ORIGINAL RESEARCH PAPER

Surgery

ENHANCED RECOVERY AFTER SURGERY: THE MULTIDISCIPLINARY 'FAST-TRACK' APPROACH.

KEY WORDS: ERAS, Fast-track, surgery

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ABSTRACT

Importance: Enhanced recovery after surgery (ERAS) protocols are multimodal perioperative care pathways designed to achieve early recovery after surgical procedures by maintaining preoperative organ function and reducing the profound stress response following surgery. The key elements of ERAS protocols include preoperative counselling, optimization of nutrition, standardized analgesic and anesthetic regimens and early mobilization. Despite the significant body of evidence indicating that ERAS protocols lead to improved outcomes, they challenge traditional surgical doctrine, and as a result their implementation has been slow. Enhanced Recovery After Surgery (ERAS) has resulted in substantial improvements in clinical outcomes and cost savings.

Observations: Enhanced Recovery After Surgery is a multimodal, multidisciplinary approach to the care of the surgical patients involving a team consisting of surgeons, anesthetists, an ERAS coordinator (often a nurse or a physician assistant) and staff from units that care for the surgical patient. The care protocol is based on published evidence. The ERAS Society, an international nonprofit professional society that promotes, develops and implements ERAS programs, publishes updated guidelines for many operations, such as evidence-based modern care changes from overnight fasting to carbohydrate drinks 2 hours before surgery, minimally invasive approaches instead of large incisions, management of fluids to seek balance rather than large volumes of intravenous fluids, avoidance of or early removal of drains and tubes, early mobilization, and serving of drinks and food the day of the operation. Enhanced Recovery After Surgery protocols have resulted in shorter length of hospital stay by 30% to 50% and similar reductions in complications, while readmissions and costs are reduced. The elements of the protocol reduce the stress of the operation to retain anabolic homeostasis. The ERAS Society conducts structured implementation programs that are currently in use in more than 20 countries. Local ERAS teams from hospitals are trained to implement ERAS processes. Enhanced Recovery After Surgery started mainly with colorectal surgery but has been shown to improve outcomes in almost all major surgical specialties.

Conclusions And Relevance: Enhanced Recovery After Surgery is an evidence-based care improvement process for surgical patients. Implementation of ERAS programs results in major improvements in clinical outcomes and cost, making ERAS an important example of value-based care applied to surgery.

INTRODUCTION:

Prolonged hospital stay and increased postoperative morbidity following major surgery has always been a cause of concern to the attending perioperative physician. In recent times, postoperative outcome is considered to be positive only when it is associated with a shortened length of hospital stay and absence of postoperative functional incapacitation. Despite all the recent advances in perioperative patient management, ensuring a positive postoperative outcome after major surgery is still a difficult goal to achieve. Enhanced recovery after surgery (ERAS) is a protocolized scientific pathway applied to boost the outcome and enhance the recovery phase after surgery.

'Fast-track surgery' or 'enhanced recovery after surgery' (ERAS) was first introduced by Kehlet (1) in the 1990s and has been described abundantly thereafter. Fast-track surgery is a multimodal approach to patient care using a combination of several evidence-based peri-operative protocols to speed-up recovery after surgical interventions and integrates a plethora of modalities in surgery, anaesthesia, and nutrition. A multi-disciplinary team is necessary to provide effective and safe fast-track methods (2). To date, fast-track surgery has yielded excellent results and there has been a significant reduction in hospital length of stay (LOS) without resulting in increased incidence of complications or re-admissions. The reported 2- to 3-day reduction in LOS initially reported in available literature (3,4) has been significantly improved over the years as the consensus guidelines for ERAS have been implemented (5). A number of randomized studies reported promising results favouring ERAS over conventional post-operative care (6,7).

ERAS protocols have rapidly gained a lot of interest and have been shown to modify the physiological and psychological response to major surgery. They have also lead to a reduction in complications and hospital stay, improvements in cardiopulmonary function, earlier return of bowel function and earlier resumption of normal activities.(8) Although the requirement and conditions for different surgeries may differ, the elements applied in the three phases of perioperative period remain almost the same.(9)

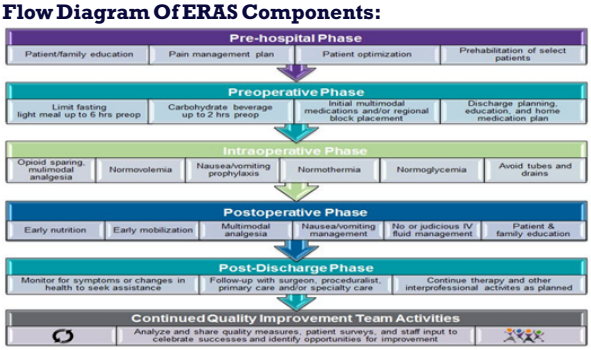
Successful implementation of ERAS protocol requires proper coordination between the surgeon, the anesthesiologist, the nursing personnel, the patient and the people looking after the patient in the perioperative period.(10) Here, an anesthesiologist plays the most vital role of guiding and monitoring some important elements such as preoperative patient selection and optimization, choice of anesthetic regimen, fluid and pain management and thus facilitates and bridges the gap between pre- and post-operative care.

Any surgical procedures, mainly abdominal surgeries, affect a patient's normal physiology by causing a homeostatic imbalance, characterized by increased systemic metabolic response, also known as stress syndrome or stress response. This can lead to organ dysfunction, pulmonary and cardiac complications, muscle weakness and fatigue, fluid retention, electrolyte disbalance and ileus, leading to increased

hospital stay and substantial financial burden for the patient and healthcare system.

In the recent past, the conventional peri-operative care, which consisted of sufficient mechanical bowel preparation, pre-operative fasting, insertion of a nasogastric tube, insertion of multiple intra-abdominal surgical drains (SD) and post-operative fasting for up to 1 week. Since fast-track surgical protocols were introduced, surgeons have focused on easing post-operative pain and the peri-operative response stress, lowering the incidence of organ dysfunction, and encouraging earlier patient ambulation. All these parameters lead to positive outcomes; successful recovery after surgery, lower post-operative morbidity, shorter LOS, and less demand on healthcare resources. Since they were first introduced in the mid-1990s, fast-track protocols have gained ground as for as care of patients for colorectal, urogynecological and other abdominal surgeries.

Flow Diagram Of ERAS Components:



The level of evidence for all these elements varies from low to high and most of the recommendations are strong.(11,12,13,14,15)(Table1).

Table 1: Evidence-based ERAS Elements With Recommendations As Per Various Guidelines

ERAS elements	Level of evidence	Grade of Recommendations
Patient education	Low	Strong
Preoperative optimisation	Low	...
Cessation of smoking-1 month	Moderate	Strong
Alcohol abstinence-1 month	Low	Strong
Preoperative fasting Solids Liquids	 Low High	Strong
Carbohydrate loading	Low	Strong
Premedication	Moderate	Weak
Mechanical bowel preparation	Moderate	Strong
Prophylaxis for thromboembolism	High	Strong
INTRAOPERATIVE AND POSTOPERATIVE ELEMENTS		
Antibiotic prophylaxis/skin preparation	High	Strong
Anesthetic protocol	Low-High	Strong
Multimodal analgesia-epidural, TAP blocks, etc	Moderate-High	Strong
Minimally invasive approach	Low-High	Strong
Prevention of intraop hypothermia	High	Strong
Prophylaxis for nausia/vomiting	Low	Strong
Perioperative fluid management		
Zero fluid balance	High	Strong

Preoperative Components in Enhanced Recovery after Surgery:

Selection of patients is the first step to properly conducted fast-track modality and it is important to hold extensive discussion with candidate patients regarding the surgical process and the early rehabilitation programs. The selected patient would undergo evaluation of their performance status and, if necessary, would undergo an optimization process. Risk factor optimization is important as post-operative complications are usually linked to pre-existing comorbidities (16,17). Patients should actively participate in the evaluation and optimization processes. At this phase, patients should be informed of the benefits and disadvantages and be motivated to facilitate their recovery (18). All available information-providing methods, such as direct interviews, leaflets and multimedia, should be used.

One target of fast-track surgery is to improve surgical outcomes by eliminating the undesired surgical stress of the patient through reduction of post-operative peripheral insulin resistance. Therefore, ERAS emphasizes pre-operative management of carbohydrate intake. Proper patient assessment and counseling, and avoidance of premedication and carbohydrate overload prior to surgery take place during ERAS.

Human response to surgical or non-surgical trauma includes a variety of neuroendocrine changes that lead to retention of both salt and water, and catabolism of the existing stored fuels of the body. In 1930, Cuthbertson *et al.* first described the aforementioned surgical stress response and it later became clear that post-operative stress was milder compared to non-surgical trauma response (19,20). Kidney dysfunction and severe electrolyte imbalance of potassium, nitrogen, phosphorus, and sulphur ions were first reported in patients suffering from long bone fractures (21). Apart from the aforementioned changes, higher levels of adrenal cortical hormones as stress response were reported in experimental studies, although alternative nerve pathways limit this response (22). Surgical stress response consists of sympathetic nervous system stimulation, local cytokine secretion and production of additional catabolic hormones (23). The hypothalamic-pituitary-adrenal axis is activated by increased cortisol and vasopressin secretion, in parallel with an elevated pancreatic secretion of glucagon. These changes lead to an upward trend in peripheral insulin resistance and further catabolism of skeletal muscle. Hyperglycemia, caused by peripheral insulin resistance, is believed to be an independent predictor of prolonged LOS and development of post-operative complications (24). All the response mechanisms are activated in an analogous manner to the initial triggering surgical trauma.

The aim of the pre-operative carbohydrate intake regime is to replicate normal metabolic response to eating breakfast, based on the concept that it stimulates endogenous insulin excretion, which down-regulates the metabolic state due to overnight fasting, and to some extent reduces the level of peripheral insulin resistance. Response to surgical trauma is accompanied by increased catabolism, muscle weakness, and more significant bacterial translocation compared to fed animals; thus, animals in the metabolically fasted state presented worse results than fed ones (25).

As a result of the aforementioned findings, pre-operative oral or intravenous administration of carbohydrates takes place up to 2 hours before surgery, in contrast to the traditional pre-operative fasting. Current evidence suggests the intake of 100 ml of clear liquid beverage containing 12.5 g of polymers of carbohydrates that do not reduce osmotic load nor delay gastric dumping (26). The 100 ml of this solution comprises 50 kcal, with osmotic pressure of 290 mOsm/kg, while the pH is 5.0. As reported by a recent study, a maximal volume of 400 ml administered up to 2 hours before pre-operative opiate-containing analgesia led to a residual gastric volume

equivalent to overnight fasting. So practically, the reason for keeping patients fasted does not exist. In this experimental study, insulin resistance was indeed reduced by either oral or intravenous peri-operative carbohydrate administration compared to overnight fasting in patients subjected to arthroplasty or colorectal surgery (27).

As becomes evident from the presented data, pre-operative carbohydrate administration reduces the post-operative development of insulin resistance and is commonly promoted as part of the processes of the ERAS pathway. These processes include routine neuraxial blockade, limited use of nasogastric tubes, limited or no use of SD, early post-operative ambulation and enteral feeding (28). Pre-operative administration of oral carbohydrate drinks, as opposed to the traditional pre-operative fasting increased patient comfort, reduced thirst and limited pre-operative anxiety as supported by a systemic review (25) and a recent randomized trial (29).

Despite the fact that it is established knowledge that pre-operative carbohydrate administration reduces insulin resistance, there is still limited evidence supporting improvement in post-operative outcomes associated with pre-operative carbohydrate administration. A randomized trial concerning pre-operative intravenous administration of carbohydrates to patients planned to undergo cholecystectomy, reported no difference in clinical results, despite decreased insulin resistance (30). In a similar fashion, other studies on oral carbohydrate treatment in patients undergoing laparoscopic cholecystectomy reported no significant differences in clinical outcomes (31,32,33). Regarding colectomy, pre-operative and intra-operative intravenous glucose administration, as well as pre-operative oral carbohydrates benefited patients with an expedited recovery and reduced LOS (34,35,36). On the other hand, a large single-centre, randomized trial on elective liver resection and colorectal procedures demonstrated that oral carbohydrate administration did not lead to a significant improvement in post-operative fatigue or shorter LOS (33). As a conclusion, pre-operative carbohydrate administration is already established as part of fast-track surgery protocols, especially for colorectal surgeries, as existing data show a benefit for the patient. Further studies and randomized clinical trials are needed in order to extend this attitude towards more surgical procedures. However, some specific details of the pre-operative carbohydrate treatment have not yet been subjected to extensive analysis and thoroughly designed procedure-specific future studies are necessary.

Intra-operative Components in Enhanced Recovery After Surgery:

Both surgical and anesthetic factors in the intraoperative period are key elements for a successful ERAS program. These factors lay the groundwork for early mobilization and feeding.

Laparoscopic surgery within an ERAS protocol has been shown to give superior recovery when compared to open surgery with ERAS protocol or laparoscopic surgery with standard care.(37) Lin *et al*. in 2009 conducted a prospective study in which they found out that laparoscopic surgery allows earlier ambulation and resultant better postoperative outcomes in comparison with standard open surgery.(38) Oblique or transverse short in length incisions are preferred as they are less painful and heal faster.(39) Minimally invasive approaches including endoscopy in varied fields such as spine surgery, orthopedic, neurosurgery have shown added benefits of decreased blood loss, decreased pain intensity, early ambulation, and cosmetic gains.(40)

A single dose of antibiotic covering both aerobes and anaerobes is recommended for infection prophylaxis and is administered just before the surgical incision is given.(41) A second dose is administered for surgical procedures lasting more than 4 h or when there is blood loss more than 1500 ml.

The goal of intraoperative fluid management is to maintain central euvolemia and minimize salt and water excess.(42) In order to achieve this, an individual fluid management plan for each patient is recommended in the ERAS protocol. As a part of this protocol, excess fluid administration should be avoided as it results in fluid shifting out of the circulation into the interstitium leading to intestinal edema and prolonged postoperative ileus.(43) Maintenance of fluid requirements during surgery can be performed with 1–3 ml/kg/h infusion of balanced salt solution with the aim of maintaining preoperative body weight. This therapy also called as zero-balance fluid therapy is sufficient for a low risk patient undergoing low risk surgery.(44) During major surgery, goal-directed fluid therapy (GDFT) can be used. GDFT refers to individualized fluid therapy using a minimally invasive cardiac output monitor.(45) It uses algorithms to optimize stroke volume and to avoid episodes of hypovolemia and postoperative oxygen debt. GDFT has been shown to significantly reduce length of hospital stay and postoperative pulmonary complications.(46,47)

Anesthetic Regimen:

Recent literature has included decreased opiate usage and decreased patient controlled analgesia for early discharge to home in orthopedic patients as a part of enhanced recovery protocols.(48) There is little evidence to favor one anesthetic technique over another but the general principles of enhanced recovery, support the use of medications which have minimal postoperative hangover and minimal effects on gastric motility.(49) Thus, short acting premedicants and volatile anesthetics or total intravenous anesthesia with short acting agents is preferred. Remifentanil is the recommended opioid. Regional anesthetic techniques to support intraoperative and postoperative pain relief can be used, for example peripheral nerve blocks, thoracic epidural catheters, etc.(50) The aim of their use is to reduce the dose of the general anesthetic and reduce the stress response to surgery. They are also known to reduce the incidence of postoperative ileus by blocking sympathetic nervous system. For musculoskeletal surgeries, regional anesthetic techniques can be used alone or in combination with general anesthesia. The use of low concentration anesthetic mixtures reduces motor block and promotes early mobilization.(51)

Avoidance of PONV (post-op nausia,vomiting) is also very important as it is one of the most incapacitating and undesired side effects of anesthesia.(52) The ERAS group recommends risk stratification of patients for PONV based on these factors (APFEL score): female sex, previous PONV or motion sickness, nonsmokers and use of opioids.(53) Two risk factors constitute moderate risk and high risk patients have three or more. The ASA guidelines (2014) suggest a multimodal approach with different strategies, such as reduction of baseline risks (e.g., adequate hydration, intraoperative use of propofol and dexmedetomidine etc.), combination antiemetic therapy using a $5HT_3$ antagonist with droperidol or dexamethasone to effectively reduce incidental or established PONV.(54) The ERAS group have recommended use of dexamethasone at induction or a $5HT_3$ receptor antagonist, for example ondansetron, at the end of surgery for moderate risk and TIVA, dexamethasone at induction and a $5HT_3$ receptor antagonist or droperidol or metoclopramide near the end of surgery for high risk cases.(55) The Cochrane review of antiemetic prophylaxis did not show a beneficial effect of one agent over another so choice of drug is dependent on patient factors, cost, and practical considerations.(56) Novel antiemetics such as palonosetron are being tried for more evidence based information.(57)

There is increasing evidence that at least for mid-to lower abdominal procedures, the use of nasogastric tubes is not indicated as they may actually hinder recovery by prolonging

paralytic ileus and predisposing to pulmonary aspiration.(58) Similarly, surgical drains may also slow the recovery of bowel function and make pain control difficult.(59) Hence, these should be avoided as far as possible.

Hypothermia is associated with increased wound infection, blood loss and high stress response predisposing to cardiac events due to release of catecholamines and cortisol.(60) It also causes patient discomfort. Forced warmed air devices, warmed intravenous fluids and warmed humidified gases should be used.Temperature monitoring is mandatory.

Post-operative Components In Enhanced Recovery After Surgery:

Traditionally, patients are transferred from the operating room to the intensive-care unit, then to high-dependency units and thereafter to the ward (61,62).

By avoiding the use of nasogastric tubes and abdominal drains and by promoting early oral fluid intake and early ambulation as part of the ERAS protocol, the patient's recovery highly depends on the post-operative analgesia. Especially in terms of ambulation and patient comfort, proper analgesic medication is critical (16). Post-operatively, ERAS patients are transferred to different post-operative care units which provide invasive monitoring. These units provide different levels of post-operative care depending on specific hospital settings and are given a variety of names: post-anesthesia care units, fast-track units, high-dependency units, step-down units, intermediate care units or intermediate care areas.

Post-operative ileus is a critical issue for the success of early rehabilitation, procedure-related morbidity, re-admission rates and overall patient results. A number of different approaches to expediting post-operative bowel motility exist. Prokinetics (metoclopramide/domperidone), oral magnesium oxide, gum chewing and bisacodyl suppositories have been evaluated and despite the lack of evidence that these agents are effective, a significant number of surgeons still use them as they claim to reduce time to bowel opening by a couple of days (63,64).

The use of post-operative pelvic drainage after low anterior resection remains a controversial subject in modern surgery. Despite the fact that placement of abdominal drains is still preferred by a number of surgeons around the globe, it has not been proven by existing evidence to have any effect on the incidence of bloody ascites, anastomosis leakage of any other complication (65).

Fast-track discharge criteria are similar to those of traditional care pathways, but necessary steps to discharge a patient are performed earlier. Fast-track patient discharge is appropriate for some ambulatory afebrile patients with adequate food and liquid intake, gastrointestinal transit for gas, and effective pain control (66,67,68). No wound complications are allowed for fast-track discharge. Medical personnel should focus on preparing patients for their forthcoming discharge, to provide patient education on the surgeon's post-operative instructions and supply any prescribed medications for after discharge (5).

All the perioperative elements of ERAS protocols stated so far are of equal and utmost importance to achieve enhanced recovery.

The Benefits of Enhanced Recovery Protocols:

Benefits of ERAS are to both the patient and the health services as a whole. Significant reductions in median length of hospital stay causes a significant reduction in hospital costs and more and more patients can be benefited by making hospital beds available. The most recent meta-analysis showed that ERAS protocols shorten the average hospital length of stay by approximately 2.3 days(69).

ERAS protocols also reduce complications by approximately 40% and consequently reduce expenses related to them(70). ERAS has widened its application effectively in the geriatric cohort undergoing orthopedic surgeries(71). In an era of pay for performance programs, ERAS is beneficial to the attending anesthesiologist as well, by reducing postoperative complications without compromising patient safety. The anesthesiologist by participating in these protocols can improve the hospital's health-care quality with the added benefit of patient satisfaction.

CONCLUSION:

Fast-track recovery programs have a number of aims, including patient comfort, reduction in stress response to surgery, faster ambulation, shorter LOS, fewer re-admissions and speedy recovery. To accomplish all these aims, specific interventions are necessary in all phases of patient care. A number of publications report that laparoscopic colorectal surgery led to a re-admission rate of 10-15%, similar to the respective rate in open colorectal resections (72,73,74,75). Non-surgical complications also exhibited a significant decrease, while surgical complications did not follow this trend (76). Multiple randomized controlled trials and meta-analyses indicate that laparoscopy can lead to reductions in post-operative pain and ileus, preservation of normal pulmonary function, improved aesthetic result, shorter LOS by 2 to 3 days, and better quality of life when compared to open colorectal surgery (77,78,79). These short-term benefits of laparoscopic surgeries have been confirmed in recent Cochrane (80) and systemic reviews (81).

It is essential to implement detailed peri-operative care protocols based on level 1 evidence for early post-operative recovery of patients subjected to colorectal resection. In these studies, it was highlighted that patients who underwent these post-operative protocols demonstrated earlier bowel movement recovery, reduced LOS and fewer complications when compared to conventional post-operative care protocols. ERAS protocols improve the opportunity for rapid, uncomplicated post-operative recovery with significant benefits for patients while improving quality and saving money. It is obvious that ERAS benefits patients and healthcare systems alike and further compliance with ERAS protocols will increase future benefits.

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