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Case Series

# Enhanced recovery after surgery (ERAS): A budding concept in neonatal intestinal surgery

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ABSTRACT

**Background:** Enhanced recovery after surgery (ERAS) is a multidisciplinary approach, widely used in adults and children for improving patient care with reduced length of hospital stay and medical costs. However, it is poorly established and perceived as unimplementable in neonates. Recently, ERAS guidelines consisting of 17 recommendations for perioperative care in neonatal intestinal surgery are laid down by the ERAS society. To elicit the feasibility of implementing ERAS protocol, we did an observational pilot study in neonates undergoing intestinal surgery at a tertiary centre to know the number of recommendations from ERAS guidelines already being followed routinely.

**Materials and Methods:** Data was collected for the neonates undergoing intestinal surgery for three months. All the relevant details were noted and analysed to find out the number of recommendations from ERAS guidelines already being implemented and the postoperative outcome of these neonates.

**Results:** Twelve neonates underwent intestinal surgery for obstruction and atresia during the study period. Eight out of 17 ERAS guidelines were already followed as a routine protocol in all these patients. Nine patients were extubated on table, one patient was extubated within 24 hours of surgery and two patients succumbed to death. Ten neonates were discharged from hospital within 6-8 days of surgery.

**Conclusion:** Many recommendations from ERAS guidelines for neonatal intestinal surgery are already being followed routinely, suggesting that the implementation of complete ERAS protocol is easily possible, which may further improve the perioperative outcome with reduced length of hospital stay.



## 1. Introduction

Enhanced recovery after surgery (ERAS) was introduced by Professor Henrik Kehlet in the 1990's, suggesting a patient centred multidisciplinary approach through the perioperative period to improve recovery after surgery.[1] The benefits include increased patient satisfaction, infrequent opioid related side effects, quick recovery, early discharge from hospital with reduced overall costs of patient care.[2–4] There have been numerous studies of ERAS in paediatric gastrointestinal and urological surgeries.[5] However, the concept is poorly established and perceived as unimplementable in neonates, either because of unawareness or infeasibility. Recently, ERAS guidelines consisting of 17 recommendations for perioperative care in neonatal intestinal surgery are laid down by ERAS society.[6] To elicit the feasibility of implementing ERAS protocol, we did an observational pilot study in neonates undergoing intestinal surgery at a tertiary paediatric centre to know the number of recommendations from ERAS guidelines already being followed routinely.

## 2. Case Series

Data was collected for all the neonates undergoing intestinal surgery at a tertiary paediatric centre for 3 months (February

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2023 – April 2023). The details noted were: Maturity, age, birth weight, indication of surgery, preoperative status with associated congenital anomalies (if any), technique of anaesthesia, intraoperative monitoring, type and quantity of fluid administered, pain relief, postoperative recovery from anaesthesia and any perioperative adverse event. The data was then analysed to find out the number of recommendations from ERAS guidelines already being implemented.

## 3. Results

Fourteen neonates underwent intestinal surgery under general anaesthesia with endotracheal intubation during the study period. Two patients who underwent exploratory laparotomy for necrotizing enterocolitis (NEC) were excluded from the study as the ERAS guidelines excluded complex surgical conditions such as NEC and abdominal wall defects. Demographic profile of these 12 neonates is summarised in (Table 1). They were operated for the procedures like intestinal atresia, obstruction, volvulus and perforation (Table 2). We found out that eight (47%) out of 17 ERAS guidelines such as maintaining normothermia, fluid management, pain relief were already implemented as a normal protocol in all these neonates (Table 3). Regarding recovery from anaesthesia, nine patients (75%) underwent tracheal extubation on table, one patient (8.3%) was extubated within 24 hours of surgery and two patients (16.7%) succumbed to death. Ten recovered patients were discharged within 6 – 8 days from hospital (Table 4).

**Table 1:** Demographic data

| Number of Neonates | Gestational age | | Birth weight | |
|---|---|---|---|---|
| | >37weeks | <37weeks | >2.5kg | <2.5kg |
| | 7 | 5 | 7 | 5 |

**Table 2:** Indication of intestinal surgery

| Type of Surgery | No. |
|---|---|
| Atresia – anorectal malformation, duodenal atresia | 6 |
| Obstruction/Hirschsprung's disease | 2 |
| Intestinal Perforation | 2 |
| Volvulus | 2 |

## 4. Discussion

ERAS identifies various preoperative, intraoperative and postoperative factors contributing to the postoperative recovery. Some of these factors include education and counselling of patients and families preoperatively, minimizing preoperative fasting, performing regional blocks, limiting opioid use, minimally invasive surgical techniques avoiding use of drains and catheters, early postoperative feeding and ambulation.[4,7] The application of

**Table 3:** Components of ERAS guidelines for neonatal intestinal surgery

| S. No. | Guidelines | Practice |
|---|---|---|
| 1. | Maintain normothermia | Implemented |
| 2. | Perioperative fluid management | Implemented |
| 3. | Administer acetaminophen regularly | Implemented |
| 4. | Opioid limiting strategy | Implemented |
| 5. | Multimodal strategies including regional techniques | Implemented |
| 6. | Restrict transfusions to maintain Hb ≥9g/dL | Implemented |
| 7. | Early enteral feeds within 24-48 h after surgery | Implemented |
| 8. | Breast milk as the first choice of nutrition | Implemented |
| 9. | Written transfusion guidelines | Applicable |
| 10. | Lingual sucrose/dextrose to reduce pain during NG/OG placement | Applicable |
| 11. | Parental education/training as caregivers | Applicable |
| 12. | Perioperative antibiotic prophylaxis within 60min prior to skin incision | Surgeon dependent |
| 13. | Perform primary anastomosis as first choice | Surgeon dependent |
| 14. | Multidisciplinary team communication utilizing established checklists | Surgeon dependent |
| 15. | Discontinue postoperative antibiotics within 24h of surgery | Surgeon dependent |
| 16. | Monitor urinary sodium in neonates with stoma | Surgeon dependent |
| 17. | Mucous fistula refeeding in neonates with enterostomy to improve growth | Surgeon dependent |

**Table 4:** Postoperative recovery from Anaesthesia

| Postoperative outcome | Details |
|---|---|
| Immediate extubation on table- 9 patients (75%) | Well optimized preoperatively |
| Extubated within 24 hours of surgery – 1 patient (8.3%) | Term, 2.4kg, operated for malrotation of gut, on dual ionotropic support preoperatively, inotropes tapered postoperatively |
| Succumbed to death while intubated on ventilatory support – 2 patients (16.7%) | a. Preterm (34w+2d), 2kg, twin delivery, Hirschsprung's disease, operated on day 17 of life and was in septic shock preoperatively<br>b. Term neonate, case of intestinal obstruction, operated on day 8 of life with preoperative sepsis on triple ionotropic support |

ERAS has been proved successful for a variety of surgeries in adults such as orthopedic, colorectal, laparoscopic abdominal, obstetric and gynecological surgeries.[4–9] Success in adults has paved the path to implement ERAS in paediatric patients, establishing a structured, multimodal approach to all aspects of perioperative care for the betterment of child's recovery from surgery.[10,11] Inspite of proven benefits of ERAS in paediatric patients, there are no guidelines for this group of patients. However, as paediatric protocols have been developed, the scope of ERAS is expanding to population of diverse age groups.[12]

Neonates could considerably benefit from ERAS as they encounter variable perioperative care and suffer high rates of complications. Recently, a comprehensive, evidence-based ERAS guideline for neonates undergoing intestinal resection surgery was developed by ERAS society, targeting term neonates of ≥37 weeks gestational age without any major comorbidities with an intention to deliver standardized, evidence-based, collaborative care throughout the perioperative period. Seven observed neonates in our study were term patients while five were preterm with low birth weight. ERAS guidelines also excluded neonates with complex surgical conditions such as NEC, abdominal wall defects and short bowel syndrome. Although we observed 14 neonates during the study period, but we excluded two patients who were operated for NEC.

The guidelines consist of 17 components, out of which eight (47%) are already being followed. These recommendations along with the interventions are as follows:

1. Recommendation- Continuously monitor intraoperative core temperature and take pre-emptive measures to prevent hypothermia (<36.5 °C) and maintain normothermia.
   Practice- Warm intravenous fluids intraoperatively and postoperatively, warm irrigation fluids during surgery are used besides temperature monitoring. Patient is covered by cotton/ plastic wrap intraoperatively and while transportation to prevent hypothermia.
2. Recommendation- Use perioperative fluid management to maintain tissue perfusion and prevent hypovolemia, fluid overload, hyponatremia, and hyperglycemia
   Practice- Ringer lactate is the fluid of choice to replace the fluid deficit and surgical losses. Glucose is not supplemented routinely, supplemented to maintain blood sugar levels of 60-120mg%. Blood pressure monitoring, heart rate, pulse oximetry waveform, capillary refill time and urine output help to guide the volume status.
3. Recommendation- Unless contraindicated, administer acetaminophen regularly during the early postoperative period (not on an "as needed" basis) to minimize opioid use.
   Practice- Acetaminophen is administered eight hourly to all the patients unless contraindicated.
4. Recommendation- Use an opioid limiting strategy is recommended in the postoperative period. Manage breakthrough pain with the lowest effective dose of opioid with continuous monitoring.
   Practice- Intraoperative fentanyl, pre-emptive acetaminophen before completion of surgery and surgical wound infiltration by long acting local anaesthetic such as bupivacaine reduce the opioid requirement in postoperative period. If the need arises, short acting opioid, fentanyl is given in minimal doses. Morphine is not used in the postoperative period.
5. Recommendation- Use regional anesthesia and acetaminophen perioperatively in combination with general anesthesia. Multimodal strategies including regional techniques should be continued postoperatively.
   Practice- Caudal epidural block with adjuvants like clonidine or dexamethasone is administered in term healthy neonates with lower intestine pathology. Intravenous acetaminophen is routinely given before completion of surgery.
6. Recommendation- Restrict transfusions to maintaining HgB ≥ 90 (9 g/dL for a term neonate with no oxygen requirement. Term neonates within the first week of life, intubated or with an oxygen requirement should be transfused to maintain a HgB ≥ 110 (11 g/dL).
   Practice- Blood transfusion is only done perioperatively to replace the maximum allowable blood loss according to the above written recommendation.
7. Recommendation- Start early enteral feeds within 24-48 h after surgery when possible. Do not wait for formal return of bowel function.
   Practice- This is followed for early restoration of bowel motility and stoma function.
8. Recommendation- Use breast milk as the first choice for nutrition.
   Practice- It is a standard practice at our institution.

Among the nine unimplemented recommendations, three (18%) can be easily implemented or might have been already followed at other institutions:

1. Recommendation- Provide lingual sucrose/dextrose to reduce pain during naso/orogastric tube placement and other minor painful procedures.
   Comment- This may not have been followed due to ignorance or due to old ways of practice, however, it can be easily applied.
2. Recommendation- Use written transfusion guidelines and take into account not only a target hemoglobin threshold, but also the clinical status of the neonate

and local practices.
Comment- Although we take the decision of transfusing blood according to the clinical status of neonate and associated co-morbidities, there are no institutional transfusion guidelines. However, a protocol can be made according to already existing neonatal transfusion guidelines.

3. Recommendation- Facilitate hands on care and purposeful practice by parents that is individualized to meet the unique needs of parents early during the admission. Sustain these to build the knowledge and skills of parents to take on a leading role as caregivers and facilitate their readiness for discharge.
Comment- It is an essential component of ERAS for every surgery and plays a vital role in early recovery.

Recommendations which are surgeon dependent and require multidisciplinary team approach are (35%):

1. Perform primary anastomosis as the first choice in patients with uncomplicated intestinal atresia.
2. Administer appropriate preoperative antibiotic prophylaxis within 60 min prior to skin incision.
3. Discontinue postoperative antibiotics within 24 h of surgery, unless ongoing treatment is required.
4. Implement perioperative multidisciplinary team communication with a structured process and protocol ("pre- and postoperative huddle") utilizing established checklists.
5. Use mucous fistula refeeding in neonates with enterostomy to improve growth.
6. Monitor urinary sodium in all neonates with a stoma. Target urinary sodium should be greater than 30 mmol/L and exceed the level of urinary potassium.

Most of these recommendations can be implemented by involving a multidisciplinary team consisting of anaesthesiologist, surgeon, neonatologist, intensivist and a nursing care personnel, who are well aware of the benefits of implementing ERAS in neonates for better outcome, patient satisfaction and reduced overall costs. Standardization of procedure and formulating a written protocol will felicitate the implementation of complete ERAS guidelines.

### *4.1. Recovery from anaesthesia*

Although the guidelines do not comment upon early tracheal extubation yet, immediate extubation after surgery is one of the key components of ERAS, as early removal of tubes and catheters help to restore the normal physiology.[12,13] In our study, nine patients underwent immediate extubation on table, while one patient was extubated within 24 hours of surgery. These 10 patients were discharged after 6-8 days of surgery. Two patients with poor preoperative status, on inotropic support with septic shock and delayed presentation, succumbed to death. This indicates that there can be additional factors contributing to delayed recovery such as prematurity, low birth weight, preoperative poor general condition, sepsis requiring ionotropic support and multiple congenital anomalies.

### *4.2. Barriers in implementing ERAS*

One of the main limitations in implementing ERAS is the concern of complications at home and higher readmission rates due to early discharge.[12] However, properly following the discharge criteria, educating the parents and post-discharge follow up are essential to overcome this fear. Reduction in operating room efficiency due to time taken for immediate extubation in operation room, can be another barrier in implementing ERAS, but it is found to be statistically insignificant.[14] Also, better patient outcome with reduced morbidity as well as overall cost reduction supersede all the apprehensions.

## 5. Conclusion

Many recommendations from ERAS guidelines for neonatal intestinal surgery are already being followed routinely, suggesting that the implementation of complete ERAS protocol is easily possible, which may further improve the perioperative outcome with reduced length of hospital stay in these neonates. Potential barriers to implementation can be overcome by the awareness and knowledge about ERAS and its benefits. Further studies on implementing ERAS may prove helpful to widen the spectrum of neonates to include preterm neonates with complex surgical procedures.

## 6. Source of Funding

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## 7. Conflict of Interest

None.

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