Anesthetic management for enhanced recovery after major surgery in children

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ABSTRACT

Introduction: Perioperative Enhanced Recovery After Surgery (ERAS) protocols, though originally created in adult surgery, are increasingly gaining applications in pediatric practice. This application addresses the unique challenge in children, who possess more complex surgical stress responses. The main goal of ERAS is to maximize postoperative recovery and improve clinical outcomes through a standardized multimodal perioperative care approach.

Materials and Methods: This review article integrates current literature and expert consensus regarding the use of ERAS principles in pediatric anesthetic care in the preoperative, intraoperative, and postoperative phases in children undergoing major surgery, also explores the implementation, benefits, and challenges of ERAS in pediatric patients, highlighting recent advancements and the impact of these protocols on recovery.

Results: The key pillars of pediatric ERAS include preoperative education and dietary optimization, multimodal opioid-sparing analgesia (e.g., regional anesthesia, non-opioid systemic analgesics), minimally invasive surgery, and goal-directed fluid resuscitation. Postoperative care includes early enteral nutrition, early mobilization, and planned discharge. Existing evidence, although further emerging, indicates that adherence to these protocols is associated with significant benefits, including shorter hospital length of stay, reduced opioid consumption, reduced intraoperative fluid administration, and faster return to normal diet.

Conclusion: ERAS protocols implemented in pediatric anesthesia are successful in optimizing recovery by reducing complications, improving pain control, and reducing length of stay. Implementation is case-specific anesthetic planning and multidisciplinary collaboration, finally maximizing outcomes and improving satisfaction for parents and children.

KEYWORDS:
Pediatric ERAS, Multimodal Perioperative Care, hospital stay reduction

INTRODUCTION

Children requiring major surgery have unique and special needs because they have more complex surgical stress reactions compared to adults, are frequently more severely affected by the external environmental disruptions and physical stress response brought on by traditional perioperative care. Consequently, it is even more crucial to optimize perioperative care for pediatrics populations.[1]

In 2018, Short et al. reported a study on the development of a pediatric-specific ERAS protocol, which adopted 19 out of the 21 ERAS elements used for adult colorectal patients. This protocol has increased awareness within the field of pediatric care by highlighting the importance of a multimodal approach to improve postoperative outcomes. ERAS protocols in pediatric surgery focus on multimodal analgesia, opioid minimization, early feeding and mobilization, and maintaining hemodynamic stability, all of which contribute to enhanced recovery and reduced hospital stays.[2-4]

This narrative review explores the implementation, benefits, and challenges of ERAS in pediatric patients, highlighting recent advancements and the impact of these protocols on recovery.

Key Components of ERAS Protocols in Pediatric Patients

The ERAS concept aims at reducing postoperative inflammatory, neurohormonal, and pain response, thereby allowing faster return to baseline function, decreasing in-patient Length of Stay (LOS), and decreasing postoperative complications.

Enhanced Recovery After Surgery (ERAS) protocols in pediatric patients encompass several key components that contribute to improved perioperative outcomes and long-term benefits. ERAS protocols involve a multimodal approach to perioperative care, focusing on reducing the stress response and associated physiological changes that accompany surgery.[1-2]

Using the modified Delphi process, Short et al. ultimately produced a concise list of suggested ERAS elements in paediatrics as follows:[2]

- Preoperative: Preoperative ERAS education, optimize medical comorbidities, avoid prolonged preoperative fasting and administer non-opioid analgesia
- Intra-operative: Venous thromboembolism prophylaxis, pre-incision antibiotic prophylaxis, standard anesthetic protocol, minimally invasive technique, prevention of nausea/vomiting, no nasogastric tubes and standardized hypothermia prevention

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- Postoperative: No intraperitoneal perianastomotic drains, goal-directed/near-zero fluid therapy, early removal of urinary catheters, prevention of postoperative ileus, opioid-sparing pain regimen, early mobilization, audit protocol compliance and outcomes and perioperative nutritional screening.

The ERAS elements are discussed in detail as follows:

Preoperative Management

In preoperative stage all patients get preoperative education and nutritional evaluation prior to surgery, and nutritional support is initiated individually before and/or after surgery. The preoperative fasting time is reduced from stopping clear fluids for at least two hours and solid foods for six hours prior to anesthesia.[2]

Preoperative education for patients and families helps alleviate anxiety, which can significantly impact recovery. Preoperative education and counselling include the goals and procedures of the ERAS protocol, pain treatment strategies, parental expectations of surgery, discharge criteria, and follow-up plans. Furthermore, ERAS protocols enhance patient and family satisfaction. This educational aspect ensures that families are well-informed about the surgical process and recovery expectations, leading to a more positive experience overall.[4]

Adequate preoperative nutrition screening and support are vital yet underrecognized aspects of ensuring optimal surgical outcomes, often due to an inconsistent use of available screening tools in the inpatient pediatric setting, and a lack of validated screening tools in the outpatient setting. Screening in pediatric patients undergoing surgery to identify individuals with malnutrition or those at risk of malnutrition is important. Malnutrition is more prevalent in pediatric patients with underlying chronic medical conditions but can be present in the general pediatric population as well. Screening may identify malnourished patients who are either underweight or overweight. Nutritional optimization is critical, as a pre-operative malnourished state, can hinder recovery.[5]

Patients need to be encouraged to drink clear water up to a maximum capacity of 3 ml/kg up to one hour before to elective general anesthesia.[2] However, the American Society of Anesthesiologists (ASA) continues to advise a two-hour clear fluid fast despite the evidence that within 30 minutes, water leaves the stomach, and within an hour, other clear fluids are nearly gone. Clear fluid fasting in children does not result in any significant change in their gastric volume or pH. Long-term fasting triggers immunological and metabolic reactions that raise insulin resistance, cause a catabolic state, and perhaps lower intravascular volume.[6] Therefore, prolonged preoperative fasting in children should be avoided to minimize metabolic stress and maintain hydration without increasing aspiration risk.

ERAS protocols emphasize the use of multimodal analgesia that combines various analgesic modalities, including neuraxial anesthesia (e.g. epidural or intrathecal morphine), regional blocks (e.g. TAP block), and non-opioid systemic analgesics (e.g. paracetamol, NSAIDs), achieve optimal pain control while minimizing opioid use and its side effects. This approach is crucial in pediatric care, where the risks associated with opioid use can be particularly concerning. The use of adjuncts like dexmedetomidine has been shown to effectively manage pain while also reducing anxiety and emergence agitation in pediatric patients.[7-9]

Intraoperative Management

The choice of anesthetic technique plays a pivotal role in the success of ERAS protocols. General anesthesia remains a common choice for many pediatric surgeries. However, the incorporation of multimodal analgesia strategies is essential to enhance recovery. The anesthetic team must carefully consider the pharmacokinetics and pharmacodynamics of anesthetic agents in children, as their responses can differ significantly from adults. For example, children have a higher cardiac output and greater total body water, resulting in a larger volume of distribution for water-soluble drugs and faster redistribution of lipophilic agents, which can alter both onset and duration of anesthetic effects compared to adults. Regional anesthesia, such as nerve blocks, has been shown to provide effective analgesia while reducing the need for opioids, which can have adverse effects on recovery. The use of caudal blocks in children undergoing lower abdominal surgeries has been associated with significantly decreased postoperative pain and opioid consumption, leading to faster recovery times and shorter hospital stays. For instance, a randomized trial evaluating epidural analgesia in major surgery (MASTER study) demonstrated improved pain scores at rest on postoperative day one and on coughing from days one to three compared to systemic opioid analgesia, highlighting the potential of regional techniques to enhance postoperative outcomes.[10]

Intraoperative management is another critical component of anesthetic care in ERAS protocols. Maintaining hemodynamic stability and minimizing fluid overload are essential to reduce the risk of postoperative complications. The use of goal-directed fluid therapy, guided by hemodynamic monitoring such as stroke volume variation, pulse pressure variation, or esophageal doppler measurements, can help optimize fluid management during surgery. Rather than administering fluids at a fixed dose, goal-directed fluid therapy, which tailors fluid administration based on specific indicators of fluid responsiveness, has been shown to improve outcomes in adults, although data in pediatric populations remain limited.[8] ERAS protocols help ensure more precise management of pediatric patients' hemodynamics by advocating for restrictive or goal-directed fluid administration, which aims to avoid excessive fluid loading that has been associated with impaired recovery, including longer hospital stays and delayed return of bowel function. Additionally, minimizing the duration of anesthesia and surgical time is vital, as prolonged procedures can lead to increased stress responses and delayed recovery. This stability contributes to better overall outcomes and fewer complications.[11]

Recommendations from adult surgical literature have identified antibiotic prophylaxis as a protective factor against surgical site infections. Neonates are at particularly high risk with rates of surgical site infections reported as high

as 13.5%. Neonatal intestinal surgery has a high prevalence of surgical site infections (SSIs), which can have serious consequences. Even though the evidence supporting antimicrobial prophylaxis in neonatal surgery is still lacking, the recommendations from the adult surgical literature in the benefits of antibiotics prophylaxis should still be considered given the SSI rates, immunocompromised state, and unpredictable pharmacodynamics in neonates. The morbidity associated with these infections is reflected in a length of stay for these infants that is three times longer than the stay of their uninfected counterparts.[12]

The anesthetic team should also focus on minimizing the use of volatile anesthetics, which can contribute to postoperative nausea and vomiting (PONV). Utilizing total intravenous anesthesia (TIVA) techniques may reduce the incidence of PONV and enhance recovery outcomes. Furthermore, the implementation of antiemetic protocols can further mitigate the risk of PONV, ensuring a smoother postoperative course for pediatric patients.[13]

In adults, hyperosmotic mechanical bowel preparation (MBP) may increase the risk of SSI, bowel wall oedema, bowel leak, and anastomotic dehiscence. A Multicentre review of 272 children underwent colostomy showed that MBP was associated with an increased risk of wound infection, increased LOS and no reduction in any other complications. These findings suggest that omitting MBP in pediatric patients may reduce postoperative morbidity, hospital costs, and patient discomfort, without increasing the risk of other complications.[14]

Postoperative Care

Postoperative care is integral to the success of ERAS protocols. Effective pain management strategies initiated in the operating room should continue into the postoperative period. The use of patient-controlled analgesia (PCA) can empower children to manage their pain effectively, promoting early mobilization and recovery. Additionally, early resumption of oral intake is encouraged, as it has been associated with improved recovery outcomes and reduced length of hospital stay.

Multimodal analgesia strategies aim to control pain effectively while minimizing the use of opioids, thereby reducing the risk of opioid-related side effects. Early mobilization encourages patients to resume normal activities as soon as possible, which is vital for recovery. Studies have demonstrated that ERAS protocols can significantly reduce the need for intraoperative and postoperative opioids, which helps in faster recovery and fewer complications.[14-15] For example, a scoping review of pediatric gastrointestinal surgeries found that ERAS protocols reduced opioid use, with one study reporting a decrease in postoperative morphine equivalent use following colostomy closure.[15] Additionally, cryoanalgesia, an innovative technique involving freezing the nerves to provide pain relief, has been integrated into some ERAS protocols for pediatric thoracic surgeries, showing promising results in reducing opioid use, enhancing physical rehabilitation, and shortening the LOS.[16] These findings support the efficacy of multimodal analgesia strategies, including cryoanalgesia, in enhancing perioperative outcomes in children.[14-16]

Postoperative early enteral nutrition and mobilization are critical components of ERAS. These practices have been associated with shorter hospital stays and quicker recovery of bowel function.[15,17-18]

A systematic review and meta-analysis including 1,416 adult patients undergoing elective colon and rectum surgery found that routine nasogastric (NG) decompression did not accelerate the return of gastrointestinal function and was associated with increased risks of pharyngolaryngitis and respiratory infections. Although this analysis was conducted in adults, its findings have important implications for pediatric patients, as avoiding routine NG tube placement may similarly reduce discomfort and complications without delaying gut recovery, aligning with ERAS principles promoting early feeding and enhanced recovery in children.[19]

Challenges in Implementing ERAS in Pediatric Patients

Despite the clear benefits, the implementation of ERAS protocols in pediatric settings faces several challenges. These include the need for multidisciplinary collaboration among healthcare providers, the necessity of tailored protocols for different age groups and surgical procedures, and the potential resistance to change from traditional practices. Furthermore, the variability in institutional resources and training can impact the consistency of ERAS protocol application.

Future Directions

Looking ahead, further research is needed to refine ERAS protocols specifically for pediatric populations. This includes exploring the long-term outcomes of ERAS implementation, understanding the psychological impacts on children undergoing surgery, and developing standardized protocols that can be adapted across various surgical specialties. The integration of technology, such as telemedicine, may also play a role in enhancing the delivery of ERAS protocols, particularly in the context of postoperative follow-up and patient education.

CONCLUSIONS

In summary, the advantages of ERAS in pediatric patients may include reduced postoperative complications, improved pain management, faster recovery times, shorter hospital stays, and enhanced patient and family satisfaction. By integrating tailored anesthetics strategies and fostering ongoing education and collaboration among healthcare providers involved in pediatric surgical care, ERAS can optimize outcomes and improve the overall experience for young patients and their families.

CONFLICTS OF INTERESTS

The author declares no conflicts of interest.

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