Enhanced Recovery After Surgery (ERAS) in Colorectal Surgery

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Abbreviations

ASA score	American society of anesthesia score
ERAS	Enhanced recovery after surgery
ERP	Enhanced recovery protocol
MBP	Mechanical bowel preparation
PCA	Patient controlled analgesia
SSI	Surgical site infection

11.1 Introduction

Hospital services are the most expensive component of health care systems and hospitals are under increasing pressure to enhance the efficiency of hospital care. Length of stay for inpatient care is quoted as an important index of efficiency. Hospital stay of 8 days after open and 5 days after laparoscopic surgery, high treatment cost, up to 80% of postoperative nausea and vomiting, and up to 20% surgical site infection rates have been reported following colorectal surgery in the literature (Thiele et al. 2015, Eberhart et al. 2002). Nagle et al. reported readmission rates of

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as high as 35.4% after discharge from the hospital (Nagle et al. 2012). End result of any surgery is not only a meticulously performed procedure but a functionally, physiologically, and psychologically well-recovered patient.

Enhanced recovery after surgery (ERAS) protocol is a collection of strategies combined in a structured pathway to decrease the physical insult and aid fast recovery after surgery thereby reducing the length of hospital stay in several ways. In fact, it is a multidisciplinary treatment protocol achieved with fewer complications. This concept was pioneered by Professor Henrik Kehlet, a surgeon from Hvidovre University Hospital in Denmark. Kehlet developed a multimodal rehabilitation program in 2001 in collaboration with university and specialized departments of surgery from northern European centers like Royal Infirmary of Edinburgh; Karolinska Institute at Ersta Hospital, Stockholm, Sweden; University Hospital of North Norway, and Maastricht University Medical Centre, Maastricht, The Netherlands (ERAS Group). They analyzed the colorectal surgery patients in these centers with respect to their clinical management and outcomes. From their study, it was shown that the length of stay in fast track centers was significantly shorter (2 days vs. 7–9 days). However, there was no influence on overall morbidity and 30-day mortality. The group considered the evidence base for individual components of perioperative care which ultimately led to the development of ERAS protocol (ERP). With the introduction of this multimodality program, the traditional perioperative care principles such as immobilization, fasting, nasogastric tube insertion, and placement of drains were abandoned. Various innovative techniques were introduced in this protocol that included consumption of a carbohydrate-rich drink before surgery, techniques of regional anesthesia, minimally invasive open or laparoscopic surgical techniques, maintenance of normothermia during surgery, optimal pain management following surgery, and prophylaxis for nausea and vomiting [Kehlet and Wilmore 2002, Kehlet et al. 2003]. As a result of implementation of this fast protocol, the surgical stress associated with surgical procedures decreased substantially.

The outcomes of surgical patients have improved as a result of incorporation of evidence-based techniques into perioperative management (White et al. 2007). For colorectal surgery, many of these are targeted at maintaining normal gut physiology. There has been a significant decrease in postoperative recovery time as a result of use of minimally invasive techniques, better analgesia using regional anesthetic techniques, use of ultra-short-acting anesthetic drugs, latest efficient energy sources, blend of new drugs, and technology. As a consequence of faster recovery time from anesthesia, patients can be directly transferred to day care surgery unit. The duration of hospital stay of patients got reduced. The introduction of ERAS concept reduced morbidity and improved quality of care by getting patients back to their preoperative status as quickly as possible (Teeuwen et al. 2010).

The concept of fast track surgery became popular since Henrik Kehlet reported a 2 days median postoperative hospital stay in colectomy patients (Basse et al. 2000). As a routine, patients subjected to colonic surgery usually require a postoperative hospital stay of around 1 week. The application of such fast track multimodal perioperative care programs in colorectal surgery patients results in a reduced length of hospital stay, less morbidity, reduced postoperative ileus, less pain, improved

pulmonary function, and less fatigue (Gatt et al. 2005). Median postoperative hospital stay of 2 days in 60 consecutive colectomy patients was reported by Basse et al. in 2000 (Basse et al. 2000).

Implementation of fast track protocol requires a multidisciplinary approach, mainly consisting of a surgeon, anesthesiologist, medical oncologist, physiotherapist, psychotherapist, stoma therapist, and other members of the nursing team. It is important to designate a task force group before implementing the ERAS protocol, which will assess the current practices in the hospital, review the literature, and suggest evidence-based recommendations for implementing the program. Clinicians' inputs are incorporated before the program is finalized and the protocol is framed. The task force should standardize the collected data. The data should include patient outcome and satisfaction, administrative compliance, and financial issues. After confirming the safety and benefits of new program, it is shared with the involved team members. As per the standard protocol, appropriate forms, patient education material, etc. are framed and ordered. After finalizing the protocol, it is handed over to concerned clinicians for implementation. Selected patients are enrolled for the fast track protocol and assessed for patient satisfaction, compliance, and outcomes. The outcomes of interest to patient and the ERAS team include relief from pain and nausea, early return of bowel functions, better wound healing, shorter hospital stay, and early return to work. Subsequent studies showed that it was also associated with reduced health care cost and improved patient satisfaction (Thiele et al. 2015; Hughes et al. 2015). Enhanced recovery protocols (ERPs) were associated with less complication rates and shorter length of hospital stay when compared to conventional perioperative patient management protocols (Spanjersberg et al. 2011). The type of approach whether open or laparoscopy did not influence the outcomes after implementing ERP (Currie et al. 2016). Regular auditing of ERP must be done to check for compliance and further suggest measures to improve the quality and outcome of protocol (Bakker et al. 2015; Day et al. 2015).

11.2 Enhanced Recovery Protocols (ERPs)

ERPs include many preoperative, intraoperative, and postoperative components. Although many surgeons currently apply some of the fast track elements which are not incorporated in a complete fast track perioperative care program, such as the omission of oral bowel preparation and drains, and early removal of the nasogastric tube, considerable variation still exists throughout Europe in the degree into which these elements are applied into daily practice (Nygren et al. 2005; Fearon et al. 2005). However, most beneficial and strongest components of the program were identified in a retrospective review of 8 years by Bakker N et al. in 2015 (Bakker et al. 2015). These include short midline or transverse incisions (laparoscopic preferred), mid-thoracic epidural or spinal anesthesia, paracetamol as baseline analgesic, avoidance of long-acting opioids and fluid overload, avoiding hypothermia, no drains, no nasogastric decompression tubes, removal of indwelling urinary

catheters, prevention of postoperative nausea and vomiting in high-risk patients, early mobilization, standard laxatives, early oral nutrition and nutritional supplements, and shorter length of hospital stay.

Patients should be followed according to protocol and following discharge should be contacted within 2 days, and then reviewed after 7–10 days and later at 30 days. Results and patient compliance should be audited and analyzed.

A protocol is not enough (Maessen et al. 2007). The importance of such collaboration has previously been described by others (Basse et al. 2000, Kehlet and Wilmore 2002, Maessen et al. 2007, Kehlet and Holte 2001, MacKay et al. 2006, Anderson et al. 2003, Kehlet and Wilmore 2008). Oral nutrition until 6 h prior to surgery and early postoperative feeding is safe as reported by various authors (Basse et al. 2000, Kehlet and Wilmore 2002, Fearon et al. 2005). This may even decrease morbidity, particularly in patients with poor nutritional status (Maessen et al. 2007).

11.2.1 Preoperative Elements

There are various components of ERAS protocol recommended in the preoperative setting. These include preoperative patient information and counseling, no oral bowel preparation, no preoperative fasting, preoperative carbohydrate loading with clear fluids up to 2 h and solids up to 6 h before induction, no pre-anesthetic medication, prophylaxis against thromboembolism (well-fitting compression stockings, intermittent pneumatic compression, low molecular weight heparin (started 2 h after insertion of epidural catheter) till patient is mobilized fully, single dose antibiotic prophylaxis half an hour before surgery with additional dose for prolonged surgery.

11.2.2 Preoperative Counseling

11.2.2.1 Milestones and Discharge Criteria

Milestones and discharge criteria per ERP should be discussed with the patient before surgery. Criteria for discharge include adequate pain control with oral analgesics, able to tolerate solid food, passage of flatus or stools, no intravenous fluid dependence, ambulatory, ability to perform self-care, no evidence of complications or untreated medical problems, adequate post discharge support and willingness to go home.

Preadmission counseling regarding milestones and defined discharge criteria are well-established aspects of ERPs (Gustafsson et al. 2012; Gustafsson et al. 2013; Adamina et al. 2011; Fearon et al. 2005; Kehlet and Wilmore 2002; Kehlet and Wilmore 2008; Delaney et al. 2003). Further in prospective trials and national audits, compliance with preoperative counseling and defined admission criteria has been shown to be inversely associated with the length of stay and complication rates (Wolk et al. 2016; Nelson et al. 2016).

11.2.2.2 Stoma Education

Educating the patient regarding various aspects of stoma care and complications is of paramount importance. This is supported by strong recommendation based on moderate quality evidence, 1B (Carmichael et al. 2017). Preoperative counseling done by a trained stoma therapist is associated with significantly improved quality of life and lesser postoperative complications with improved patient independence regardless of type of stoma (Danielsen and Rosenberg 2014, McKenna et al. 2016, Millan et al. 2010). In fact, stoma creation is one of the independent risk factors for a prolonged length of hospital stay after colorectal surgery (Delaney et al. 2003; Cartmell et al. 2008). Many studies have shown that structured stoma education significantly helps in improving the quality of life, reducing length of hospital stay and hospital cost and improving psychological state of the patient (Danielsen et al. 2013; Altuntas et al. 2012).

11.2.2.3 Hydration

Patient should be counseled to avoid dehydration. This is supported by strong recommendation based on moderate quality evidence, 1B (Carmichael et al. 2017). Dehydration has been found to be one of the most common causes of hospital readmission after stoma creation, ranging from 40 to 43% (Messaris et al. 2012; Hayden et al. 2013). Patients must be counseled preoperatively regarding the possibility of dehydration and the means to prevent it. Nagle et al. reported reduced readmission rate for dehydration from 15.5 to 0% following preoperative counseling (Nagle et al. 2012).

11.2.2.4 Bowel Preparation

There is no benefit of mechanical bowel preparation (MBP) alone in colonic surgery as stated in 2013 guidelines for perioperative care in elective colonic surgery and a 2011 Cochrane review. MBP causes distress to the patient (Gustafsson et al. 2013; Guenaga et al. 2011). However combining MBP with oral antibiotic preparation (OBP), significant reduction in surgical site infection rate has been reported after colorectal surgery (Chen et al. 2016; Mik et al. 2016; Kim et al. 2014).

11.2.2.5 Nutrition

Contrary to the traditional practice of overnight fast, consumption of clear fluids and carbohydrate-rich beverages <2 h before surgery has been found safe. It improves patient's sense of well-being as well (American Society of Anesthesiologists Committee 2011). The concept is fully supported by ASA and European Society of Anesthesiologists (Smith et al. 2011). Studies including multiple randomized controlled trials have supported and shown that ingestion of clear fluids within 2–4 h of surgery is associated with smaller gastric volume and higher gastric pH at the time of surgery as compared to allowing taking fluids >4 h before induction of anesthesia (Sutherland et al. 1987; Agarwal et al. 1989; Yagci et al. 2008).

In a cochrane review of 2014 which included 27 trials and 21 randomized studies including 1685 patients, no significant increase in complication rate or hospital stay was found (Smith et al. 2014; Awad et al. 2013). However, a meta-analysis

of 43 trials showed improved length of hospital stay compared to fasting group (Amer et al. 2017). Therefore, it is recommended to encourage use of carbohydrate-rich drink in nondiabetic patients to attenuate insulin resistance induced by surgical stress and starvation.

11.2.2.6 Optimization

Postoperative morbidity can be reduced by improving the functional capacity of the patient by proper preoperative optimization. It can also help in faster postoperative recovery (Le Roy et al. 2016, Carli and Zavorsky 2005). Optimization may be considered in patients with comorbidities undergoing elective surgery. However, this is supported by a weak recommendation with moderate quality evidence (Carmichael et al. 2017).

11.2.2.7 Proforma

Proforma should be framed as per the standard ERP for preoperative, intraoperative, and postoperative management and compliance with such order forms has been shown to be associated with reduced hospital stay (ERAS compliance group 2015). Complete compliance with the protocol is better than in piece meals (Carter and Kennedy 2012).

11.2.3 Intraoperative Measures

11.2.3.1 Bundle Measures

Colon care bundle is a set of measures to be implemented in the perioperative period to reduce the surgical site infection (SSI) and improve patient outcome (Tanner et al. 2015). The SSI prevention bundle includes: chlorhexidine shower, mechanical bowel preparation with oral antibiotics, intravenous antibiotic within 1 h of incision, and preparation of surgical field with chlorhexidine in the preoperative period. During the operation, theater room traffic should be limited, a wound protector should be used, separate tray for wound closure should be used, and glove and gown should be changed before fascial closure. Normothermia and blood sugars should be maintained in the perioperative period. In the postoperative period, dressings should be removed within 48 h followed by daily cleansing with chlorhexidine.

Other measures of SSI bundle include cessation of smoking, appropriate hair removal, limited use of intravenous fluids, use of double gloves, lavage of subcutaneous tissue, and use of Penrose drains for obese patients supplementary oxygen.

11.2.3.2 Fluid Management

During major abdominal surgery, a maintenance infusion rate of 1.5–2 mL/kg/h of balanced crystalloid solution is recommended (Brandstrup et al. 2003). Excessive fluid administration and fluid overload should be avoided as it can significantly impair organ function and increase postoperative morbidity and hospital stay. Goal-directed fluid therapy based on objective indices of hypovolemia and fluid

responsiveness is recommended in patients undergoing major colorectal surgery and high-risk patients (severe cardiopulmonary illness or age >70 years, limited physiological reserve, or prolonged surgery of >8 h). It has been found to reduce postoperative morbidity and hospital stay and guide physicians about fluid administration (Hamilton et al. 2011; Benes et al. 2014). Use of normal saline is associated with increased postoperative morbidity and mortality and renal dysfunction. However, chloride restricted crystalloid solution is preferred to normal saline as it decreases the risk of hyperchloremic metabolic acidosis (Burdett et al. 2012; McCluskey et al. 2013). In patients with preexisting renal dysfunction or those at risk should be managed with crystalloids rather than colloid solutions as increased risk of acute kidney injury has been reported with use of colloids (Gillies et al. 2014; Qureshi et al. 2016).

Fluid restriction is thought to enhance mobilization and recovery and reduce the complication rates (Brandstrup et al. 2003). The level of fluid restriction, however, is not yet settled. Mackay et al. did not find any effect and Holte et al. described increased morbidity after strict fluid restriction (MacKay et al. 2006; Holte et al. 2007). Behrns et al. reduced the hospital stay to 4.4 days, but the patients were discharged on liquid diet regardless of bowel function (Behrns et al. 2000).

11.2.3.3 Nausea and Vomiting

Nausea and vomiting are one of the most common postoperative complications, leading many a times to prolong the length of hospital stay. Control of these complaints has been found to significantly reduce hospital stay, overall cost, and patient satisfaction (Hill et al. 2000; Habib et al. 2004). The incidence of postoperative nausea and vomiting of 30% in all patients to 80% patients at high risk has been reported (Franck et al. 2010; Eberhart et al. 2002). Considering the high incidence of this complications, it is recommended to use multimodal antiemetic prophylaxis for all patients irrespective of risk. Besides, antiemetics are generally safe, cost-effective, and carry low risk (Eberhart and Morin 2011).

11.2.3.4 Anesthesia and Pain Management

Open laparotomy wounds are usually associated with significant postoperative pain. In patients undergoing open colorectal surgery, thoracic epidural analgesia as compared to parental analgesia is considered to be the gold standard for controlling pain (Block et al. 2003). Stress hormone release is blocked and insulin resistance is inhibited by epidural analgesia with opiate-restriction before surgery. This may reduce the surgical stress response, decrease postoperative pain, reduce postoperative ileus and pulmonary complications (Basse et al. 2000; Kehlet and Wilmore 2002; Kehlet and Holte 2001; White et al. 2007). Apart from epidural anesthesia, patient controlled analgesia (PCA) is another alternative for pain relief (Delaney et al. 2003).

However, in laparoscopic surgery the same does not hold true. For parental analgesia, multimodal therapy is recommended. Minimizing the use of opioids is associated with early return of bowel function and reduced hospital stay (Thiele

et al. 2015; Bakker et al. 2015). Postoperative analgesia can be achieved by the use of nonselective or selective nonsteroidal anti-inflammatory drugs (NSAIDs) if not contraindicated, acetaminophen, gabapentinoids, ketamine, and even steroids. These drugs help in surgical recovery and reduce systemic opioid consumption (Eipe et al. 2015; Vignali et al. 2009). Other measures like infiltration of wounds by local anesthetic agent has also shown promising results in terms of postoperative pain control (Fiore et al. 2013).

11.2.3.5 Surgical Technique

Minimally invasive approach should be used whenever appropriate and necessary expertise is available. This is supported by a strong grade of recommendation based on high quality evidence, 1A (Carmichael et al. 2017). Minimally invasive approach has been found to be beneficial in terms of less blood loss, less pain, early return of bowel function, shorter hospital stay, and reduced overall surgical and nonsurgical complications for management of colorectal diseases as compared to open approach (Hewett et al. 2008; Veldkamp et al. 2005). Multiple studies have shown advantage of minimally invasive surgery with respect to short-term outcomes and equivalent better and long-term outcome as equivalent to open approach for colorectal cancers (Bonjer et al. 2015; Van der Pas et al. 2013; Jeong et al. 2014; Kang et al. 2014).

11.2.3.6 Tubes and Drains

There is enough evidence in the literature that there is no benefit of putting nasogastric tubes and intra-abdominal drains in colorectal surgery to prevent or decrease postoperative complications like nausea and vomiting, return of bowel function, anastomotic leaks, and hospital stay (Feo et al. 2004; Brown et al. 2001; Merad et al. 1999).

11.2.3.7 Postoperative Measures

Fluid Therapy

Resumption of oral feeding in postoperative period with clear liquids should be encouraged as early as possible in patients undergoing any type of surgery. Intravenous fluids should be discontinued to avoid negative impact of excess fluid on clinical outcome (Varadhan and Lobo 2010, Brandstrup et al. 2003).

Feeding

According to ERPs, regular diet should be started immediately following elective colorectal surgery. Early resumption of diet has been shown to accelerate gastrointestinal recovery, reduce risk of ileus, reduce rate of postoperative complications and mortality, and decrease hospital stay (Dag et al. 2011; Lobato Dias Consoli et al. 2010; da Fonseca et al. 2011; El Nakeeb et al. 2009).

Also chewing sugar-free gums many times a day may be associated with small improvement in gastrointestinal recovery and reduced hospital stay (Chan and Law 2007, Ho et al. 2014, Li et al. 2013).

Catheters

Urinary catheters should usually be removed after 24 h for uncomplicated colonic and upper rectal resections and after 48–72 h following mid and lower rectal resections. Early removal of urinary catheters has been shown to have many beneficial effects in terms of urinary tract infection and urinary retention (Emori et al. 1991; Lee et al. 2015; Yoo et al. 2015).

Mobilization

Immobilization for a prolonged period is associated with various complications like thromboembolism, insulin resistance, skeletal muscle loss, atelectasis, and reduced exercise capacity (Brower 2009, Convertino et al. 1997). Mobilization reduces insulin resistance, risk of thrombo-embolic complications undesired muscle loss and fatigue and improves pulmonary function and tissue oxygenation (Kehlet and Wilmore 2002; Fearon et al. 2005).

Early and progressive mobilization is associated with reduced hospital stay (Carmichael et al. 2017). In ERPs, early mobilization refers to any mobilization started within 24–48 h (Feroci et al. 2013).

11.2.4 Conclusion

Treatment of colorectal surgery patients according to ERP leads to faster recovery and shorter hospital stay without affecting mortality and morbidity. Additionally, the implementation of this fast track protocol after proper analysis and standardization is associated with significant improvements of perioperative parameters. Principles of ERAS program are applicable and beneficial in view of the dearth of hospitals and expertise available in most parts of the world.

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