

ENHANCED RECOVERY AFTER SURGERY PROTOCOLS
TO IMPROVE OUTCOMES FOR BARIATRIC SURGERY PATIENTS

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Chapter 1: Introduction

Bariatric surgery is the most effective therapy available for morbid obesity; it can result in improvement or complete resolution of obesity comorbidities. The types of bariatric surgery procedures that are available have increased since 1991 and there have been continual advancements in surgical technique. Bariatric surgery is remarkably safe, especially considering that the patient population that has this surgery is high risk because of obesity and its related comorbidities. However, complications can take place; mortality rates are low, probably because of the standardization of bariatric surgical care.

The acute complications of bariatric surgery, which occur in 5–10% of patients depending on the procedure, patient risk, age, and condition, mirror those after other abdominal operations; that is, hemorrhage, obstruction, anastomotic leaks, infection, arrhythmias, and pulmonary emboli. These complications can be deadly; their prognosis depends on early recognition by a surgeon who is familiar with the issue at hand (Pories, 2008). In order to minimize these complications, different perioperative care modalities should be examined and care guidelines should be updated and reviewed every 3 to 5 years. One of those modalities is Enhanced Recovery After Surgery (ERAS).

The Problem

ERAS is sometimes referred to as “fast-track surgery,” a concept introduced by Henrik Kehlet in the 1990s. Kehlet demonstrated that applying the ERAS protocols to open colonic surgeries reduces the length of stay following the procedure to 2 to 3 days. Implementing the protocols was a practice change that involved many professional competencies; therefore an integrated, multidisciplinary approach to the procedure was necessary. Unfortunately, from the

first concept of “fast-track surgery” to today, there are still unanswered questions concerning what the evidence suggests is best practice and what we actually practice.

When comparing an ERAS program with traditional perioperative care, ERAS represents a transition in the process of care that includes interventions that reduce surgical stress, maintain physiologic function, and expedite return to baseline. Each intervention in the ERAS protocols plays a small part in better outcomes, but using them together brings the most benefits to patients (Scott et al., 2015).

Purpose of the Study

In this project I examined the ERAS protocols and their success with the bariatric surgery population. Bariatric surgery has been proven to be the most effective treatment for morbid obesity, resulting in sustained weight loss as well as marked positive effects on comorbidities associated with obesity. Although several of the individual ERAS components have been introduced in bariatric surgery, there are few reports in the literature on the effects resulting from adoption of complete ERAS pathways (Thorell et al., 2016).

Fresno Heart and Surgical Hospital in Fresno, California, is an accredited Bariatric Center of Excellence. Over 1200 bariatric procedures a year are performed in the hospital. We have developed an ERAS committee to create ERAS order sets to allow for the implementation of ERAS pathways. I am currently collecting data from our bariatric patients to compare information prior to and after the ERAS implementation. This study is still being conducted and results will not be discussed or used in this project.

The ERAS protocols have three sections that allow for interventions during three different phases of care in bariatric surgery: preoperative, intraoperative, and postoperative care. I reviewed 15 research articles discussing these interventions and the results and outcomes of

applying the interventions to the bariatric surgical patient. Preoperative interventions discussed are: preoperative teaching, pre-rehabilitation and exercise, smoking and alcohol cessation, preoperative weight loss, glucocorticoids, preoperative fasting, and carbohydrate loading. Intraoperative interventions are: perioperative fluid management, standardized anesthesia protocols, airway management, ventilation strategies, neuromuscular blocks, nasogastric tubes, and abdominal drainage. Postoperative interventions are: postoperative analgesia, thrombophylaxis, early postoperative nutrition, postoperative oxygenation, and non-invasive positive pressure ventilation (Thorell et al., 2016).

Chapter 2: Methodology

This project focuses on the ERAS protocols for the bariatric patient. Many studies have been conducted on ERAS for other surgical specialties such as colorectal surgery; however, few have researched the effects of ERAS on the bariatric patient population. This review evaluated the current literature on ERAS in obesity surgery. A systematic review of primary and secondary outcomes of 15 bariatric-focused articles was conducted. A systematic review is a study that methodically integrates research evidence about a specific research question using carefully developed sampling and data collection procedures that are spelled out in advance in a protocol. In a systematic review, reviewers use methodical procedures that are, for the most part, reproducible and verifiable. Systematic reviews explicitly aim to avoid reaching incorrect or misleading conclusions that could arise from a biased review process or from a biased selection of studies included in the review (Polit & Beck, 2012).

Project Design

This project employed the PRISMA statement, a 27-item checklist. The aim of the PRISMA statement is to help authors improve the reporting of systematic reviews and meta-analyses. This project was conducted in an academic setting as fulfillment of requirements for a thesis project. A committee was put in place to help guide the project. The committee consisted of Christine Bennett, MSN, FNP-C, a faculty advisor from Fresno Pacific University; Dr. Pearl Ma, a content expert and bariatric surgeon; and Natasha Cogdill, MSN, FNP, as mentor. Institutional Review Board approval was not required because this was a research review and I conducted no original research. The studies that were reviewed did not contain any private patient information and therefore examination of this literature did not violate any ethical research guidelines. The review did not require a budget as no large costs were associated with it.

The only cost was for materials needed for gathering the necessary studies for the review. All of the studies were obtained without any cost; access to the few that required a research membership or a fee was obtained without charge through the university virtual library.

Data Collection

All 15 studies reviewed were published within the last 5 years and contained relevant information regarding ERAS protocols and bariatric surgery. Articles dealing with revision surgeries and not primarily with bariatric surgeries were excluded. Research resources utilized to gather the necessary studies were Pubmed, CINAHL, evidence-based journals, and the Cochrane library. The initial search was for the phrase “Enhanced Recovery After Surgery protocols” and subsequent searches were widened to include the key words “ERAS,” “bariatric surgery,” “morbidly obese,” “gastric bypass,” and “sleeve gastrectomy.”

Data Analysis

The studies reviewed in this project were assessed with the CASP literature appraisal tool to determine the validity of the studies’ results. This tool helped to ensure that each selected study incorporated the rigor necessary to produce sound, evidence-based conclusions. Only studies that produced adequate evidence according to the CASP tool were included in this project. The results of my examination of these studies were placed in a literature review matrix (Table 1) that summarized their most important components such as sample size, design, results, and limitations or recommendations.

Chapter 3: The Literature

This literature review evaluated current research regarding ERAS and its effect on bariatric surgery outcomes. The literature was evaluated to discover evidence that ERAS protocols can improve bariatric patients' outcomes, including length of hospitalization, complications, and readmissions to the hospital. The goal of this review was to examine the relationship between the implementation of ERAS programs and improvement in patient outcomes. Fifteen articles were selected for review. They are described below and the salient features of each are listed in the matrix at the end of this section.

Fast-Track in Bariatric and Metabolic Surgery: Feasibility and Cost Analysis Through a Matched- Cohort Study in a Single Centre

Simonelli et al. (2016) conducted a monocentric prospective study of 103 bariatric surgery patients who were managed with the enhanced recovery pathway. They compared this group with a retrospective, immediately previous group of 103 patients managed with standard care. The aim of this study was to compare differences between the ERAS and control groups in mean postoperative length of stay; costs for surgery and recovery; and complication, readmission, and reoperation rates in the short term.

The findings demonstrated that the enhanced recovery pathway in bariatric surgery is feasible, safe, and cost-effective in high-volume obesity centers with well-trained surgeons (Simonelli et al., 2016). Length of stay was decreased from 4.18 days in the control group to 1.79 days in the ERAS group. The mean operation time per patient from entry in the operating room to exit was 190.2 minutes in the control group and 133.54 minutes in the ERAS group. The decreased length of stay and decreased operation times resulted in an obvious cost savings

without worsening surgical outcomes. The researchers recommended more randomized controlled trials to confirm this preliminary experience.

Results of Implementing an Enhanced Recovery After Bariatric Surgery (ERABS) Protocol

Mannaerts et al. (2015) compared a cohort treated according to an Enhanced Recovery After Bariatric Surgery (ERABS) protocol with a cohort treated before implementation of ERABS. Between January 2010 and June 2014, a total of 2126 consecutive patients received bariatric surgery; 10 of these patients were excluded from the study for not meeting inclusion criteria. The researchers found that procedural times were significantly decreased following the implementation of the ERABS protocol. Also, the mean number of surgical procedures in one operating room increased significantly, from 5.2 to 6.1 procedures per day. The mean length of stay decreased from 3.0 to 2.1 nights. Before implementation of ERAS, 39.4% of all patients were discharged on the first postoperative day; since the implementation, this percentage increased to 74.2%, with 91.7% of patients being discharged within 2 days of their operation.

The Mannaerts et al. (2015) study demonstrated that implementation of ERAS protocols optimizing and standardizing perioperative care results in significant reductions in length of hospital stay and postoperative morbidity. This finding has sparked interest in using these protocols for the bariatric surgery population. In the current literature, very low rates of perioperative complications have been described within ERAS programs, but how and which complications are scored in the different studies is unclear. The importance of intensively monitoring results and complications after introduction of an ERAS program was stressed in this article, as was the need for ERAS protocols to be updated regularly.

Outcome of Laparoscopic Gastric Bypass (LRYGB) with a Program for Enhanced Recovery After Surgery (ERAS)

Hahl, Peromaa-Haavisto, Tarkiainen, Knutar, and Victorzon (2015) performed a prospective, observational study of 388 consecutive patients who underwent laparoscopic Roux-en-Y gastric bypass (LRYGB) surgery under ERAS protocols in a general hospital. The ERAS protocols consisted of a standardized set of pre, intra, and postoperative modalities to decrease the stress response of patients. Primary outcome measures were length of stay, postoperative morbidity, readmissions, and reoperations.

During the initial training for ERAS, while staff was dealing with the learning curve, length of stay dropped from 4 days for the first 108 operations to 2 days for the last 109 patients; mean operation time fell from 110 to 74 minutes. During this time, morbidity averaged 19%. With the introduction of an ERAS program, length of stay dropped from 2 days to 1 day, overall morbidity dropped from 19 to 10%, and major complications decreased from 4.6 to 3.4% (Hahl et al., 2015). The implementation of ERAS protocols did not have any effect on other outcome measures such as weight loss and resolution of comorbidities. However, it is important to note that these outcomes were not negatively impacted either. The hope in implementing an ERAS program is that it will lead to reduced hospital costs. This study did not address the impact of ERAS on costs; few studies have done so properly. Further research is recommended to determine the best methods for evaluating the impact of ERAS protocols on hospital costs.

Efficiency and Safety Effects of Applying ERAS Protocols to Bariatric Surgery: A Systematic Review with Meta-Analysis and Trial Sequential Analysis of Evidence

Singh et al. (2016) performed a meta-analysis to evaluate literature on pathways for the development of ERAS protocols for the bariatric surgery population. Using a medical database,

they searched for articles describing comparative trials of ERAS and conventional bariatric surgery procedures published up to June 2016. Their results suggest that the use of ERAS protocols reduces length of stay by about 1.5 days without any significant increase in overall or major complications, anastomotic leak, or readmission rates. Length of stay, which is a measure of efficacy, was chosen as the primary outcome variable whereas incidence of complications and readmissions, both of which are measures of safety, were chosen as secondary outcome variables.

The Singh et al. (2016) meta-analysis was based on nonrandomized studies and comparisons with historical controls; thus it was limited by significant risk of bias. The use of ERAS protocols for bariatric surgery is still in the beginning stages, and the protocols will require standardization. The authors were unable to delineate results according to type of procedures because documentation was lacking in the included trials. Therefore, results could not be subdivided according to the nature of the surgical procedure. There is a need for more randomized trials comparing the safety of ERAS protocols with that of conventional care in order to confirm the findings of this meta-analysis.

Experience with an Enhanced Recovery After Surgery (ERAS) Program for Bariatric Surgery: Comparison of MGB and LSG in 374 Patients

Blanchet et al. (2017) investigated the effectiveness and safety of an ERAS protocol with laparoscopic omega loop gastric bypass and laparoscopic gastric sleeve in bariatric patients. The study was a prospective comparative cohort study with patients 18 years of age and older who met the accepted criteria for bariatric surgery. Preoperative education was provided to stress the importance of the ERAS preoperative protocols. Intraoperatively, anesthesia providers followed the ERAS protocols using short-acting agents without opioid analgesics and prophylactically

administering medications for prevention of pain, nausea, and vomiting. In the recovery unit, pre-identified postoperative protocols were utilized, staying in line with the non-opioid pain control plan. Peripheral IV lines were removed in order to facilitate early ambulation. Patients were contacted 1 day following discharge by a nurse and asked to complete a survey regarding their pain, nausea, vomiting, and ease of mobility.

Between April 2015 and March 2016, a total of 374 patients had a bariatric procedure with ERAS protocols. The length of stay for all procedures was 1.24 days; 322 patients were discharged on Day 1 and by Day 2, nearly all patients (362) had been allowed to go home (Blanchet et al., 2017). The results demonstrated that the use of an ERAS program was equally safe and effective for both the gastric bypass procedure and the gastric sleeve procedure. Length of stay was decreased from 2.1 to 1.24 days. The postoperative complication rate was low at 2.9% and the readmission rate was also low at 2.1%. As with other studies, the researchers recommended greater standardization of ERAS protocols for application to bariatric surgery. Until more high-level evidence is available, high-risk patients should be excluded from further studies.

Enhanced Recovery After Bariatric Surgery in the Severely Obese, Morbidly Obese, Super-Morbidly Obese and Super-Super Morbidly Obese Using Evidence-Based Clinical Pathways: A Comparative Study

Sinha, Jayaraman, Punhani, and Chowbey (2016) performed a retrospective analysis of 823 patients who underwent laparoscopic bariatric surgery. The goal of the study was to assess the effects of body mass index (BMI) on recovery and anesthetic outcome parameters. Data were collected prospectively from those having surgery between August 2013 and March 2015. Patients having revision surgery were excluded from the study. The perioperative protocol was

standardized and all patients underwent an assessment by the anesthesia provider 10 to 15 days preoperatively.

Though some studies have reported no additional risk with increasing BMI numbers, the Sinha et al. (2016) study clearly indicates that several comorbidities may show significantly higher prevalence the higher the BMI. This association could be attributed to the fact that higher-BMI patients have an increased risk of obstructive sleep apnea. With obstructive sleep apnea, the requirement for non-invasive ventilation increases time to ambulate and time for discharge readiness.

Early ambulation can be considered one of the more important markers for ERAS protocols. Although there is little supporting evidence, it is the single most important prophylactic measure following a surgical procedure. Faster emergence, opioid-free pain management, and early ambulation are the three factors that offer the greatest benefits to the bariatric population. Bariatric patients are very high risk because of the morbidity and mortality associated with their obesity. However, in the Sinha et al. (2016) study the ERAS guidelines were rigidly followed, making it possible to optimize all comorbidities and avoid adverse events.

Implementing Enhanced Recovery After Bariatric Surgery Protocol: A Retrospective Study

In a retrospective study, Proczko, Kaska, Twardowski, and Stepaniak (2015) compared operating room logistics and postoperative complications between patients receiving surgery pre-ERABS and patients following ERABS protocols in an academic hospital. The 374 patients in the study were undergoing either a laparoscopic Roux-en-Y gastric bypass or a laparoscopic sleeve gastrectomy procedure. Of these, 228 were in the pre-ERABS group and 146 in the ERABS implementation group. The primary outcome analyzed in this study was length of stay in the hospital, measured in days. Secondary outcomes analyzed were turnover, induction, surgery,

and procedure times; numbers of readmissions and reoperations; and complications in the 30 days following the procedure.

Length of stay in the hospital was significantly shortened from 3.7 days for the pre-ERABS group to 2.1 days for the ERABS patients (Proczko et al., 2015). Surgery times were 15 minutes less for gastric bypass for the ERABS group and 12 minutes less for gastric sleeve. Induction times were reduced from 15.2 minutes pre-ERABS to 12.5 minutes. Turnover times also decreased, from 38 minutes pre-ERABS to 11 minutes with ERABS. The incidence of reoperations, readmissions, and complications within 30 days after discharge did not change with the implementation of ERABS. The reduction in length of stay can be attributed to changes in the anesthesia protocol. Patients were up and walking as soon as possible following the procedure, helping them to quickly become fully mobile. Also, oral intake of fluids was introduced soon after recovery to help bring patients back to their physiological baseline. This study confirmed that dedicated bariatric centers that utilize ERABS guidelines can process a large number of bariatric surgeries without compromising their quality care standards.

Randomized Clinical Trial of Enhanced Recovery Versus Standard Care After Laparoscopic Sleeve Gastrectomy

Lemanu et al. (2012) conducted a randomized clinical trial of patients undergoing laparoscopic gastric sleeve surgery between August 2011 and May 2012. The only inclusion criteria were that patients had to have their operation at the Manukau Surgery Center in New Zealand. Patients who had already had a primary operation and were seeking revision surgery were excluded from the study. Patients were split into three groups: an ERAS group, a control group, and a historical group. The ERAS group received ERAS guideline-directed care in the preoperative period and continuing for 30 days following their operation. Patients in the control

group underwent laparoscopic gastric sleeve surgery while receiving standard bariatric perioperative care.

In terms of hospital stay, there was a marked difference between the three groups. The overall length of stay was 1 day for the ERAS group, 2 days for the control group, and 3 days for the historical group (Lemanu et al., 2012). The researchers did not identify a difference in perioperative morbidity between the ERAS and control groups, although morbidity during the study was slightly less in the ERAS group than in the historical group. This result gave strength to the assumption that crossover would occur due to lack of blinding. Also, the lack of blinding may have contributed to the lack of difference between the randomized study groups with respect to complication rates. Length of stay is one of the most important markers for ERAS studies; it indicates how well an ERAS protocol is designed and carried out. The major limitation of this study, as mentioned above, was its lack of blinding, which increased the risk for performance bias. This same limitation has been encountered in all the randomized trials investigating ERAS protocols reviewed for the present project.

**Guidelines for Perioperative Care in Bariatric Surgery:
Enhanced Recovery After Surgery (ERAS) Society
Recommendations**

Thorell et al. (2016) conducted a systematic review of literature published from January 1966 to January 2015, focusing on meta-analyses, randomized control trials, and large prospective cohort studies. Databases used to identify relevant literature were Medline, Embase, and Cochrane. Keywords included in the search were: “obesity,” “obese,” “bariatric,” “gastric bypass,” “sleeve gastrectomy,” “fast track,” and “enhanced recovery.” The authors focused their efforts on recent publications of good quality; retrospective studies were included if research of

greater quality was not found. Methodological quality was graded using the Delphi checklist. Strength of evidence and conclusions was assessed and agreed upon by all the authors.

One of the preoperative interventions looked at was provision of preoperative information and counseling. The researchers did not find a large amount of evidence to suggest that preoperative education and counselling had an impact on outcomes of bariatric surgery. Preoperative information and education were shown to reduce anxiety. Pre-habilitation and exercise can enhance functional and physiological capacity to allow patients to have a speedier recovery after surgery. Another preoperative intervention examined was carbohydrate loading. The authors reviewed a study in which patients ingested an iso-osmolar drink 2-3 hours before induction. The desired outcomes of carb-loading were the attenuated development of postoperative insulin resistance, reduced postoperative nitrogen and protein losses, and maintenance of lean body mass (Thorell et al., 2016).

In general, most data reporting beneficial effects associated with ERAS have been generated from studies involving elderly and sometimes more frail patients. This is not the case for research on ERAS for bariatric patients because these patients are usually younger and more physically fit. Because the recommendation for the use of most of the ERAS interventions for bariatrics was graded as strong, the use of systematic ERAS pathways may lead to improved patient outcomes for the bariatric surgery population. It was surprising to see that the level of evidence for many of the elements was graded as low. However, it should be noted that the low grade for evidence reflects the current situation for many areas of modern medicine.

**Is There a Role for Enhanced Recovery After
Laparoscopic Bariatric Surgery? Preliminary
Results from a Specialist Obesity Treatment Center**

Barreca, Renzi, Tankel, Shalhoub, and Sengupta (2016) prospectively collected data between February 2011 and December 2014 on 288 consecutive morbidly obese patients undergoing laparoscopic gastric bypass and laparoscopic sleeve gastrectomy from a single bariatric surgeon in the United Kingdom. They found no significant differences between the subjects. Of the total, 278 patients were evaluated for early discharge on Day 1 post op, 10 were excluded because of delayed postoperative recovery. Overall, 100 of the 278 patients were discharged on Day 1 following their surgery. Before the implementation of the ERAS protocols, only 1 in 63 patients was able to be discharged on postoperative Day 1. The rate of discharge on Day 1 progressively increased from 38% in 2012 to 39.5% in 2013 and 44.8% in 2014. Multivariable logistic regression indicated significantly higher odds of being discharged on the first day postoperative for bariatric patients exposed to the ERAS protocols compared with those operated on before the implementation of ERAS. Fourteen of the 288 patients were readmitted within 30 days after discharge; only 5 required a second operation. Four patients were readmitted after they had been discharged on Day 1 postop, and 10 patients were readmitted after being discharged home on Day 2 postop. This difference was not statistically significant.

The authors concluded that bariatric surgery can be effectively performed in the context of an ERAS program (Barreca et al., 2016). After implementing the ERAS program, the facility in the study was able to discharge more than one-third of its gastric bypass patients and more than 67% of its gastric sleeve patients within 24 hours of surgery. The utilization of ERAS protocols proved to be successful in accomplishing the planned goals of reducing physiological

stress, achieving early return of body function, and well-tolerated reduction in length of hospitalization.

The Successful Implementation of a Modified Enhanced Recovery After Surgery Program for Bariatric Surgery in a South African Teaching Hospital

Loots, Sartorius, Paruk, and Clarke (2016) conducted a study to report on the introduction of a modified ERAS protocol for obesity surgery in a busy teaching hospital in South Africa. The goal was also to assess the feasibility and efficacy of the program. The researchers collected data on 62 patients who underwent surgery for morbid obesity between January 2011 and March 2016. Fifty-three patients underwent laparoscopic sleeve gastrectomy and nine patients underwent laparoscopic Roux-en-Y gastric bypass. There were no conversions to open procedures. Complete adherence to ERAS protocols was achieved in 53 patients. The patients who adhered to the protocol had a mean length of stay of 3 days. The nonadherent group had a mean length of stay of 4 or more days.

The reasons for the successful outcomes with ERAS are multifactorial and include patient-related and system-related factors (Loots et al., 2016). Recovery from surgery rather than length of stay should be the goal of implementing an ERAS program; however, the two outcomes are intertwined. Patients in this study who were adherent to the ERAS perioperative pathway had a shorter length of stay and better postoperative follow-up. Nonadherence in the preoperative setting should serve as a warning signal and prompt reassessment of the perioperative plan.

The conclusion of the researchers was that adherence to ERAS pathways was associated with minimal postoperative complications, significantly shorter hospital stays, and better postoperative follow-up (Loots et al., 2016). They also concluded that the complex, high-risk elective

bariatric procedure is feasible in the low-income country of South Africa, the study setting, especially with ERAS. This article is important because few ERAS programs have been implemented in South Africa.

One-Hundred Seventy-Nine Consecutive Bariatric Operations after Introduction of Protocol Inspired by Principles of Enhanced Recovery after Surgery (ERAS) in Bariatric Surgery

Matlok et al. (2015) evaluated the implementation of an ERAS-inspired protocol for bariatric patients at a high-volume laparoscopic center in Poland. A total of 179 bariatric surgical procedures were performed at the center between April 2009 and March 2014. After exclusion criteria were applied, 170 participants were selected for the study. All patients were encouraged to drink fluids 5 hours after their surgery. Also, they were mobilized the day of surgery; they dangled their legs off the side of the bed or stood up from the bed without assistance. Within the first 24 hours, 163 of the patients were fully mobilized. Complications occurred in 18 patients. The most frequent complications were rhabdomyolysis and postoperative nausea and vomiting.

The mean duration of hospitalization was 2.9 days (Matlok et al., 2015). It should be emphasized that standard hospitalization duration in this group of patients before implementation of the ERAS protocol was 5.3 days. Within the first 30 days, three patients required readmission for dehydration. No re-operations were necessary for any of the participants in the first 30 postoperative days.

The results of the Matlok et al. (2015) study confirmed the effectiveness and safety of the ERAS-inspired protocol introduced for bariatric surgery in this bariatric center in Poland. The results presented in the study showed that over 85% of patients fulfilled discharge criteria within 24 hours of the procedure. Extended hospital stays were often the result of concerns that geographical constraints would result in rehospitalization in a different center in closer proximity

to the patient's home. Overall, the evidence suggests that average hospital stays could be shortened without increased risk of complications or readmissions.

**Enhanced Recovery After Bariatric Surgery (ERABS):
Clinical Outcomes from a Tertiary Referral
Bariatric Centre**

In a prospective study, Awad et al. (2013) collected data on consecutive patients undergoing primary bariatric procedures (laparoscopic Roux-en-Y gastric bypass, sleeve gastrectomy, and gastric banding) within an ERABS pathway. Procedures were performed over a 9-month period (April 2012 to January 2013) at Imperial Weight Centre in London, England. This center is a regional high-volume tertiary referral bariatric center that employed four consultant bariatric surgeons and a bariatric fellow. Interventions utilized included shortened preoperative fasts, intra-operative humidification, early mobilization and feeding, avoidance of fluid overload, incentive spirometry, use of prokinetics and laxatives. During the 9-month study period, a total of 280 bariatric procedures were performed. Of these, 226 primary bariatric procedures were included in the study. The remaining 54 patients were excluded because they were having revision surgeries.

Mean lengths of stay were 1.88 and 2.30 days for LRYGB and sleeve gastrectomy patients, respectively (Awad et al., 2013). Furthermore, almost a third of gastric bypass and sleeve patients were successfully discharged on the first post-operative day. Half of the gastric band procedures were performed in a day-case setting. These results were achieved with an impressive 30-day hospital readmission rate of 2.7%. This study demonstrated that applying an ERABS protocol is feasible and safe and associated with low morbidity, acceptable lengths of stay, and low 30-day hospital readmission rates. The presence of multiple medical comorbidities should not preclude use of such a protocol with bariatric patients.

Postoperative Care and Functional Recovery After Laparoscopic Sleeve Gastrectomy vs. Laparoscopic Roux-en-Y Gastric Bypass Among Patients Under ERAS Protocol

Major et al. (2018) gathered prospective data for morbidly obese patients who were seeking treatment in an academic center. Data collection was performed by the authors, who were also directly involved in the treatment process. Patients were divided into two groups according to procedure: laparoscopic sleeve gastrectomy (LSG) group and LRYGB group. In order to minimize bias, patients were treated in accordance with the ERAS pathway, including preoperative, intraoperative, and postoperative interventions. Primary endpoints were factors determining the influence of the type of bariatric procedure on postoperative functional recovery: postoperative nausea and vomiting, stool passage, IV fluid administration, oral fluid intake, diuresis, diuretics management, extra painkillers management, postoperative fever, length of hospitalization, and readmission. Secondary endpoints were operative outcomes influenced by the type of bariatric procedure: operative time, mean IV fluid administration during the operation, intraoperative adverse events, postoperative complications, and reoperations.

The Major et al. (2018) study revealed a higher risk of postoperative nausea and vomiting in the LSG group. Amount of IV fluid administered during the operation day was significantly higher in the LSG group. Mean diuresis was similar in both groups. Administration of painkillers was similar in both groups. Mean length of stay was significantly higher in LSG group. Readmission rates were not influenced by the type of operation. Rates of intraoperative adverse events were comparable between groups. These results seem to be consistent with previously published studies.

The Major et al. (2018) study was the first literature reviewed to compare early postoperative course and functional recovery of patients undergoing LSG and LRYGB under an

ERAS protocol. Limitations were typical of a non-randomized design and a relatively small group. Influence of the type of procedure on excess weight loss and improvement of obesity-related comorbidities after bariatric treatment were not analyzed.

For patients undergoing surgery in this approach, the first days after surgery are crucial for maintaining homeostasis by controlling metabolism, administering fluids, and supporting the return of key functions such as improvements in cardiopulmonary function, early return of bowel function, and early resumption of normal activities. The primary goal is to achieve early functional recovery, which is not necessarily associated with shorter length of stay. Thus, the primary endpoints of the study focused on these parameters (Major et al., 2018).

Implementation of the Spanish National Enhanced Recovery Program (ERAS) in Bariatric Surgery: A Pilot Study

Ruiz-Tovar et al. (2016) conducted a multi-centric prospective pilot study of 125 consecutive patients undergoing bariatric surgery with ERAS at three Spanish hospitals between January and June 2015. Compliance with the protocol, morbidity, mortality, hospital stay, and readmission were evaluated. Inclusion criteria were age over 18 years and BMI greater than 40 or greater than 35 with comorbidities associated with obesity. The results of the study were similar to those reported by other researchers after implementation of fast-track protocols and similar to the actual evidence available in the literature for bariatric surgery. Several researchers reported hospital stays of less than 24 hours, and some authors suggested that bariatric surgery could become day-case surgery. Ruiz-Tovar et al. reported median hospital stay of 2 days, but no patients were discharged within the first 24 hours after surgery.

When protocols such as ERAS are implemented, the goal should be full compliance with all measures outlined. However, full compliance is often very difficult to achieve. In the Ruiz-

Tovar et al. (2016) study, overall compliance was very high at 83.6%, but compliance with its individual components varied. The items of the protocol with less compliance were early oral fluid administration and goal-directed fluid therapy. Poor compliance with these components could be related to the taste of the oral fluid, rejection by patients, and unavailability of devices. To effectively implement the ERAS protocols, improved training for and involvement of all professionals who assist the patients is necessary. Sign-boards placed at patients' bedsides identifying the protocols may help. The researchers concluded that the Spanish National ERAS protocol is safe with a high implementation rate. Thus it can be recommended to other institutions.

Synthesis of the Literature

Multiple studies have shown that applying ERAS protocols to bariatric surgery is feasible, well-tolerated, and associated with low levels of morbidity and mortality. In every study reviewed, length of stay in the hospital was significantly reduced with the implementation of ERAS protocols. Surgery procedure times were also decreased in multiple studies, allowing for more procedures to be completed on a daily basis. Also, evident in multiple studies was the need to use a consistent surgical team well versed in the use of ERAS protocols.

Recommendations for further research were also similar in multiple studies. The need for further research into cost savings with the use of ERAS protocols was mentioned. The available research at this time for that outcome is very limited; additional investigation of cost savings was suggested. Literature on ERAS for bariatric surgery is limited compared to literature on ERAS for other surgical specialties such as colorectal or gynecology. Recommendations were made for more focused research on ERAS for the bariatric population.

Table 1

Literature Review Matrix Presenting Important Features of Studies Reviewed

Author, Year, Country	Sample Size	Methods	Results	Conclusions & Limitations
Simonelli et al. 2016, Luxembourg	103 pre-ERAS patients 103 post-ERAS patients	Prospective study, comparative w/ retrospective data	LOS 3.18 vs. 1.47 days w/ ERAS. DEC. PROC. Times & RA rates	ERAS safe, effective. Lack of data on the control group.
Mannaerts et al. 2015, The Netherlands	2,126 patients	Prospective data on LRYGB & LSG patients. Consecutive cases	Dec LOS 3.0 to 2.1 nights, Inc. PO discharge rate on 1 st PO day to 74.2% from 39.4 % pre-ERAS	Substantial LOS decrease. No significant change in # of complications. Cost effective, efficient
Hahl et al. 2015, Finland	388 consecutive cases LRYGB w/ ERAS	Prospective study	Mean LOS was 1-3 days 323 DC on first PO day 49 DC on 2 nd PO day	Standardization of care is necessary. Further research needed to evaluate costs.
Singh et al. 2016, India	144 articles	Systematic review PRISMA guidelines Meta-analysis	Dec. LOS by around 1.5 days No increase in complications or RA rates	Supportive of efficacy of ERAS. Protocol is safe to use in morbidly obese.
Blanchet et al. 2017, France	374 patients	Prospective comparative study	Mean LOS was 1.24 Proc. time was 42 min. vs 31.1 min	Equally safe & effective for LRYGB&LSG. Still evolving, not yet standardized. Higher level of evidence needed.
Thorell et al. 2016, Scandinavia	Not listed	Search of literature 1/1966 & 1/2015. Meta-analyses, RCTs, & large prospective cohort studies	Shorter LOS No change in RA rates Or PO complication or fatigue scores	More research needed on ERAS for bariatrics. Some evidence weak, yet recommendation still high

Author, Year, Country	Sample Size	Methods	Results	Conclusions & Limitations
Proczko et al. 2015, Poland	186 GB, 144 GS, 31 BAND 13 Revision	Retrospective comparison Pre & Post ERAS OR logistics & complications	LOS 3.7 to 2.1 days Proc Times dec by 15 min Induction dec by 15 min TO times from 38- 11 min	Incidence of RA and reoperations, complications showed no change
Sinha et al. 2016, India	823 patients	Retrospective analysis. Prospective data of Lap bariatric surgery	Aggressive optimization protocols can avert effects of BMI on outcomes	Higher BMI means Inc. ambulation time & DC readiness time
Lemanu et al. 2012, New Zealand	116 patients 78 ERAS, 40 control, 38 historical	Comparison of data from the three groups	LOS shorter in ERAS No difference between groups in complication rate	More cost savings studies needed. Lack of blinding, risk of bias
Barreca et al. 2016, United Kingdom	288 consecutive patients	2/2011-12/2014 Prospective data, 1/2012 all pts were ERAS	100 pts DC on day 1 178 DC on day 2 14 readmits, not statistically significant RA changes	Retrospective could be due to learning curve of surgeons and their hesitancy to DC before ERAS
Loots et al. 2016, South Africa	62 patients	1/2011-3/2016 Prospective data compared with/WO ERAS	Non-ERAS group longer LOS, better FU rate ERAS	ERAS r/t minimal complications, shorter LOS. Feasible in this center
Matlok et al. 2015, Poland	170 patients	4/2009-3/2014 Analysis of bariatric sx patients	Better tolerance of oral liquids and ambulation postop	Reduced LOS w/o increased complications or readmissions
Awad et al. 2013, London, England	226 patients	4/2012-1/2013 Prospective data collection	Mean LOS .69, 1.88, 2.30 for band, LRYGB, LSG. 2.7% readmission rate	ERABS protocol safe, low morbidity, low RA rate. Lack of evidence base in bariatric specialty.

Author, Year, Country	Sample Size	Methods	Results	Conclusions & Limitations
Major et al. 2018, Poland	574 patients	4/2009-11/2016 Comparative study of LRYGB vs LSG. Statistical analysis w/ Statistica	Inc. PONV in LSG. Inc. IV fluids in LSG. No difference in oral intake. Mean LOS slightly higher in LSG group	PO txt of LSG required significantly more supervision and longer time until functional recovery achieved. Non-randomized design. Relatively small group.
Ruiz-Tovar et al. 2016, Spain	125 participants	1/2015-6/2015 Multicentric prospective pilot study	Median PO pain on day 2 was a 2(0-5) PONV in 7 patients Median LOS 2 days RA rate was 2.4%	Spanish National ERAS protocol is safe with a high implementation rate. It can be recommended to establish this protocol to other institutions.

Chapter 4: Results

This research evaluated the effectiveness of implementing ERAS protocols in the care of bariatric surgery patients. Fifteen research articles on the topic were reviewed. The consensus from articles that investigated the outcomes of ERAS care protocols was that the protocols were effective in decreasing length of stay, reducing operation times, and lowering complication and readmission rates during the first 30 days following the procedure. All the articles that addressed length of stay showed a decrease from 3 to 6 days to 1 to 3 days. The studies indicated that procedure times could be decreased by around 10 minutes and turnover times improved by about 15 to 20 minutes on average. The shorter lengths of stay and procedure times were shown to not cause an increase in complications or readmissions. Patients who did not adhere to the ERAS protocols and were therefore deemed non-compliant had less successful results than patients who complied with the program. The literature also indicated that more research needs to be done focusing on the specialty of bariatric surgery.

Laparoscopic bariatric surgery can be associated with moderate to severe pain, and effective opioid-free analgesia is essential for facilitating and expediting postoperative recovery and preventing opioid-related misadventures. Transversus abdominis plane (TAP) block has proven to be efficacious as part of a multi-modal analgesia. Studies in which TAP block was used to reduce postoperative pain demonstrated that it was successful in reducing the requirement for postoperative opioids, promoting early ambulation, and preventing opioid-related nausea and vomiting.

Chapter 5: Discussion, Recommendations, and Conclusion

Standardization of anesthetic protocols, good surgical technique, and use of a didactic medical and nursing postoperative protocol are factors that contribute to the good clinical outcomes described in the articles reviewed in this project. Several of the components of ERAS protocols have a strong evidence base and are now widely considered best practice. At bariatric centers where large numbers of surgeries are performed every year with the same skilled staff of surgeons, there was less room for improvement than at smaller facilities where fewer procedures take place.

Throughout all 15 studies reviewed there was strong demonstration that the application of ERAS protocols is feasible, safe, and associated with low morbidity, an acceptable length of stay, and low 30-day hospital readmission rates. Also, the literature demonstrated that the presence of multiple medical comorbidities should not preclude the use of ERAS protocols with bariatric patients. Patients with more severe comorbidities experienced the same positive outcomes as those with fewer severe comorbidities of obesity. Participants reported many positive aspects of their ERAS experience and favored the program, particularly because home was the preferred place for recovery.

It is imperative that we not look at these protocols as a way to increase the number of procedures that can be performed by discharging patients as soon as possible following surgery; we cannot discharge patients until they have reached full functional recovery. High demand for bariatric operations creates the tendency for surgeons to perform them on an outpatient basis. However, this is not optimal for the patient. Bariatric patients can be highly complex with severe comorbidities and should always be admitted for at least 1 to 2 days following their surgical procedure. Patients must be well-educated on the details of their post-operative care and

recovery. Discharge instructions must be explained and patients' understanding of those instructions must be evaluated. Patients' insights should be solicited to aid in developing treatment programs to ensure a holistic approach to care is adopted, an approach that enhances the psychological, social, and physical wellbeing of patients.

Recommendations for Further Research

When conducting my search for literature on ERAS protocols and the bariatric surgery patient, I found an abundance of studies supporting ERAS with other surgical specialties but not many focusing on bariatrics. With obesity rates and rates of comorbidities increasing each year, it is imperative that more research be done to establish best practice for procedures that address obesity. Also, several articles mentioned the fact that little research has been done on the cost effectiveness of implementing a bariatric ERAS program. Further research should be conducted on the sustainability of bariatric ERAS programs. Issues were found with sustaining compliance with some of the more difficult components of the protocol; research could explore ways to improve compliance.

Limitations of the Research

The main limitation of this study was the lack of available information. Finding relevant articles focusing on bariatric surgery was difficult. As Table 1 illustrates, no research was found on use of ERAS in bariatrics in the United States; all the literature on the topic described studies conducted in other countries. This was surprising because the U.S. population has some of the highest rates of obesity, metabolic syndrome, and diabetes. The author believes a full and detailed understanding of the population seeking bariatric procedures, including its needs and barriers to healthcare, will result in the implementation of feasible and effective solutions to the problem. The author is aware that the strategies found in the literature review cannot be applied

to a specific population without first studying and conducting further research within that population.

Conclusion

As this literature review project illustrates, many studies have demonstrated the benefits of implementing an ERAS program for the bariatric population. The literature reviewed was not local and not centered on the population of California's Central Valley. However, it does serve as a starting point for the development of future programs at our local hospitals that have successful bariatric surgery programs.

To facilitate early discharge of patients after bariatric surgery, patient performance status needs optimization and expectations need to be adequately managed preoperatively in a multidisciplinary setting with education. As discussed in the studies, preoperative patient preparation, structured anesthetic protocols, and postoperative care with recurrent visits to the patient's bedside and close monitoring of pain control and vital parameters all play essential roles in the achievement of patient discharge in that first 24 to 48 hours.

An important aspect of ERAS in general is continuous change in practice that affects outcomes. One study pointed out that the number of laparoscopic surgeries has increased in the last 3 to 5 years by about 25%. Use of ERAS in laparoscopic surgery is likely to account for some of the improvement and sustainability of the surgical outcomes. It is important for the further development of ERAS to recognize that continuous re-evaluation of the evidence and the guidelines will be necessary. The improvements we make today must not hinder the developments of tomorrow.

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ENHANCED RECOVERY AFTER BARIATRIC SURGERY

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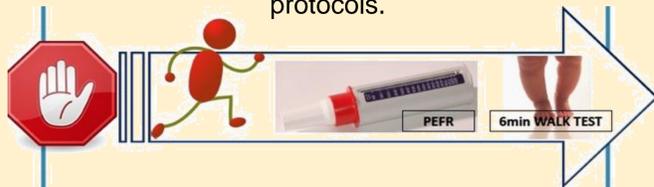
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Abstract

During the last two decades, an increasing number of bariatric surgical procedures have been performed worldwide. There is no consensus regarding optimal perioperative care in bariatric surgery. When a patient is undergoing a surgical procedure, the fall from their normal physiologic state actually exceeds a level caused by illness alone. This is because of the endocrine and metabolic impact of the surgical stress. This decline is then followed by a slow recovery back to a pre-existing level of functioning. If ERAS protocols are implemented one would likely see an earlier recovery. During the intraoperative phase, surgical and anesthetic techniques are used to minimize the surgical stress response. This project will aim to present such a consensus and to provide recommendations for elements in a set of evidence-based "enhanced" perioperative protocols.



Methodology

This review aims to evaluate the current literature on ERAS in obesity surgery. Using the PRISMA guidelines, a systematic review of primary and secondary outcomes following the implementation of ERAS protocols for bariatric surgery was conducted. Research resources utilized to gather the necessary studies were Pubmed, CINAHL, Evidence-Based Journals, and the Cochrane Library. Initial search was for Enhanced Recovery After Surgery protocols, subsequent searches included more focused searches including key words "ERAS", "Bariatric Surgery", "Morbidly Obese", "Gastric Bypass", and "Sleeve Gastrectomy". For appraisal of the studies included in this project, the CASP Literature Appraisal Tool was used to determine the validity of the results produced in my chosen fifteen studies. This tool helped to ensure that each study incorporates the rigor necessary to produce sound evidence-based conclusions. Only studies that produce adequate evidence according to the CASP tool were included in this project.



Results

- With ERABS, the mean length of stay in several studies decreased from about 3.0 to 2.1 nights ($p < 0.001$).
- Prior to ERABS, 39.4% of patients were discharged on the first postoperative day. Since the introduction, this percentage increased to 74.2% of all subjects, with 91.7% of all subjects being discharged on postop day two.
- Induction times were reduced from 15.2 minutes to 12.5 minutes.
- Procedure times were also shorted by 12-15 minutes.
- Turnover times improved from 38 minutes to 11 minutes with the use of ERABS protocols.
- No increase in complication or 30 day post op readmission rates were noted in any of the 15 studies reviewed.



Discussion

Literature supporting the use of ERAS protocols for other surgical specialties is more abundant where literature focusing on bariatric surgery is more sparse. More research needs to be completed evaluating the effects of ERAS pathways and health costs in patients undergoing bariatric surgery. Surgery will continue to evolve with time; different techniques and supplies continue to be made. With this change, we should also be looking at how to improve the outcomes of patients and how to further develop our standards of care. Research shows that morbidity and mortality of the obese population is markedly higher than the non obese. Obesity rates continue to rise and therefore so will bariatric surgery procedures. Providers must do their due diligence to make sure these patients continue to have safe outcomes.

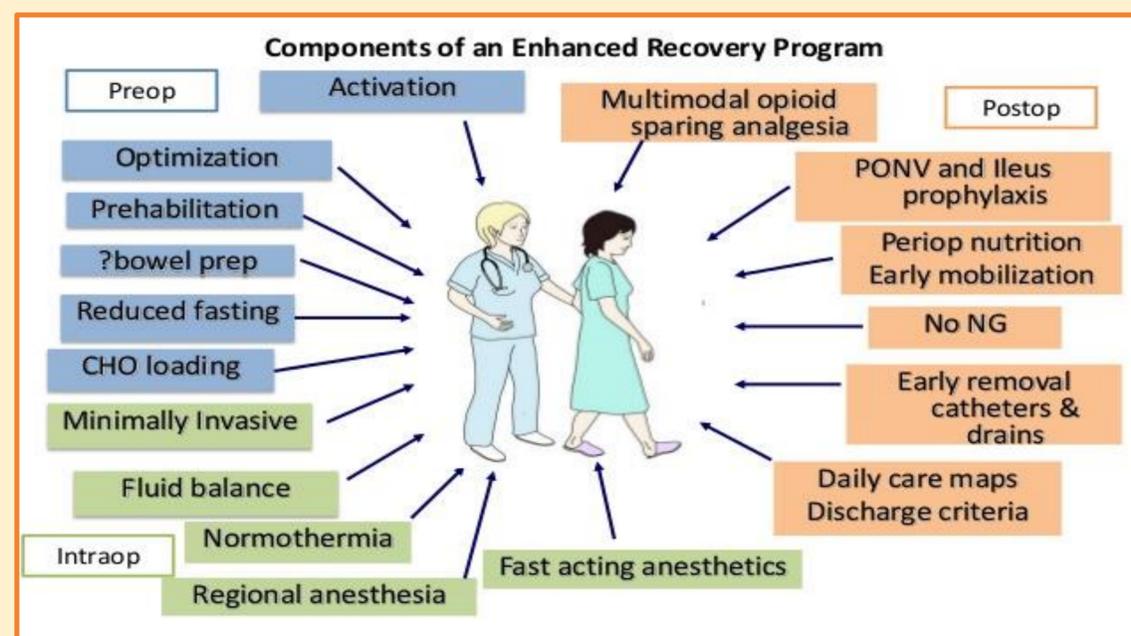
Introduction

Bariatric surgery is the most effective treatment for morbid obesity, resulting in sustained weight loss as well as pronounced effects on obesity-related comorbidities. The number of surgeries performed worldwide increased from 146,000 to 340,000 between 2003 and 2011. Enhanced recovery after surgery (ERAS) pathways involve a series of perioperative evidence-based interventions that were developed initially for elective colorectal surgery. ERAS pathways aim to maintain physiological function, enhance mobilization, reduce pain and facilitate early oral nutrition post-operatively by reducing perioperative surgical stress. By decreasing stress on the body, length of stay will be decreased and healthcare costs will be reduced.

PICO:

Are ERAS strategies versus conventional care in postoperative bariatric patients effective in reducing the length of hospital stay while improving patient outcomes?

ERAS Interventions



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