



Colorectal/Cloaca

## Implementation of an enhanced recovery protocol in pediatric colorectal surgery<sup>☆</sup>



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### ABSTRACT

**Purpose:** Enhanced recovery protocols (ERPs) have been shown to improve outcomes in adult surgical populations. Our purpose was to compare outcomes before and after implementation of an ERP in children undergoing elective colorectal surgery.

**Methods:** A pediatric-specific colorectal ERP was developed and implemented at a single center starting in January 2015. A retrospective review was performed including 43 patients in the pre-ERP period (2012–2014) and 36 patients in the post-ERP period (2015–2016).

Outcomes of interest included number of ERP interventions received, length of stay (LOS), complications, and readmissions. **Results:** The median number of ERP interventions received per patient increased from 5 to 11 from 2012 to 2016. The median LOS decreased from 5 days to 3 days in the post-ERP period ( $p = 0.01$ ). We observed a simultaneous decrease in median time to regular diet, mean dose of narcotics, and mean volume of intraoperative fluids ( $p < 0.001$ ). The complication rate (21% vs. 17%,  $p = 0.85$ ) and 30-day readmission rate (23% vs. 11%,  $p = 0.63$ ) were not significantly different in the pre- and post-ERP periods.

**Conclusions:** Implementation of a pediatric-specific ERP in children undergoing colorectal surgery is feasible, safe and may lead to improved outcomes. Further experience may highlight other opportunities for increased compliance and improved care.

**Level of evidence:** Treatment Study. Level III.

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The concept of Enhanced Recovery After Surgery (ERAS) was first described by Kehlet as a tool to optimize perioperative care through the use of fast-track elements [1]. Perioperative protocols based on these guidelines aim to maintain homeostasis and reduce surgical stress in order to facilitate a quicker return to baseline for patients after major surgical procedures [2]. General tenets of ERAS include perioperative counseling, limited preoperative fasting, early postoperative enteral intake and mobilization, opioid-sparing analgesia, and limited use of intravenous fluids, surgical drains and tubes [3]. Studies have demonstrated decreased hospital length of stay (LOS), complications and in-hospital costs associated with the implementation of these enhanced recovery protocols (ERPs) in diverse adult surgical populations [4–10].

**Abbreviations:** ERAS, Enhanced Recovery After Surgery; LOS, length of stay; ERP, enhanced recovery protocol; TAP, transverse abdominis; ICD-9-CM, International Classification of Diseases, Ninth Revision, Clinical Modification; SBO, small bowel obstruction.

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As a result, surgeons have embraced these concepts and perioperative guidelines have been published for numerous adult procedures, including gastrectomy, cystectomy, pancreaticoduodenectomy, colon resection, and rectal and pelvic surgery [11–15].

Despite these positive results in adults, data on safety, feasibility and effect on outcomes associated with the use of ERPs in pediatric populations is limited. A literature review performed by Shinnick et al. demonstrated the paucity of high-quality literature examining outcomes associated with the implementation of ERPs in children. The pediatric studies identified included fewer than 5.6 ERAS interventions, on average, which is considerably less than adult protocols that include up to 20 components. These studies did suggest that the application of ERPs in children's surgery may result in decreased LOS and decreased narcotic use without a detectable increase in complications [16].

While these preliminary results indicate that the use of ERPs may be safe and effective in pediatric populations, it is possible that not all of the elements in the adult pathways may be applicable or desirable for children. These protocols may require revision in order to meet the unique perioperative needs of children. With this consideration in mind, we developed a pediatric-specific ERP and began implementing the protocol in a select population in January 2015. The purpose of this study was

to compare outcomes before and after the implementation of this new ERP in children undergoing elective colorectal surgery.

## 1. Methods

### 1.1. Study design

We performed a retrospective review of all patients age 5 to 20 years who underwent an elective major colon and rectal operation by 2 board-certified pediatric surgeons before (January 1, 2012 to December 31, 2014) and after (January 1, 2015 to December 31, 2016) the implementation of a new pediatric-specific ERP. The pre-ERP cohort served as a control group in order to determine outcomes after the implementation of the protocol. The primary outcome was LOS or time to discharge, at which time it was assumed the patient had met all discharge criteria. In order to be deemed safe for discharge, a patient was required to be tolerating a regular diet, ambulating without assistance and have adequate pain control with oral pain medications. Secondary outcomes included number of ERP elements received by each patient, volume of intraoperative fluids received, volume of narcotics received, time to regular diet, complication rate, and 30-day readmission rate. Complications were defined as an event that resulted in a prolonged LOS, need for reoperation, or readmission. Approval for this study was obtained from the Children's Healthcare of Atlanta Institutional Review Board (CHOA IRB 15–166).

### 1.2. Protocol development

Using a multidisciplinary team, including a surgeon, an anesthesiologist, a pain specialist, peri-operative nursing and a surgical nurse practitioner, a pediatric-specific ERP was developed to include preoperative, intraoperative and postoperative elements of care (Table 1). Using existing adult ERPs as a template, our pediatric ERP was designed to address the distinct perioperative needs of children undergoing surgery. Prior to implementation, extensive education regarding the protocol was provided to team members including pediatric surgical fellows, preoperative nurses, anesthesiologists, anesthesiologists, PACU nurses, and nurses on the surgical floor. Standardized instructional handouts were developed and distributed to all patients placed on the protocol at the time of their preoperative clinic visit. A standard ERAS order set was developed for use in the PACU and on the postoperative unit. All patients following the protocol were labeled as “ERAS patients” in the electronic medical record and on the operating room schedule in order to alert all providers of their status on the protocol, and all patients had a hard copy of the protocol placed on their chart when they reached the ward postoperatively.

### 1.3. Protocol implementation

Prior to initiation of the ERP, patients undergoing elective colorectal procedures were generally managed in the following manner with some variation. Preoperatively, patients were given non-standardized counseling and told to expect an LOS of about 3 to 5 days for laparoscopic procedures and 5 to 7 days for open procedures. Variably, patients received a mechanical bowel preparation and an oral antibiotic preparation with neomycin and metronidazole at home the day before surgery. They were made NPO at midnight and no preoperative analgesic medications were administered. Most patients received either a transverse abdominis (TAP) block or epidural for pain management, however there was no standardized approach to deciding who received which intervention and the decision was at the discretion of the anesthesiologist. Preoperative antibiotics were administered in the operating room within an hour of incision. Intraoperative fluid and narcotic administration was at the discretion of the anesthesia team and was not standardized. Postoperatively, patients remained NPO until postoperative day 1 at which time they received clears and diet was advanced to regular

**Table 1**

Pediatric-specific ERP components organized by phase of care.

#### Preoperative clinic visit

Detailed counseling including preset discharge criteria provided by surgical NP

#### Day before operation

Bowel preparation (antibiotics only): Neomycin 10 mg/kg TID; Metronidazole 250 or 500 mg

#### Day of operation, preoperative holding area

Clears allowed up until 2 h before operation

Preoperative carbohydrate loading: 20 oz. Gatorade or apple juice completed 2 h before operation

Loading dose of gabapentin 15 mg/kg 3 h before surgery

Placement of sequential compression devices (SCDs) (age > 12)

#### Intraoperative

Antibiotic prophylaxis, given <1 h prior to incision

Laparoscopic technique

Avoidance of nasogastric tubes and perianastomotic drains

Regional anesthesia: TAP (ileocectomy, colectomy, ileostomy reversal);

Epidural (J-pouch)

Minimization of opioids

Maintenance of normothermia

Maintenance of near zero fluid balance: limit crystalloids to 3–4 mL/kg/h

#### Postoperative, surgical ward

Early mobilization on postoperative day 0

Early oral intake starting with clears in the PACU and advancement to regular diet

Maintenance of near zero fluid balance: limit unnecessary boluses

Opioid-sparing pain regimen:

- Ketorolac (0.5 mg/kg up to 30 mg max dose) IV q6h × 72 h
  - Gabapentin (10 mg/kg up to 600 mg max dose) PO q8h × 72 h
  - Acetaminophen (10 mg/kg up to max 650 mg) PO q6h
  - Morphine (0.05 mg/kg or 0.1 mg/kg) IV q4h PRN breakthrough pain
  - Hydromorphone (0.005 mg/kg or 0.01 mg/kg) IV q4h PRN breakthrough pain
- Prevention of nausea and vomiting

- Ondansetron (0.1 mg/kg or 0.15 mg/kg) injection q8h

Aggressive pulmonary toilet: incentive spirometry on postoperative day 0

when bowel function returned. Generally, patients received narcotics as first line medications for pain management with many patients receiving a patient controlled anesthesia pump with demand morphine available as needed. Once tolerating a regular diet, fluids were discontinued and medications were transitioned to oral administration. If an epidural was placed, it was removed when the patient was tolerating a regular diet and able to take oral pain medications. Discharge criteria included ability to tolerate a regular diet, return of bowel function and adequate pain management with oral medication. Beginning in January 2015, two surgeons began using our pediatric specific ERP in patients undergoing elective colorectal surgery as outlined in Table 1.

### 1.4. Data collection and analysis

Cases were identified by retrospective chart review based on International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes between January 2012 and December 2016. Cases that were managed according to the ERP were prospectively logged in a database. Cases that were not performed electively or were inpatient at the time of surgical intervention were excluded. Demographic information, diagnoses, operative details, and elements of the ERP were collected. We tracked 13 of the 19 elements included in the protocol. Because of the retrospective nature of this study, information was not consistently documented in the medical record for the following protocol elements: 1) preoperative carbohydrate loading, 2) maintenance of intraoperative normothermia, 3) time of postoperative mobilization, 4) use of incentive spirometry, 5) volume of intravenous fluids received postoperatively, and 6) episodes of postoperative nausea and vomiting.

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