Fast-Track Pediatric Surgery

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Abstract
Fast-track surgery was developed by the Danish surgeon Henrik Kehlet in the 1990s. It was initially termed enhanced recovery after surgery (ERAS) and represents a comprehensive perioperative therapeutic concept with the aim to reduce discomfort, the physiological postoperative stress response, postoperative pain, and complications by means of combining organizational and therapeutic measures.

Numerous studies confirmed the safety and effectiveness of fast-track concepts and a substantial reduction of the hospital stay compared with conventional strategies in children and adolescents. These studies showed that the use of fast-track achieves an improvement in patients comfort and the quality of care. The acceptance of fast-track of patients and parents is excellent.

This chapter contains a description of the conceptual background, the development, and the current status of fast-track pediatric surgery.

Keywords
Fast-track surgery • Children • Enhanced recovery after surgery • Clinical pathways • Pain therapy protocol

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Introduction
Surgical concepts are often characterized by traditions, personal preferences, and habits. The dogmatic application of measures without scientific evidence is not an exception. The use of preoperative enemas, long-lasting postoperative fasting and immobilization, postoperative drains, and nasogastric tubes may be some examples of such habits. In addition, insufficient analgesia may be associated with a delayed postoperative recovery and increased incidence of complications.
Historical Aspects

Initial fast-track studies have been performed by general surgeons in adult patients. The primary aim of this concept was to reduce the stress response and organ dysfunction during the postoperative period and to increase the comfort of patients. The prerequisite for achieving these goals is as simple as effective. An effective pain therapy is considered as essential, while simultaneously avoiding factors that cause discomfort, pain, and stress and counteract mobilization such as drains, catheters, and tubes. Opioids should be avoided to bypass relevant side effects such as nausea, fatigue, respiratory problems, and bowel and bladder dysfunction. Minimally invasive techniques as well as epidural and regional anesthesia should be preferably used (Basse et al. 2002, 2004; Kehlet 2011).

The beneficial effects of single elements of fast-track have been described decades before the term was established (Kehlet 1997). The Danish surgeon Henrik Kehlet could rely on this evidence when he combined these single measures to a highly effective concept. His philosophy was to reduce the duration of hospital stay and perioperative complications such as thrombosis and pneumonia by means of an accelerated convalescence (Basse et al. 2004). Kehlet introduced major changes in perioperative patient care and integrated new concepts of nursing and anesthesia (Basse et al. 2002; Wilmore and Kehlet 2001).

Initially, fast-track strategies have been applied in colonic surgery. The mean hospital stay could be reduced from 8 to 2 days, and the complication rate was significantly lower when compared with conventional care (Basse et al. 2004). Since these reports fast-track concepts have also been established in e.g. major upper gastrointestinal surgery, cardiac surgery, genitourinary, and orthopedic procedures (Azhar et al. 2016; Bond-Smith et al. 2016; Mir et al. 2015; Mohamed et al. 2004; Möller et al. 2001; Mulholland et al. 2005; Ottesen et al. 2002; Pecorelli et al. 2016; Husted et al. 2011; Vricella et al. 2000).

Current Concept

Today, colorectal surgery has remained the most common application of fast-track concepts. In a recent Cochrane review, it was confirmed that fast-track can be applied safely with a significantly reduced hospital stay (Spanjersberg et al. 2011). However, there is a considerable diversity in the design of many of the available descriptive studies. It was assumed that it remains difficult to meet the requirements of evidence-based medicine for every of the up to 20 different fast-track components. Seghal et al. (2012) viewed the most relevant fast-track components reported from six randomized controlled trials: preoperative instructions and psychosocial support by a multidisciplinary team, minimally invasive techniques, fasting, fluid management, and concepts of anesthesia. Positive effects of minimally invasive techniques, reduced fasting periods, a needs-based fluid administration, and regional or spinal anesthesia were demonstrated in patients undergoing colorectal surgery. The authors concluded from the effectiveness of single components that also the overall concept is beneficial.

The Evolution of Fast-Track Pediatric Surgery

Fast-track concepts are especially suitable in children. Young patients and their parents perceive medical measures and the hospitalization as particularly stressful, and the recovery in children is generally faster than in adults. Therefore, fast-track/ERAS programs will be increasingly implemented in the pediatric population as it aims to combine both surgical outcomes and efficiency of care (Leeds et al. 2016).

First systematic attempts to evaluate fast-track in children have been reported by pediatric anesthesiologists and cardiac surgeons more than 10 years ago (Patel et al. 2001; Vricella et al. 2000). Further fast-track experience was gained in children who underwent appendectomy (Grewal et al. 2004; Serour et al. 2005; Vegunta et al. 2004), pyloroplasty, and nephrectomy (Mohamed et al. 2004; Mulholland et al. 2005;
Metzelder et al. 2006; Jesch et al. 2006). Since 2004, fast-track studies have been performed in routine pediatric surgery.

A first pilot study from Germany included frequent procedures such as appendectomy, bowel anastomosis, fundoplication, hypospadias repair, pyeloplasty, and nephrectomy. Successful implementation of the fast-track concepts could be achieved in more than two-thirds out of 159 children (Reismann et al. 2007). The mean hospital stay (2.3 days) was substantially reduced compared with corresponding data from other hospitals regarding similar procedures and patients with a similar case mix index. Complications did not occur. A drawback was a high intensity of pain at the evening of the day of surgery due to minimal use of opioids. However, patients and parents were highly satisfied with fast-track treatment, and 96% of the respondents would have decided for fast-track again.

In a subsequent study, 20 types of routine procedures were investigated, and the concepts of pain therapy were optimized (Reismann et al. 2009). Thirty-six percent of patients could be treated according to the fast-track regimen, and analgesia was substantially improved. Again, there were no fast-track-associated complications. The mean hospital stay was significantly reduced compared with data from other institutions (4.6 vs 9.7 days, $p < 0.01$). The first school or kindergarten visit was on average 6 days after discharge. A detailed comparative analysis of urological procedures (pyeloplasty and (hemi-) nephrectomy) confirmed these results (Dingemann et al. 2010).

Another study focused on patients who could not undergo the full fast-track protocol for various reasons. The applicability of the single fast-track measures was specifically assessed in 203 children using defined success criteria (Reismann et al. 2012). The majority of the objectives were achieved with a success rate of more than 75%. The postoperative survey revealed again a high acceptance rate with 94% of patients and parents being satisfied with the treatment.

Recently, several authors reviewed current fast-track and ERAS approaches, stating that although there is a paucity of high-quality literature for the pediatric population, the available literature indicates that these protocols are safe and beneficial (Shinnick et al. 2016; Pearson and Hall 2016).

### The Concepts and Components of Fast-Track Pediatric Surgery

As a result of numerous studies, the following criteria have been elaborated for pediatric surgical institutions to ensure successful and safe application of fast-track (Table 1; Reismann and Ure 2009):

1. Fast-track surgery is a concept with defined measures. Therefore, fast-track should be designated as a special focus within the department.
2. Fast-track is interdisciplinary and may be summarized as “comprehensive.” A network of pediatric surgeons, pediatric anesthesiologists, pain therapists, nurses, and coworkers from other areas should be created. Responsible persons who are focused on fast-track may be designated.
3. Clinical pathways are essential. They comprise detailed information regarding the treatment from the preoperative diagnostics in an outpatient setting to the postoperative treatment after discharge for every type of procedure/operation.
4. Minimally invasive techniques are essential to minimize the adverse effects of the surgical trauma. Equipment and expertise for minimally invasive surgery are mandatory.

### Table 1 General requirements for the implementation of fast-track pediatric surgery (Hannover criteria acc. to (Reismann et al. 2009))

| Criteria                                                                 | Details                                                                 |
|--------------------------------------------------------------------------|------------------------------------------------------------------------|
| Designation of fast-track pediatric surgery as a special focus           | - Designation of fast-track pediatric surgery as a special focus        |
| Network of pediatric surgery, pediatric anesthesia, pediatric nursing, and other areas with appointment of responsible persons who are focused on fast-track | - Network of pediatric surgery, pediatric anesthesia, pediatric nursing, and other areas with appointment of responsible persons who are focused on fast-track |
| Detailed clinical pathways for all fast-track procedures                 | - Detailed clinical pathways for all fast-track procedures             |
| Equipment and expertise for minimally invasive surgery                   | - Equipment and expertise for minimally invasive surgery               |
| Pain management protocols, routine pain measurement, and 24 h pain therapy service for children | - Pain management protocols, routine pain measurement, and 24 h pain therapy service for children |
Table 2  Fast-track pathways/protocols (Reismann et al. 2007, 2012)

| Diagnostic procedures in an outpatient setting |
|------------------------------------------------|
| Specific instructions of patients and parents (additional use of videos and brochures) |
| Admission 2 h before surgery |
| No specific preoperative preparation/no bowel preparation |
| Specific anesthesia concepts/minimally invasive methods whenever applicable, minimal operative handling/routine pain measurements with validated scales |
| Analgesia according to pain protocol/24 h pain service |
| Early postoperative mobilization and nutrition |
| Discharge from day 1 on after the operation according to discharge criteria |
| Protocols for cooperation with pediatricians after discharge |

5. Effective pain treatment is a central aspect. Routine pain measurement using validated scales and a 24 h pain service are essential.

Detailed clinical pathways on preoperative diagnosis and management, operative and perioperative procedures, and the postoperative care should be established by the interdisciplinary team of all involved fields (Table 2). The interdisciplinary team is involved in training and instruction of all caretakers.

In detail, diagnostic measures are performed in an outpatient setting. Emphasis is placed on the instruction of patients and parents to ensure their cooperation during the postoperative course with special regard to immediate mobilization and early nutrition. This can be done by a specially trained nurse. A booklet or video-CD may be helpful to explain the protocols. Patients are admitted on the day of surgery, preferably 2 h before the operation, and may be instructed again. Stressful preoperative measures such as colonic irrigation and long fasting periods are omitted.

Fast-track concepts include minimally invasive techniques whenever applicable. Tubes and drains are not used routinely. Immediate postoperative mobilization is supported by a combination of nonsteroidal anti-inflammatory drugs (NSAIDs) for basic pain treatment and very reluctant use of opioids. Pain medication should be in first line given regularly; application on demand can be started after 24 h. The need for analgesics is adjusted according to an elaborated pain treatment scheme with closely monitored pain measurements. Certain combinations of drugs should be reserved for specific pain levels. We recommend a “rescue medication” for situations with sudden pain, e.g., nalbuphine. The pain scales used are age appropriate. We recommend the use of the children’s and infant’s postoperative pain scale (CHIPPS) (Büttner et al. 1998) for children under the age of 4 years, the smiley scale (Keck et al. 1996) for children up to 9 years of age, and the visual analogue scale (VAS) (LaMontagne et al. 1991) for older children.

Nutrition and mobilization are initiated at the day of operation. In addition, the use of specific discharge criteria may be helpful: no fever, a pain score lower than 3 on a 10-point scale without the use of opioids, advanced mobilization with a mobilization score of 2 or above (Table 3), full oral nutrition without nausea and vomiting, good wound conditions without signs of infection, and parent and patient’s agreement on discharge. For the successful continuation of fast-track after discharge, the close communication between pediatric surgeons and the pediatrician, who takes care of further treatment, is essential. Finally, some procedures suitable for fast-track are shown in Table 4.

Conclusion and Future Directions

In conclusion, children are generally suitable for fast-track surgery due to their capacity for quick recovery. Fast-track concepts can be applied to children undergoing various routine procedures. Even those patients who cannot undergo the full fast-track pathway may benefit from single fast-track measures.
Table 3  Fast-track elements and criteria of their successful application in the German setting. The elements are considered feasible when successfully applied to at least 75% of the patients (Reismann et al. 2012)

| Element | Definition of successful application |
|---------|-------------------------------------|
| 1. Analgesia | Pain intensity of <1/3 of the maximum scale points* at the evening of the operation day (18.00 h) |
| 2. Postoperative nutrition | Full oral nutrition at the 2. postoperative day at 18.00 h (two full meals without nausea and vomiting) |
| 3. Postoperative mobilization | 2 score pointsb at the 2. postoperative day at 18.00 h |
| 4. Applicability of minimal invasive surgery | No conversion and no postoperative complication with adverse effect in procedures suitable for minimally invasive techniques |
| 5. Hospital stay | Significantly shorter hospital stay compared to G-DRG data on similar patients in hospitals with similar case mix index and similar structure |
| 6. Postoperative symptoms | No nausea or vomiting |
| 7. Complications | No complications |
| 8. Patient’s/parent’s judgement | Satisfaction of patients/parents, no readmission (>90%) |

*aPain scales:
For children aged <4 years: children’s and infant’s postoperative pain scale (CHIPPS) (Büttner et al. 1998)
For children aged 4–9 years: smiley scale (Keck et al. 1996)
For children aged ≥10 years: visual analogue scale (VAS) (LaMontagne 1991)

*bMobilization scale:
0: No mobilization
1: Sitting on the edge of the bed or short mobilization out of the bed (infant)
2: Short walk in the patient’s room or feeding outside the bed
3: Walk along the corridor or mobilization in the pram

Table 4  Examples of types of procedures with confirmation of excellent feasibility of fast-track concepts

| Abdominal procedures: |
|-----------------------|
| Fundoplication |
| Pyloromyotomy |
| Appendectomy |
| Splenectomy |
| Heller’s cardiomyotomy |
| Cholecystectomy |
| Choledochal cyst resection and biliodigestive anastomosis |
| Resection/deroofing of cysts of the liver or spleen |
| Resection of mesenteric cyst |
| Urogenital procedures: |
| Pyeloplasty |
| Nephrectomy |
| Hypospadias repair |
| Varicocelectomy |
| Operation for intra-abdominal testis/Fowler-Stephens procedure |
| Ureteral reimplantation |
| Interventions on the internal genitalia (ovary, tubes, uterus) |
| Heminephrectomy |
| Urachal cyst resection |
| Thoracic procedures: |
| Resection of pulmonary sequestration |
| Wedge resection of the lung |
| Lung lobe resection |
| Biopsy/resection of tumors and cysts |

Cross-References

- Achalasia
- Anesthesia and Pain Management
- Appendicitis
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