-analyses concerning only rectal surgery (pelvic anastomoses). They included 3 RCTs, and they found that the use of a drain after rectal surgery did not seem to affect the leakage rate or overall outcome [88].

Summary and recommendation	Pelvic drains should not be used routinely.
Evidence level	Low
Recommendation grade	Weak

Urinary drainage

Patients risk for urinary retention should be assessed preoperatively. Major risk factors can include male sex, preexisting prostatism, open surgery, neoadjuvant therapy, large pelvic tumours, and APR.

Transurethral catheter Urinary drainage used to be standard in rectal resections because urinary function may be impaired. However, catheter-associated urinary tract infections are the most common hospital-acquired infection, accounting for almost 40 % of all nosocomial infections.

In fast-track surgery, urinary drainage should be as short as possible (ideally ≤24 h). A recent prospective study indicated that routine urinary bladder catheterisation after pelvic surgery may be safely removed on postoperative day 1 [89], as indicated in a previous study [90]. If epidural analgesia is used, there is a potential risk for urinary retention but, after 24 h of urinary bladder catheterisation, this risk is low. A recent randomised study (215 patients) advocated early removal (the morning after surgery) of the bladder catheter. Leaving the bladder catheter as long as the epidural leads to a higher incidence of urinary tract infections and prolongs LOSH [91].

Summary and recommendation	After pelvic surgery with a low estimated risk of postoperative urinary retention, the transurethral bladder catheter may be safely removed on postoperative day 1, even if epidural analgesia is used.
Evidence level	Low
Recommendation grade	Weak

Suprapubic catheter Several randomised trials have reported that suprapubic bladder drainage compared with urethral catheterisation is associated with lower rates of urinary tract infection and/or less discomfort in patients undergoing abdominal surgery, whereas another study showed no such benefits [92]. However, the duration of catheterisation in these studies was ≥4 days.

Summary and recommendation	n patients with an increased risk of prolonged postoperative urinary retention, placement of a suprapubic catheter is recommended.
Evidence level	Prolonged catheterisation: Low
Recommendation grade	Weak

Prevention of ileus

Prevention of postoperative ileus is a key objective in the recovery. Optimal prevention care involves balancing fluids, using analgesics that allow optimal gut function and avoiding PONV as outlined elsewhere, but also specific treatments as outlined below

Chewing gum Gum chewing has been shown in a systematic review and meta-analysis (n = 272) to be safe and beneficial in reducing time to first bowel movement by 1 day after gastrointestinal surgery [93]. There was no effect on LOSH.

Summary and recommendation	A multimodal approach to optimising gut function after rectal resection should involve chewing gum.
Evidence level	Moderate
Recommendation grade	Strong

Postoperative laxatives and prokinetics In a report from a well-established ERAS programme, the use of oral laxatives such as oral magnesium has been associated with normalisation of gastrointestinal transit after colonic resection [94]. Administration of magnesium hydroxide in combination with bisacodyl suppositories has been described in a cohort study of patients undergoing radical hysterectomy [95]. A randomised trial of bisacodyl alone in 200 patients undergoing colorectal resection (outwith a defined ERAS protocol) demonstrated a 1-day reduction in time to defaecation, with no alteration in tolerance of oral food or LOSH. Morbidity and mortality were unaltered [96]. A randomised trial (n = 74) of postoperative administration of oral magnesium to patients undergoing elective hepatic resection within an enhanced recovery protocol demonstrated a 1-day reduction in time to defaecation but again with no influence on other outcomes [97]. When oral magnesium oxide was combined with disodium phosphate in fast-track hysterectomy, a randomised trial (n = 53) demonstrated a 1-day reduction in time to defaecation [98], but with no change in other outcomes. Although one study (n = 49) recently failed to show a difference of oral magnesium within a well-established ERAS setting in colonic surgery, no randomised trial has investigated the use of oral laxatives specifically in rectal surgery with/without ERAS, so further studies are necessary. The overall question of whether stimulant laxatives are associated with anastomotic dehiscence has not been addressed in a randomised trial of sufficient size.

Summary and recommendation	A multimodal approach to optimising gut function after rectal resection should involve oral laxatives.
Evidence level	Low
Recommendation grade	Weak

Postoperative analgesia

Although most of the studies have not distinguished analgesia for colon surgery from that of rectal surgery, some distinction between the two types of surgery must be made in view of the extensive tissue dissection with the latter

procedure. Furthermore, there is limited knowledge of the impact of postoperative analgesic techniques when ERAS is used. For rectal procedures, the considerations shown below must be taken into account:

The surgical approach for laparotomy can be achieved with a vertical incision from the umbilicus down or a horizontal incision. Epidural analgesia is indicated for open procedures because it provides superior analgesia to systemic opioids [99]. Continuous intravenous infusion of lidocaine has been shown to spare postoperative use of opioids [100]. However, no data are available for comparing continuous intravenous lidocaine versus epidural for postoperative analgesia within an ERAS programme. For laparoscopy or assisted laparoscopy in which a small horizontal incision is used and in the context of the ERAS programme, epidural analgesia or continuous intravenous infusion of lidocaine provided good pain relief in the first 24 h with a similar time to return of bowel function or LOSH [101].

Abdominoperineal resection includes excision of the rectal stump, which requires further consideration. These patients might have preoperative pain partially induced by neoadjuvant radiotherapy and which might be neuropathic in nature, thereby requiring a multi-pharmacological approach. Thoracic epidural anaesthesia (TEA, inserted at the T10 level) might not be sufficient to cover the perineal and sacral incisions, so some arrangements are needed. In the first instance, addition of morphine to bupivacaine might increase the spread of anaesthesia and be effective. If this is not sufficient, another epidural can be inserted at the lumbar level (L3–4), even if this approach might cause some motor block in the lower limbs (and therefore might delay mobilization) and also significantly increase the risk of urinary retention.

Alternatives are a combination of thoracic epidural analgesia, infusing only local anesthetic, and systemic (patient-controlled anaesthesia (PCA)) or oral opioids as rescue analgesia to control perineal pain. No studies are available. Continuous infusion of local anesthetics via preperitoneal wound catheters has been shown to provide satisfactory pain relief and fewer side effects [102]. However, no studies using the ERAS programme are available.

Transversus abdominis plane (TAP) blocks can be used [103, 104]. There is only limited evidence suggesting the use of perioperative TAP blocks to reduce opioid consumption and pain scores after abdominal surgery when compared with systemic opioids or placebo. The side effects of opioids are not reduced by the use of TAP blocks. The efficacy of bilateral local anesthetic boluses through a subcostal TAP block catheter has been compared with epidural analgesia in only 66 patients undergoing upper abdominal surgery, without showing major analgesic benefits. However, a comparison has been made with other analgesic techniques and using the ERAS protocol, but not in all studies.

Multimodal analgesia with paracetamol (acetaminophen) and non-steroidal anti-inflammatory drugs (NSAIDs) has been shown to spare opioid use and side effects by 30 %. Cyclo-oxygenase (Cox)-2 inhibitors can be used safely in conjunction with epidural anaesthesia. Recently, two reviews of mainly retrospective studies and work on animals and humans highlighted a possible association between ibuprofen, diclofenac and celecoxib and a higher incidence of anastomotic dehiscence [105, 106]. No studies have established whether administration of ketamine, gabapentin or tramadol in the postoperative period impact positively on postoperative outcome after rectal surgery. Patients need to be monitored daily by the Acute Pain Team (whose role is to optimize analgesia to facilitate mobilisation) to limit the incidence of side effects such as hypotension, nausea and vomiting.

Summary and recommendation	TEA is recommended for open rectal surgery for 48–72 h in view of the superior quality of pain relief compared with systemic opioids. Intravenous administration of lidocaine has also been shown to provide satisfactory analgesia, but the evidence in rectal surgery is lacking. If a laparoscopic approach is used, epidural or intravenous lidocaine, in the context of ERAS, provides adequate pain relief and no difference in the duration of LOSH and return of bowel function. Rectal pain can be of neuropathic origin, and needs to be treated with multimodal analgesic methods. There is limited evidence for the routine use of wound catheters and continuous TAP blocks in rectal surgery.
Evidence level	Epidural for open surgery: High; Epidural for laparoscopy: Low; Intravenous lidocaine: Moderate; Wound infiltration and TAP blocks: Low
Recommendation grade	Epidural for open surgery: Strong Epidural for laparoscopy: Weak Intravenous lidocaine: Weak Wound infiltration and TAP blocks: Weak

Perioperative nutritional care

Early oral intake (within 24 h) In the well-nourished patient with preserved gastrointestinal function in the days after surgery, high-quality hospital food introduced within

24 h will fulfil most nutritional requirements, and little artificial nutritional support is required. It has been well-established that any delay in the resumption of normal oral diet after major surgery is associated with increased rates of infectious complications and delayed recovery [107]. Importantly, early oral diet has been shown to be safe in patients with a new non-diverted colorectal anastomosis [107]. Meta-analyses highlight an increased risk of vomiting; considerable efforts must be made to prevent postoperative ileus and a risk of aspiration.

Summary and recommendation	An oral ad libitum diet is recommended 4 h after rectal surgery.
Evidence level	Moderate
Recommendation grade	Strong

Oral nutritional supplements There are no randomised trials showing whether oral nutritional supplements (ONS) act to supplement total food intake in patients undergoing rectal surgery within an ERAS protocol.

A large prospective series confirmed that an oral diet after colorectal resection within an ERAS protocol can be substantial (≈1,200 kcal daily from the first day after surgery) [108] but in itself cannot prevent postoperative weight loss (by ≈3 kg on postoperative day 28). There may, therefore, be a role for extended routine use of protein-rich supplements in ERAS protocols. Two trials of perioperative nutritional supplements in the outpatient phase lasting 4–16 weeks demonstrated significant effects on postoperative morbidity [109, 110] in general surgical patients, but another trial did not [111].

Summary and recommendation	In addition to normal food intake, patients should be offered ONS to maintain adequate intake of protein and energy.
Evidence level	Low
Recommendation grade	Strong

Perioperative glycaemic control

Insulin resistance is a physiological response to surgical injury characterised by impaired uptake of peripheral glucose and accelerated hepatic glucose release, resulting in hyperglycaemia [112]. Hyperglycaemia is common in non-critically ill postoperative patients with and without a preoperative diagnosis of DM [113] The risk of complications associated with hyperglycaemia in the surgical patient first became widely appreciated with publication of an interventional trial of intensive insulin treatment. This demonstrated appreciable reductions in morbidity and mortality from treatment of hyperglycaemia with insulin in mainly postoperative patients with planned admission to an Intensive Care Unit (ICU) [114]. Subsequent multivariable regression analyses revealed that lower glucose concentrations were the important factor [115]. A recent multicentre trial confirmed these findings in the subgroup of patients with trauma [116]. No subsequent trials of intensive insulin therapy in surgical patients have been published.

However, there is little doubt that hyperglycaemia is harmful also in routine perioperative care outside the ICU [117–119]. There is no high-level evidence on what glycaemic target is appropriate in this setting; expert opinion only is available. The US Endocrine Society has recommended a pre-meal blood glucose target of <7.8 mmol/l and a random glucose value of <10.0 mmol/l [120].

Strategies for achieving such targets are evolving. Intensive insulin treatment is not advised due to the intake of discrete meals in most patients [120]. The traditional and still widely used sliding-scale subcutaneous insulin regimen is a reactive rather than preventive strategy, and is not supported by available clinical evidence [121]. Basal-bolus subcutaneous insulin therapy was shown to result in better glycaemic control and lower overall complication rates in diabetic, non-critically ill surgical patients in a recent randomised trial [122].

In elective major surgery, there is an opportunity to prevent or attenuate metabolic responses to surgery, rather than having to treat them with insulin. Several stress-reducing interventions in ERAS attenuate insulin resistance as single interventions, including preoperative oral carbohydrate treatment [123, 124], epidural blockade [125, 126] and minimally invasive surgery [127]. If such interventions are combined in an ERAS protocol, hyperglycaemia can be avoided even during full enteral feeding starting immediately after major colorectal surgery [128].

Summary and recommendation	Maintenance of perioperative blood sugar levels within an expert-defined range results in better outcomes. Therefore, insulin resistance and hyperglycemia should be avoided using stress-reducing measures or if already established by active treatment. The level of glycaemia to target for intervention at the ward level remains uncertain, and is dependent upon local safety aspects.
Evidence level	Use of stress-reducing measures: Moderate; Level of glycaemia for insulin treatment: Low
Recommendation grade	Use of stress-reducing treatments: Strong; Insulin treatment (non-diabetics) at the ward level: Weak

Early mobilisation

Extended bed rest is associated not only with an increase risk of thromboembolism but also with several unwanted effects such as insulin resistance, muscle loss, loss of muscle strength, pulmonary depression, and reduced tissue oxygenation.

Encouraging postoperative early mobilisation is important to avoid patient discomfort (pain and ileus) because patients must be adequately nursed, keeping their independence as much as possible. Patients should be out of bed 2 h on the day of surgery, and 6 h per day until hospital discharge [129].

Summary and recommendation	Patients should be nursed in an environment that encourages independence and mobilisation. A care plan that facilitates patients being out of bed for 2 h on the day of surgery and 6 h thereafter is recommended.
Evidence level	Low
Recommendation grade	Strong

Audit and outcome measures

The evidence of improved outcomes with the implementation of individual elements of ERAS protocols is presented in this paper. We have included more recent studies undertaken within an ERAS protocol and evaluated the impact of specific interventions with an ERAS control cohort. All surgeons in 'developed countries' are functioning in an era of: reform of healthcare management; reduced cost initiatives concomitant with increased patient safety and providers for improved outcomes mandates; and pay-for-performance programmes. Incumbent upon perioperative care is the implementation and auditing of care improvement strategies. During the early reporting of ERAS, critics of fast-track protocols questioned whether reported improvement could be due only to increased observation. The impact of this Hawthorne effect (improved performance due to known observation) also brought into question the validity of early reports of improved outcomes from the US-based Surgical Complications Improvement Program (SCIP) [130]. In many ways, the SCIP and ERAS protocols as well as the US-based National Surgical Quality Improvement Program (NSQIP) share the difficult blessing of improved observed outcomes without clarity as to which variable of care resulted in the improvement. By implementing the stress-reducing elements of perioperative care that have convincing supporting studies, the ERAS programme has shown outcome improvements over implementation of single elements into a background of traditional care. For example, allowing patients to eat on the first postoperative day was found to be safe [131]. Once an ERAS programme is in place, however, it is impossible to 'dissect out' the use of immediate ad libitum oral nutrition to determine its impact on the outcomes observed with the entire protocol [2]. Quite similar is the finding that compliance with NSQIP and SCIP interventions resulted in general improvements in outcomes, but individual elements did not result in improvements in the outcomes of interest. Improved compliance with recommended perioperative antibiotic use did not reduce further the prevalence of surgical-site infections [130]. Whether or not the individual components of greatest impact can be defined, auditing is essential to maintain compliance and to provide a background from which future studies are shaped. Adherence to an established protocol is proven to be in linear relationship to improved outcomes [33]. Also, all improvements in the ERAS programme and ERAS Society protocols have arisen from database review and compliance auditing [132]. Auditing is necessary. The question is which components should be strictly recorded and followed, as well as, how the data are retrieved, stored, shared, and analysed.

As with any intervention, variability exists between healthcare systems. Many outcomes most easily retrieved from the medical records are linked to use of health system resources. Thus, LOSH, overall cost, complications requiring readmission to hospital, longer operations, need for blood transfusions, and similar outcomes are often reported. Each of these may be important or may only be a marker for improved care. For example, a patient is not actually "healthier" because he/she leaves the hospital 14 h sooner than another, but he may be recovering with lesser difficulty as witnessed by meeting discharge criteria sooner. As discussed above, rectal resections are different from colon resections with respect to indication, preoperative optimisation of patients, intraoperative challenges, and postoperative needs. This is particularly true if considering preoperative chemoradiation for malignancy, immunosuppression for inflammatory bowel disease, previous pelvic surgery, ostomy creation, and flap closures. Considering these factors, which are not specifically addressed in ERAS studies of colon resection, will create a relative stratification of perioperative risk factors for a clearer assessment of the same outcome analysis.

In short, auditing of any change in perioperative care is prudent and, in some healthcare settings, essential. Occasionally the outcome variable defined by a healthcare system does not directly define better or worse outcomes, and care providers need to be involved in these analyses and care management plans to ensure fair evaluations of outcomes and the best possible auditing of their work.

The outcomes of interest in rectal resection are essentially the same as those in colon resection. However, there

is significant difference in risks for worse outcomes in rectal resection. Hence, preoperative assessment and definition of risks specific to rectal resection is required.

The best studies of ERAS in rectal resection will be specific to this population in accrual and auditing. Given the number of rectal resections compared with colon resections, few centres have adequate numbers of patients to independently undertake the rigorous evaluation already accomplished in ERAS for colon resection. The ongoing multinational efforts of the ERAS Society Research Committee, in conjunction with the ERAS Interactive Audit System, will result in adequate subject numbers to provide strong outcomes analyses for the pelvic bowel resection patient group. This system will also act as a background upon which new interventions may be introduced in randomised or large cohort study design.

Summary and recommendation	All patients should be audited for protocol compliance and outcomes
Evidence level	Low
Recommendation grade	Strong

Overall traditional versus ERAS care

The principles of ERAS have largely been established on the basis of elective segmental colonic resection [1]. Initially, the focus was on open surgery and latterly on laparoscopic resection. Rectal surgery, however, represents a different challenge. The magnitude and duration of surgery is longer, blood loss is greater, the patients may have received preoperative chemoradiation, and the frequent use of a stoma requires significant educational input. Moreover, the rate of anastamotic leaks is higher and overall morbidity and mortality greater. On the one hand, this suggests that there may be even greater gains to be had by adopting optimal nutritional and metabolic care in patients undergoing more major surgery. On the other hand, traditionalists worry about any adverse influence of altered practice, especially with respect to anastamotic integrity. In particular, concerns have been expressed about the use or lack of use of MBP [23], epidurals, vasopressors, NSAIDs, and laxatives.

Within an enhanced recovery programme for open colorectal surgery, male sex, preoperative comorbidity and age >80 years have been shown to be independent determinants of prolonged LOSH and postoperative morbidity [133]. Such data suggest that, even with enhanced recovery, rectal surgery represents a greater challenge than colonic surgery. An international survey of surgeons (123 surgeons in 28 countries) reported recently that 63 % use enhanced recovery for rectal cancer [134]. Thus, despite the greater challenges for ERAS in rectal surgery, the trend seems towards widespread adoption of ERAS for such patients.

There are no prospective randomised trials that have specifically focused on the role of ERAS in rectal surgery alone. All randomised trials that have included rectal surgery have also included an admixture of colonic resections. The numbers of patients in such studies are relatively small and even in the context of meta-analyses it has not been possible to separate the rectal patients [135]. Thus, it is not possible to be definitive about the influence of traditional versus ERAS care upon recovery, morbidity or mortality. However, published case series with retrospective controls have suggested a consistent reduction in LOSH by 3–5 days whether the resection is undertaken by open or laparoscopic means [136–138]. There has been no reported increase in postoperative complications or mortality, suggesting that managing rectal cancer patients within an ERAS protocol is safe.

Summary and recommendation	Rectal surgery undertaken within an enhanced recovery programme is safe and improves recovery as reflected by a 3–5 day reduction in LOSH.
Quality of evidence	Low
Recommendation grade	Strong

Health economics and quality of life (QoL)

Although implementation of an ERAS protocol is a complex and time-consuming multidisciplinary project, available data demonstrate that such costs are offset by subsequent savings in reduced LOSH [139, 140] and reduced complication rates [140]. Furthermore, significant long-term cost savings are possible in ERAS protocols: an average calculated cost saving of NZD 6,900 per patient was reported for 50 consecutive ERAS patients compared with 50 patients who underwent traditional care [140].

Few significant differences have been reported in terms of QoL [139, 141], perhaps because health-specific QoL instruments for perioperative care have been unavailable and investigators have instead used generic QoL instruments or instruments developed for certain diagnoses rather than perioperative care. This is currently being addressed with the development of well-validated, health-specific abdominal surgery perioperative QoL scores [142]. Better data are available on the important phenomenon of postoperative fatigue, which has been reported to be decreased within ERAS care in observational studies [143, 144].

Summary and recommendation	ERAS protocols are cost-neutral or cost-effective and result in reduced fatigue. They are recommended as the current standard of care.

Table 2 Guidelines for perioperative care in elective rectal/pelvic surgery: Enhanced Recovery After Surgery (ERAS®) Society recommendations

Item	Recommendation	Evidence level	Recommendation grade
Preoperative information, education and counseling	*Patients should routinely receive dedicated preoperative counselling*	Low	Strong
Preoperative optimisation	*Preoperative optimisation of medical conditions (e.g., anaemia), cessation of smoking and alcohol intake 4 weeks before rectal surgery is recommended. Increasing exercise preoperatively may be of benefit. Preoperative specialised nutritional support should be considered for malnourished patients*	Medical optimisation: Moderate Pre-habilitation: Very low Cessation of smoking: Moderate Cessation of excess consumption of alcohol: Low	Medical optimisation: Strong Pre-habilitation: No Cessation of smoking: Strong Cessation of excess consumption of alcohol: Strong
Preoperative bowel preparation	*In general, MBP should not be used in pelvic surgery. However, when a diverting ileostomy is planned, MBP may be necessary (although this needs to be studied further*	Anterior resection: (No MBP) High Total mesorectal excision (TME) with diverting stoma: (use MBP) Low	Anterior resection: Strong TME with diverting stoma: Weak
Preoperative fasting	*Intake of clear fluids up to 2 h and solids up to 6 h prior to induction of anaesthesia*	Moderate	Strong
Preoperative treatment with carbohydrates	*Preoperative oral carbohydrate loading should be administered to all non-diabetic patients*	*Reduced postop insulin resistance*: Moderate *Improved clinical outcomes*: low	Strong
Preanesthetic medication	*No advantages in using long-acting benzodiazepines* *Short-acting benzodiazepines can be used in young patients before potentially painful interventions (insertion of spinal or epidural, arterial catheter), but they should not be used in the elderly (age >60 years)*	Moderate	Strong
Prophylaxis against thromboembolism	*Patients should wear well-fitting compression stockings, and receive pharmacological prophylaxis with LMWH. Extended prophylaxis for 28 days should be considered in patients with colorectal cancer or other patients with increased risk of VTE*	High	Strong
Antimicrobial prophylaxis	*Patients should receive antimicrobial prophylaxis before skin incision in a single dose. Repeated doses may be necessary depending on the half-life of drug and duration of surgery*	High	Strong
Skin preparation	*A recent RCT has shown that skin preparation with a scrub of chlorhexidine-alcohol is superior to povidone-iodine in preventing surgical-site infections* [44]	Moderate	For skin preparation in general: Strong Specific choice of preparation: Weak
Standard anesthetic protocol	*To attenuate the surgical stress response, intraoperative maintenance of adequate hemodynamic control, central and peripheral oxygenation, muscle relaxation, depth of anesthesia, and appropriate analgesia is strongly recommended*	Epidural: Moderate IV Lidocaine: Low Remifentanil: Low High oxygen concentration: High	Epidural: Strong IV Lidocaine: Weak Remifentanil: Strong High oxygen concentration: Strong
PONV	*Prevention of PONV should be included as standard in ERAS protocols. More specifically, a multimodal approach to PONV prophylaxis should be adopted in all patients with ≥2 risk factors undergoing major colorectal surgery. If PONV is present, treatment should be via a multimodal approach*	High-risk patients: High In all patients: Low	Strong
Laparoscopic resection of benign disease	*With proven safety and at least equivocal disease-specific outcomes, laparoscopic proctectomy and proctocolectomy for benign disease can be carried out by an experienced surgeon within an ERAS protocol with the goals of reduced perioperative stress (manifested by decreased postoperative ileus), decreased LOSH, and fewer overall complications*	Low	Strong
Laparoscopic resection of rectal cancer	*Laparoscopic resection of rectal cancer is currently not generally recommended outside of a trial setting (or specialized centre with ongoing audit) until equivalent oncologic outcomes are proven*	Moderate	Strong
Nasogastric intubation	*Postoperative nasogastric tubes should not be used routinely*	High	Strong

Table 2 continued

Item	Recommendation	Evidence level	Recommendation grade
Preventing intraoperative hypothermia	*Patients undergoing rectal surgery need to have their body temperature monitored during and after surgery. Attempts should be made to avoid hyothermia because it increases the risk of perioperative complications*	High	Strong
Perioperative fluid management	*Fluid balance should be optimised by targeting cardiac output and avoiding overhydration. Judicious use of vasopressors is recommended with arterial hypotension. Targeted fluid therapy using the oesophageal Doppler system is recommended*	Moderate	Strong
Drainage of peritoneal cavity	*Pelvic drains should not be used routinely*	Low	Weak
Transurethral catheter	*After pelvic surgery with a low estimated risk of postoperative urinary retention, the transurethral bladder catheter may be safely removed on postoperative day 1, even if epidural analgesia is used*	Low	Weak
Suprapubic catheter	I*n patients with an increased risk of prolonged postoperative urinary retention, placement of a suprapubic catheter is recommended*	*Prolonged catheterisation*: Low	Weak
Chewing gum	*A multimodal approach to optimising gut function after rectal resection should involve chewing gum*	Moderate	Strong
Postoperative laxatives and prokinetics	*A multimodal approach to optimising gut function after rectal resection should involve oral laxatives*	Low	Weak
Postoperative analgesia	*TEA is recommended for open rectal surgery for 48–72 h in view of the superior quality of pain relief compared with systemic opioids. Intravenous administration of lidocaine has also been shown to provide satisfactory analgesia, but the evidence in rectal surgery is lacking. If a laparoscopic approach is used, epidural or intravenous lidocaine, in the context of ERAS, provides adequate pain relief and no difference in the duration of LOSH and return of bowel function. Rectal pain can be of neuropathic origin, and needs to be treated with multimodal analgesic methods. There is limited evidence for the routine use of wound catheters and continuous TAP blocks in rectal surgery*	Epidural for open surgery: High Epidural for laparoscopy: Low Intravenous lidocaine: Moderate Wound infiltration and TAP blocks: Low	Epidural for open surgery: Strong Epidural for laparoscopy: Weak Intraveous lidocaine: Weak Wound infiltration and TAP blocks: Weak
Early oral intake	*An oral ad libitum diet is recommended 4 h after rectal surgery*	Moderate	Strong
Oral nutritional supplements	*In addition to normal food intake, patients should be offered ONS to maintain adequate intake of protein and energy*.	Low	Strong
Postoperative glucose control	*Maintenance of perioperative blood sugar levels within an expert-defined range results in better outcomes. Therefore, insulin resistance and hyperglycemia should be avoided using stress-reducing measures or if already established by active treatment. The level of glycaemia to target for intervention at the ward level remains uncertain, and is dependent upon local safety aspects*	Use of stress-reducing measures: Moderate Level of glycemia for insulin treatment: Low	Use of stress-reducing treatments: Strong Insulin treatment (non-diabetics) at the ward level: Weak
Early mobilisation	*Patients should be nursed in an environment that encourages independence and mobilisation. A care plan that facilitates patients being out of bed for 2 h on the day of surgery and 6 h thereafter is recommended*	Low	Strong

Evidence level	Low
Recommendation grade	Weak

Comment

These guidelines in perioperative care for rectal surgery are based on the current literature (summarised in Table 2). They aim to help surgeons and anaesthetists to employ current best practice to enhance the recovery of patients undergoing major rectal surgery. The ERAS Society is involved in updating guidance to support the use of best perioperative care. The current guidelines are in development from two consensus papers [1, 145]. We decided to produce separate guidelines for colonic and rectal resections because there are differences developing in best practice. The present guidelines were produced using the GRADE system [4] using strict criteria to

determine the levels of evidence. As explained in the methods section, the reviewers take into consideration the potential good versus potential harm argument that the treatment may have when setting the level of the recommendation. This may allow for strong recommendation even if the data behind the evidence are of moderate, or even low, quality, but the harm is considered negligible.

Since the practice of surgery and anesthesia is continuously changing, there is a need for regular updates of the knowledge base and for continuous training of those involved in the treatment of surgical patients. The ERAS Society for Perioperative Care (www.erassociety.org) was initiated by the former ERAS Study Group and was formed in 2010 to support these processes. The Society participates in the improvement of perioperative care by developing new knowledge through research, education and also by being involved in the implementation of best practice.

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Conflict of interest The ERAS Society® receives an unrestricted grant from Nutricia. OL has served as an external advisor to Nutricia and has occasionally received travel and lecture honoraria from Nutricia, Fresenius-Kabi, BBraun, Baxter and Nestle. OL also previously held a patent for a preoperative carbohydrate drink formerly licensed to Nutricia. All other authors declare no conflicts of interests.

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