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Preparing Enhanced Recovery After Surgery for implementation in pediatric populations

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Abstract

Standardization in perioperative care has led to major improvements in surgical outcomes during the last two decades. Enhanced Recovery After Surgery (ERAS) programs are one example of a clinical pathway impacting both surgical outcomes and efficiency of care, but these programs have not yet been widely adapted for surgery in children. In adults, ERAS pathways have been shown to reduce length of stay, reduce complication rates, and improve patient satisfaction. These pathways improve outcomes through standardization of existing evidence-based best practices. Currently, the direct evidence for adapting ERAS pathways to pediatric surgery patients is limited.

Challenges for implementation of ERAS programs for children include lack of direct translatability of adult evidence as well as varying levels acceptability of ERAS principles among pediatric providers and patients' families. We describe a proposed ERAS program for pediatric colorectal surgery patients in an era of limited direct evidence and discuss what further issues need to be addressed for broader implementation of pediatric ERAS pathways.

Keywords

ERAS; enhanced recovery after surgery; pediatric; surgery; implementation

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1. Introduction

Standardization in perioperative care has led to major improvements in surgical outcomes during the last two decades. Care driven by clinical pathways, including concentration of complex procedures in high-volume centers, “fast track” pathways, and surgical site infection prevention bundles, is based on a culmination of best practices in the care of surgical patients. Enhanced recovery after surgery (ERAS) programs are one example of a clinical pathway impacting both surgical outcomes and efficiency of care.[1] Initially described for colorectal surgery patients, ERAS protocols have now been adapted and described for most complex surgical procedures with similar results. Thus far, ERAS successes have primarily been described in the adult population. Few studies, however, explore ERAS program success in a pediatric population.[2] Even looking at surgical standardization more generally, the practice of evidenced-based care being implemented through stepped protocols and institutional pathways has rarely been adopted in pediatric populations.

One potential argument against standardized pathways in pediatric surgical patients is that the overwhelmingly good outcomes of pediatric patients relative to adults limit the potential marginal benefit from time-consuming and organizationally-demanding bundled care algorithms. For the same procedure, postoperative outcomes, such as mortality, major morbidity, or even length of stay, vary substantially between children and adults. Although perioperative mortality is less in children, the best evidence available suggests that some pediatric surgery procedures have many of the same common, high-morbidity outcomes observed in adult populations.[3] In particular, pediatric colorectal procedures account for a disparate burden of surgical site infection (SSI) relative to other surgical procedures in children.[4] Likewise, at our institution, pediatric ACS NSQIP data mirrors this finding, where pediatric colorectal surgery patients encompass the highest degree of SSI compared to other procedural groups, experiencing surgical infection rates of 5-18% (Unpublished data, Jelin, 2016; Boss, 2016). The high infection rate in the setting of relatively common pediatric colorectal procedures make this subspecialty an attractive group for early ERAS pathway trials in children. The goal is for these children to have expedited bowel recovery, decreased infection rate, decreased length of stay, and increase patient and family satisfaction.

The majority of the individual components of consensus ERAS bundles do not have corresponding supporting evidence for use in children.[5] In addition, there is little previously published work regarding how to effectively provide ERAS-related perioperative education – a major component of many ERAS bundles – to children and their primary caregivers. Additionally, the perioperative education will need to be modified to be age-specific in order to allow children to be participants in their care.

In this report, we explore common ERAS principles for adult colorectal surgery in the context of how they can best be implemented in a pediatric patient population. Specifically, we will demonstrate how the potential benefits of ERAS may be adapted for pediatric surgery patients while also addressing a number of unique obstacles impacting effective implementation.

2. Adult ERAS Legacy

The ERAS protocol was initially developed in Europe during the early 2000s as a way of centralizing and standardizing many of the previously developed, but lesser-implemented evidence-based perioperative care interventions for colorectal surgery. Its primary sponsor, the ERAS Society, organizes the protocol into three contexts of care: preoperative, intraoperative, and postoperative. Each phase of care includes multimodal interventions that have been demonstrated to shorten post-operative recovery and reduce post-operative complications. Central tenets of these interventions include a multidisciplinary team approach, patient engagement and education, increased preoperative volume loading, optimized nutritional status, appropriate antibiotic prophylaxis, short-acting anesthetics, minimizing opioid analgesics, limiting intra- and post-operative fluid resuscitation, and early post-operative mobility.[6]

Recently, there has been increased interest in ERAS protocols in the U.S. largely because they are one of the most effective approaches to improving the value of perioperative care by reducing length of stay and reducing post-operative complications. Moreover, standardizing institutional protocols has reduced provider variation and communication errors.[7] At multiple institutions, and with a variety of adult patient populations and diseases, ERAS programs led to a reduced length of stay by 1 to 2 days without increasing readmission rates, a decrease in post-operative complications by 30%, and shortened return of bowel function by 1 day.[8,9] Systematic reviews have also demonstrated that both internal costs and societal costs were lower for 80% of programs examined.[10,11] Although implementation effectiveness and the difficulty of changing individual provider practices perpetuate, ERAS pathways are the current gold standard by which other quality improvement efforts for colorectal surgery are compared against.

3. Basis for ERAS in Children

A key underlying principle attributed to the success of ERAS pathways in adult patients is that interventions standardize well-understood clinical knowledge rather than testing novel care paradigms. Moreover, these pathways mitigate errors that may arise from undue institutional- and provider-level variation. ERAS pathway development is not about creating new hypotheses for better care but rather focused on organizing the best available scientific evidence into an implementable bundle that helps standardize care across a practice, institution, or professional society.

There is a large degree of variability within pediatric surgical patient care including individual provider practice preferences amidst a larger group. A recent national analysis of administrative data demonstrated surgeon and institutional perioperative antibiotic prescribing variation that was both internally inconsistent (median variation, 78.1%) and also nearly half of the time did not meeting national guidelines.[12] Standardization of pediatric surgical disease management has also been shown to improve outcomes. Slusher *et al.* demonstrated that standardization of the management of acute appendicitis decreased antibiotic needs and reduced admissions without changing length of stay or abscess incidence.[13] ERAS pathways provide evidenced-based practice recommendations while

openly acknowledging that those deviating from the science-based care pathway have little basis to justify their nonstandardized variant of the “art of surgery.” Based on the evidence available, it seems as though pediatric outcomes could improve with protocol-driven care.

The direct implementation of ERAS protocols in children has been limited, primarily by lack of evidence for extrapolation to a pediatric patient population. The only meta-analysis performed on ERAS programs used in children found a total of five prior studies that specifically implemented perioperative recovery protocols which included at least four components of the ERAS Society recommendations. Of the ERAS implementations, even the most comprehensive only included 6 of the 20 recommended ERAS Society interventions. None of the reported studies had appropriate controls. Likewise, we have not identified any methodologically rigorous, published pediatric ERAS experience supporting bundled ERAS implementation in pediatrics to develop one’s own program upon.[2]

Theoretically, adult recovery paradigms should be translatable to pediatric patients if appropriately modified. Each pediatric patient is unique, but pediatric patients who are verbal and easily engaged could be offered a recovery pathway similar to the one used by adults. Adolescent patients may in fact recover more quickly than adults; however, coping mechanisms, communication skills, and priorities between the two groups are vastly different.

Data supporting the use of individual ERAS components in children is beginning to appear. One of the main ERAS elements is multimodal analgesia intraoperatively and postoperatively. This tenant supports the use of regional anesthesia techniques in pediatric populations, as an adjunct to general anesthesia intra-operatively and postoperative pain management. Advanced, ultrasound guided techniques for regional anesthesia in younger, even premature, children are highly successful; however, some pediatric anesthesia providers have limited exposure to or experience with these techniques.[14] Additionally, it has also been shown that excess perioperative fluid administration may have the same negative consequences as it does in adults.[15] In terms of post-operative care, early enteral feeding and advancement has been shown to have no negative effect on post-operative readmissions for short-stay pyloromyotomies.[16]

One of the most promising small studies to date by West et al matched pediatric inflammatory bowel disease patients at the authors’ institutional hospital versus adult controls operated on at the associated tertiary referral hospital. Both groups underwent the same procedure but adult patients recovered more quickly under ERAS principles. Pediatric patients averaged an additional 3 days in the hospital and 3 days without a solid diet while having no difference in readmissions or in-hospital morbidity.[17] These results suggest that ERAS protocols offer an easy way to improve the cost of care while having either a neutral or improved effect on clinical outcomes.

4. Challenges

Despite the high potential for surgical quality improvement offered by ERAS pathways to pediatric patients, limitations and challenges exist. Caution needs to be exercised about what

“evidence-based” guidelines are borrowed from the adult ERAS literature because of the routinely cited mantra that, “Children are not small adults.”

First, it is important to recognize that there are common adult practices that have not been proven in children. Some may even not be theoretically sound because of physiological differences between adults and children. For example, one of the major components of the ERAS pathway is goal-directed fluid management, but it is less clear that pediatric patients are as vulnerable to volume shifts as adults. Volume has been associated with worse outcomes in pediatric cardiac surgery patients, but this has not yet been demonstrated in other traditional ERAS foci like colorectal and hepatobiliary pediatric patients.[15,18] Other common ERAS-supported practices with little to no support in the pediatric general surgery evidence base include elimination of postoperative nasogastric tubes, promotion of post-operative chewing gum, and early elimination of antibiotic prophylaxis.

Another component with a limited evidence base from the inter-disciplinary ERAS pathways are anesthesia protocols as they apply to children. There is limited data regarding the interpretation of intraoperative monitoring devices (e.g., bispectral index monitors) in pediatrics and the use of common pain adjuncts (e.g., ketamine, dexmedetomidine, tramadol).[19]

The lack of pediatric literature is further complicated by the divergence of specific disease incidences between children and adults within a similar disease group, such as colorectal surgery. For example, cancer as a gastrointestinal disease is nearly unheard of in the pediatric colon. Moreover, there are pediatric-specific diseases that have no clear analog in the adult population including necrotizing enterocolitis and congenital anorectal malformations. It will be necessary to carefully select pediatric patients and ERAS components to ensure that these interventions are being applied appropriately. Although we have released an ERAS protocol for adolescent patients, the institution is only now addressing what specific neonatal populations would be good enhanced recovery candidates, such as those with procedures for post-necrotizing enterocolitis ostomy takedowns and anorectal malformations being early targets. Regardless of the specific protocol chosen, we are optimistic about the potential benefits of standardizing practices to reduce or eliminate institutional and provider-level variation may be reduced or eliminated.

4.1 Culture Change

The success of ERAS in the pediatric surgical population is highly dependent on the quality of implementation and team dynamics. The biggest hurdle to effective implementation originates from changing culture and optimizing teamwork rather than gaps in scientific evidence. It is important to realize that culture change will need to be acknowledged and addressed amongst multiple stakeholders.

Parents and guardians are potentially the greatest advocates for ERAS success but could also represent a risk for implementation that did not previously exist with adult ERAS programs. The pediatric surgery practice model today embraces family-centered care. Effectively implementing ERAS pathways relies heavily on engaging family and caregivers early. In general, parents have adapted well to and appreciate bundled pathways. Ure *et al.*

demonstrated 95% parent satisfaction two weeks after a fast track postoperative care pathway in a European pediatric population.[20] In the United States, ERAS will require evolved expectations on the part of families. For example, a large part of ERAS protocols focuses on a conceptual belief that postoperative patients do better when accelerated until they fail. What this means in practice is that ERAS patients often get advanced more quickly and leave the hospital faster, but there may need to be an accepted higher rate of readmissions and clinic “rescue” visits because a minority of patients will have early postoperative complications (wound infections, ileus) at home rather than in the hospital. Although this logical need for increased post-hospital care has not been born out in the adult literature,[9] the effect in pediatric patients is not known. If more readmissions do occur, will parents tolerate setbacks in care as well as the adult population does? In the Adibe *et al* study, early feeding had no effect on readmission but there was a significant difference in the amount of vomiting episodes.[16] ERAS programs in children may ultimately lead to better traditional outcomes but will this be at the cost of decreasing parent satisfaction? Will parents now be forced to “self-triage” at home if small declines in post-operative progress or late-developing post-operative complications occur? Overcoming these issues will require anticipatory education for patients and parents as well as engagement strategies that align postoperative outcomes with the heartfelt desires and anxiety of supportive family members. Changing the paradigm to routinely include standard preoperative counseling and communication where ERAS-oriented postoperative expectations are addressed will be key.

In addition to expectation-setting, ERAS pathways do add an additional care burden for parents that are often already stretched thin with a chronically ill child. The preoperative needs of an ERAS pathway may overwhelm parents resulting in accidental errors in prehospital care (e.g., medications, fluid-loading, bowel preparation). Understanding how caregivers affect adherence to ERAS process measures will be an important area for further monitoring and potential exploration. Early, prehospital lack of adherence may prove to be an important exclusion criterion for ERAS pathway assignment for surgery.

There is also a paucity of evidence about how to promote enthusiasm and support amongst medical team members when standardization of care is not as readily familiar in children. Practicing pediatric surgeons were trained in an era where the unique physiology and conditions of pediatric patients imparted a higher degree of subjective decision-making. At our institution, each pediatric surgeon closes his ostomy in a fundamentally unique way compared to each of his partners. Multimodal pain-relieving strategies vary among pediatric anesthesiologists based on experience, evidence, and general best practice consensus both inside and outside of the institution. Finally, ERAS requires a degree of nursing leadership and direct clinical team involvement that may be a significant change to existing institutional cultures. Prior studies have shown that multidisciplinary ERAS pathway adherence directly correlates to improvement in postoperative outcomes.[21] The institution and all of its stakeholders have to be dedicated to and support Pediatric ERAS, or it will fail prematurely.

5. The Hopkins Pilot

We believe that similar outcome improvements observed from adult ERAS pathways should be reproducible from pediatric ERAS pathways. At Johns Hopkins Children’s Center, we

have started pediatric colorectal surgery patients greater than 12 years old on a modified ERAS pathway. The ERAS protocol at our institution demonstrates how adult ERAS principles can be adapted to pediatric patients (Table 1). This pathway was developed as part of the perioperative quality improvement program at the institution. A multidisciplinary team was convened that included surgeons, anesthesiologists, quality experts, perioperative nurses, pharmacists, and administrators. Initial engagement was fostered through “town hall” style discussions at departmental meetings. Key components of the ERAS pathway were actualized through consensus-building exercises with relevant stakeholders. Feedback was obtained from the adult ERAS pathways at The Johns Hopkins Hospital to help address local design needs, and feedback was obtained from patients before modifying the patient education manual to a pediatric population. A comprehensive audit tool captures both ERAS process adherence (e.g., bowel preparation completion rate, early ambulation rate, reliance on adjuvant nonnarcotic medications) as well as traditional outcomes measures. “Success” for our program will be measured in a similar fashion to adult ERAS pathways with particular attention to process measures, length of stay, readmission rates, complication rates, and satisfaction surveys. Looking ahead, the ERAS implementation has also incorporated frequent interval meetings for multidisciplinary feedback and incremental modifications.

5.1 Next Steps

While the challenges for successfully implementing ERAS bundles in a pediatric population are numerous, there are many readily achievable options for enhancing a program’s chance of success. First, the current limits of scientific knowledge of ERAS implementation can be readily addressed through more focused research. The success of ERAS in the adult population, as well as the success of standardized care pathways in general, can guide potential research in the pediatric population. Specifically, as pediatric ERAS guidelines are formulated, additional age stratification of results will need to be performed to ensure that ERAS principles for a 12 year-old boy with Crohn’s disease are modifiable and adaptable to an infant with necrotizing enterocolitis.

The emphasis on increasing family engagement also requires a number of modified strategies. Most adult ERAS programs heavily emphasize preoperative patient engagement. When we began to implement our own pediatric ERAS protocol, we adapted many of the patient education materials to shift the focus to family-centered care (see Online Supplemental Material for family ERAS education model we developed).

Finally, engaging front-line health workers is an area of increased attention in the current era of quality improvement. One of the most fundamental methods for engagement is to increase an institution’s “culture of measurement” with the introduction of clinical audits and process metrics, which has been widely promoted by many of the early European proponents of ERAS pathways.[22] Many models for rapid institutional change have also been described that typically involve a top-down culture change that then creates a self-learning change ecosystem where front-line workers begin to address limitations of new care models directly. Examples include the Comprehensive Unit-based Safety Program (CUSP) and high reliability organization models popularized to implement standardization of care by allowing

front-line healthcare providers to identify problems, propose solutions, enact plans, and ultimately self-monitor their progress. These programs have become integral parts of the United States government's Agency for Healthcare Research and Quality patient safety and healthcare quality reform efforts largely because of their dual focus on incremental bedside patient safety improvements while simultaneously building on front-line healthcare worker engagement.[23,24] We believe that effectively changing the culture of pediatric surgical practice will be the most important qualifier for a successful ERAS implementation.

6. Conclusion

The application of ERAS pathways in children has the potential to improve perioperative outcomes and reduce provider- and institution-level variability and error. The hurdles to pediatric ERAS pathway implementation are unique, and it is unlikely that adult ERAS programs can or should be executed in pediatric patients without a better understanding of their scientific evidence for child pathophysiology, the family-centered contextual environment, and cultural acceptability by all members of the care team. In addition to such bespoke modifications, the issues described above represent themes for targeted research, and through such efforts a comprehensive standardized approach to perioperative care in children is possible.

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Table 1

Adaptation of standard ERAS principles to The Johns Hopkins Children's Center Pilot ERAS Implementation in Adolescent (12 years and older) Colorectal Surgery

ERAS	JH CC
Preoperative	
Preadmission counseling and education	Included
Fluid and carbohydrate loading	Gatorade® / Pedialyte® 2 hours prior to surgery
No prolonged fasting	Gatorade® / Pedialyte® 2 hours prior to surgery
Standardized bowel prep	Antibiotic + mechanical
Antibiotic prophylaxis	Included
Skin preparation	Chlorhexidine wash night before and morning of surgery; provided in clinic packet
Thromboprophylaxis	All patients > 14 years
Avoid anxiolytic premedication	Included
Intraoperative	
Short-acting anesthetics	Internal anesthesia consensus group
Mid-thoracic epidural	Regional approach: transversus abdominis plane block versus epidural for open cases
Avoiding drains	Excluded – rarely applicable to population
Avoidance of salt and water overload	Internal anesthesia consensus group
Maintenance of normothermia	Included
Postoperative	
Continuing mid-thoracic epidural	Low thoracic epidural
Avoid nasogastric tubes	Included
Prevention of nausea and vomiting	Included
Avoidance of salt and water overload	Included
Early removal of catheter	Included
Early oral nutrition	Included
Non-opioid analgesia	Opioid minimization
Early mobilization	Included
Stimulation of gut motility	Excluded – lacking evidence
Outcomes reporting	Included