

## Enhanced recovery pathways in orthopedic surgery

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### Abstract

The enhanced recovery after surgery (ERAS)<sup>®</sup> concept, sometimes referred to as “fast track”, “accelerated,” or “Rapid Recovery” surgery, was first introduced in 1997. The concept of ERAS targets factors that delay postoperative recovery such as surgical stress and organ dysfunction. ERAS protocols or programs are a care package of evidence-based interventions used in a multimodal and coordinated clinical care pathway. They represent a multidisciplinary approach directed to reducing postoperative complications, shortening length of hospital stay, improving patient satisfaction, and accelerating recovery. ERAS was initially centered on abdominal and colorectal surgery patients; however, ERAS protocols have been widely extended to include other specialties. Orthopedic surgery, particularly elective hip and knee arthroplasty is one of such areas where ERAS principles have been adopted. It has been associated with reduced length of hospital stay, readmission rate, and improved functional recovery. The common interventions used in orthopedic ERAS programs have been divided into those performed in the preoperative, intraoperative, and postoperative phases of care. A PubMed literature search was performed for articles that included the terms enhanced recovery and orthopedic surgery. In this article, we summarized the clinical application of ERAS and highlighted the key elements that characterize an enhanced recovery program.

**Keywords:** Enhanced recovery after surgery, nutrition, orthopedic surgery, postoperative care, preoperative care

### Introduction

Enhanced recovery after surgery (ERAS)<sup>®</sup> was first described by Danish surgeon Henrik Kehlet in 1997.<sup>[1]</sup> The idea behind ERAS was a reduction of postoperative physical and psychological stress, thereby decreasing recovery time and overall financial burden. Bardram looked at nine colorectal surgeries in which patients were treated with a multimodal approach including epidural analgesia, early mobility, and early oral nutrition, which represented the first fast-track recovery programs described.<sup>[2]</sup> Bardram reported

that effective pain relief facilitated early mobilization in the patients and that hospital stay was reduced to two days without any reported nausea, vomiting, or ileus. He further reported that postoperative fatigue and impairment in functional activity were avoided. The conclusion of the study suggested that major advances in postoperative recovery could be achieved by early and aggressive perioperative care in high-risk elderly patients undergoing colonic surgery.<sup>[2]</sup>

Today, orthopedic surgery remains one of the most common ambulatory and hospital surgical procedures in the nation. Over the last 10–20 years the rate of total joint replacements has increased with the aging population. Approximately 4 million Americans who have had a knee replacement are currently living with a total knee replacement and the cost of these types of surgery is projected to rise.<sup>[3]</sup> Additionally,

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length of hospital stay continues to be an accurate predictor of monetary burden on the healthcare system for this type of elective procedure.<sup>[4]</sup> The burden of cost lies in postoperative care, including physical and occupational therapy, nutrition, and social services, which directly influence cost accrued.<sup>[5]</sup> To address this burden, ERAS programs have been implemented at institutions and are designed to improve patient outcomes while at the same time limiting cost and decreasing readmission rates after surgery. In fact, many institutions develop their own ERAS protocols based on the given financial burden that a particular surgery has on that institution to hopefully decrease length of stay, decrease complications, and decrease medical costs.<sup>[6]</sup> The concept of ERAS and its increased safety and efficacy in orthopedic surgery is continually being investigated. Reports suggest a decrease in the length of hospital stay after total arthroplasty from 4–12 to 1–3 days with no significant increase in readmission for any reason.<sup>[7,8]</sup> The evidence appears clear that ERAS protocols improve hospital and patient outcomes, however, these processes can be streamlined to facilitate implementation. This article will dive into the various characteristics of an ERAS protocol designed specifically for orthopedic surgery and will discuss: Preoperative assessment, fasting, bowel preparation, anesthetics pre-op, and intra-op, prophylactic thrombosis prevention, postoperative nausea and vomiting, nutrition, and fluid management.

## Components of Enhanced Recovery after Surgery in Orthopedic Surgery

Preoperative evaluation – As with any surgery, preoperative evaluation and optimization status are critical prior to an elective procedure. Preoperatively, patients can meet with the surgical teams and anesthesia teams separately to discuss expectations. Additionally, patient participation in preoperative classes that address commonly asked questions and inform the patient of the procedures can be helpful to both the patient and the healthcare staff.<sup>[7]</sup>

### Preoperative Phase

#### Preoperative assessment and organ dysfunction optimization

Pre-existing conditions such as coronary artery disease, hypertension, chronic obstructive pulmonary disease, diabetes and organ dysfunction are strong determining factors of postoperative complications and duration of hospital stay.<sup>[9-11]</sup> It is crucial to meet with patients several weeks before their scheduled surgery. It allows the preoperative team to optimize any organ dysfunction, address issues that may cause any potential risk, and to optimize preoperative anemia. It also

gives the opportunity to initiate alcohol and smoking cessation programs if indicated.

#### Preoperative education

Preoperative education should aim for achievable goals involving postoperative pain management, physiotherapy, and mobilization. Systemic reviews of preoperative education show a considerable reduction in patient anxiety and emotional stress while also establishing greater patient confidence with higher satisfaction.<sup>[12]</sup> On the contrary, there is little evidence to support the use of structured preoperative education to reduce postoperative complications, improve pain, or shorten the length of hospital stay. Preoperative education benefited patients with depression, unrealistic expectations, and those with limited support. Discomfort is expected in the immediate post therefore, it is important to manage possible unrealistic expectations that patients may have operative period regardless of any analgesic approach used.

Many orthopedic centers provide a preoperative education class where a multidisciplinary team including nurses, physical and occupational therapists, and care coordinators explain the care pathway, and address patient's physical, social, and psychological needs prior to their surgery.

#### Preoperative fasting and nutrition

The concept of fasting from midnight prior to anesthesia for elective surgeries has been challenged with ERAS programs. Instead, clear fluid has been permitted up to 2 hours prior to induction of anesthesia and solid food has been permitted up to 6 hours prior to induction of anesthesia. Growing evidence suggests there is no patient safety benefit associated with prolonged fasting. For example, fasting for long periods of time can induce a catabolic state, which can increase the stress response to surgery resulting in insulin resistance and hyperglycemia, thereby prolonging the recovery period.<sup>[13]</sup> However, a more cautious fast has been recommended for the morbidly obese patient and those with poorly controlled diabetes mellitus.

Nutritional status is important in ERAS and should be addressed in the preoperative assessment. Malnutrition is associated with wound infection, delayed healing, sepsis, and increased risk of mortality. Additionally, ERAS recommends a carbohydrate load via a clear carbohydrate reach drink 2–3 hours before surgery. The idea is to present the patient to surgery in a metabolically fed state leading to less postoperative protein loss and preservation of muscle mass. There is limited information available regarding ERAS nutritional status and orthopedic surgery, however, in some ERAS protocols. In some ERAS protocols carbohydrate loading with a clear carbohydrate liquid 2 hours prior to surgery decreased insulin

resistance reduced thirst, reduced hunger and decreased anxiety in the patient.<sup>[14]</sup>

### Preoperative anesthetics and analgesics

The opioid crisis in the United States has prompted a multimodal approach to pain management in the preoperative, perioperative, and postoperative periods. For example, NSAIDs, acetaminophen, preoperative bupivacaine, adenosine, magnesium, clonidine, and venlafaxine have all been effective analgesics in patients undergoing breast surgery.<sup>[15]</sup> There is also evidence that sedatives and anxiolytics can be avoided with appropriate preoperative counseling, whereas histamine H<sub>2</sub> blockers and proton pump inhibitor prophylaxis can be used in patients who have had a shortened fasting period.<sup>[16]</sup>

### Prophylaxis against thromboembolism

The most commonly used venous thromboembolism (VTE) prophylaxis in the hospital are unfractionated and low molecular weight heparin. Various surgical societies have developed their recommendations for VTE prophylaxis. The two competing recommendations are from the American College of Chest Physicians (ACCP) and the American Academy of Orthopaedic Surgeons (AAOS). The ACCP recommends 10–14 days of prophylaxis. The AAOS holds the view that pulmonary embolism (PE) and DVT are regarded separately, and prevention should be more focused on PE.<sup>[17]</sup> Complicating this decision is the use of neuraxial catheters in epidurals. The American Society of Regional Anesthesia and Pain Medicine recommends against the use of VTE prophylaxis 12 hours prior to insertion or removal of a catheter.<sup>[17]</sup> These recommendations from the various societies must be considered with any ERAS protocol.

## Intraoperative Phase

The goal in the intraoperative phase is to reduce the physical stress of the surgery. Stress-free anesthesia and surgery to attenuate the trauma-induced physiological responses leading to a reduction of morbidity and mortality have been proposed. Reducing the physical stress of the surgery can be achieved with:

### Minimally invasive surgical techniques

#### *Anesthesia technique*

Neuraxial anesthesia has always been preferred and considered superior to general anesthesia in ERAS protocols. It provides a sympathetic blockade, inhibits stress hormone release, and attenuates postoperative insulin release. When compared with general anesthesia, spinal anesthesia has been associated with shortened length of hospital stay, reduction in pulmonary complications, kidney injury, blood transfusion, and 30-day mortality.<sup>[18]</sup> However, none of the studies compared spinal

anesthesia with the newer mode of the general anesthesia such as total intravenous anesthesia (TIVA), which may result in better outcomes.

#### *Local infiltration analgesia*

Local infiltration analgesia (LIA) is administered by surgeons intraoperatively, in and around the joint. Ropivacaine is most commonly used as local anesthetic, mixed with epinephrine and/or steroids. LIA is more useful when used in total knee arthroplasty. It provides postoperative pain relief 6–12 hours after total knee arthroplasty. However, when used in total hip arthroplasty, it has no analgesic effect.

#### *Maintaining normothermia*

Normothermia has been considered part of the anesthetic management in ERAS programs for joint arthroplasty. Maintaining perioperative normothermia and preventing intraoperative heat loss have been associated with reduced infections, coagulopathy, blood transfusion rate, and cardiovascular complications.<sup>[17]</sup> Intraoperative heat loss is a major risk factor that leads to increased stress responses with increased cortisol and catecholamine release, and nitrogen loss. The most beneficial method of warming is forced air warming. Preoperative operating room warming did not prevent intraoperative hypothermia in total joint replacement surgery.<sup>[19]</sup> Neuroprotective effects of hypothermia is an intriguing area of research, but no consensus has been made regarding mild hypothermia in any ERAS protocol, and so adequate normothermia is still recommended to prevent the complications listed above.<sup>[17]</sup>

### Optimal intraoperative fluid balance

Suboptimal fluid balance can affect tissue oxygenation and interfere with wound healing.

Blood conservation strategies:<sup>[20]</sup>

1. Correction of any existing anemia preoperatively with iron supplements or erythropoietin is crucial particularly in patients with multiple high risks
2. Hypotensive anesthesia technique to minimize blood loss without increasing the risk of stroke, myocardial infarction, or kidney injury
3. Blood salvage techniques: autologous blood transfusion or cell salvage. However, this technique alone did not eliminate the need for allogeneic transfusion particularly in patients with preexisting anemia
4. Tranexamic acid: antithrombotic drug its use has been shown to reduce intraoperative blood loss and rate of blood transfusion irrespective of the route of administration. It may be given orally, intravenously, or topically onto the joint space.

## Intraoperative anesthetics and analgesics

There is evidence suggesting that regional anesthesia confers a greater advantage in total joint arthroplasty from a physiological standpoint. It is sufficient for surgery, provides a sympathetic block, inhibits stress hormone release, and decreases insulin resistance. Reduced length of stay is also associated with the use of neuraxial anesthesia as opposed to general anesthesia.<sup>[17]</sup> Epidurals in major open surgeries have been shown to decrease respiratory complications and decrease bowel ileus as opposed to general anesthesia with concurrent opioid use.<sup>[21]</sup> Many ERAS protocols advocate a multimodal approach to pain management to limit opioid use. Additionally, neuraxial techniques have been shown to blunt the stress response and decrease length of stay, which are all important in extended recovery programs.

### *Perioperative fluid management*

Goal-directed fluid management is an important component of ERAS protocols for all types of surgeries.<sup>[22]</sup> Strict fluid management may be more important in larger surgeries that may have more blood loss associated with the procedures, as opposed to elective total joint replacements. Regardless, goal-directed fluid replacement therapy can result in less postoperative infection, organ dysfunction, and transfusion requirements.<sup>[23]</sup> Patients in an ERAS protocol generally have less fluid deficits since they avoid prolonged fasting and bowel preparation in surgery. Intravenous fluids should be discontinued as soon as the patient can take in enough fluids by mouth.

## Postoperative Phase

The postoperative phase can be divided into two key elements: enhancing postoperative comfort and optimizing postoperative care.

### **Multimodal opioid-sparing analgesic techniques**

Multimodal analgesia is the combination of analgesic techniques and various analgesic drugs from different pharmacological classes. Epidural analgesia, continuous or patient-controlled, peripheral nerve blocks, single injection or continuous, acetaminophen, NSAIDs, gabapentin, and ketamine, have all been used for this purpose. An important component of an ERAS protocol is to provide an effective postoperative pain relief. However, postjoint arthroplasty pain can be challenging. The aim of postoperative pain management should be directed toward reducing the discomfort more than eliminating the pain. Reducing the pain as much as possible must be weighed against the medications, side effects, and the delay in mobilization due to any regional technique or nerve block.<sup>[24]</sup>

## Prevention of postoperative nausea and vomiting

The typical risk factors for postoperative nausea and vomiting (PONV) are female sex, nonsmoker, history of PONV, motion sickness, and the need for postoperative opioids.<sup>[25]</sup> The best way to prevent PONV is to avoid using general anesthesia and opioids altogether. Total intravenous anesthesia with minimization of volatile anesthetics while maximizing regional and neuraxial techniques will likely decrease postoperative nausea and vomiting. Patients with two risk factors should receive dexamethasone at induction or the end of the procedure or a serotonin receptor antagonist at the end of the procedure. Those with three or more risk factors should receive both. Diabetic patients should be evaluated on a case-by-case basis for postoperative or intraoperative insulin requirements.

### **Early immobilization and rehabilitation**

Prolonged bed rest postoperatively is associated with increased risk of thromboembolism, pulmonary complications, insulin resistance, and delayed wound healing. Early mobilization and physical therapy are key elements of successful a ERAS protocol. A detailed assessment preoperatively to identify the patient's expectations and the goals of rehabilitation is important. Physical therapy is recommended on day 0 and as early as 2–6 hours postoperatively as permitted by patient stability. Adequate analgesia with the multimodal approach is vital to enable successful and less distressing early ambulation.

## Conclusion

ERAS is a patient-centered approach and evidence-based intervention that aims to improve both the patient experience and clinical outcomes. After its success in colonic surgery, ERAS was adopted in orthopedic surgery for elective hip and knee arthroplasty. The ERAS pathway consists of a selected number of interventions divided into those performed preoperatively, intraoperatively, and postoperatively. Those interventions demonstrated a better impact on patient outcomes when performed together. The ERAS pathway has improves outcomes and reduces the length of hospital stay. However, despite the significant progress in ERAS implementation in recent years, its widespread adoption is limited, and there is still significant work and research to be done.

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### **Conflicts of interest**

There are no conflicts of interest.

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