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ORIGINAL ARTICLE

Structured intervention for management of pain following day surgery in children

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What is already known

- We are faced with an increased flow of pediatric patients undergoing day surgery.

What this article adds

- Following structured intervention pain was well managed in children after ambulatory surgery.

Keywords
children; day surgery; postoperative pain; pain assessment; analgesics; parents; information

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Summary

Background: Ambulatory surgery forms a large part of pediatric surgical practice. Several studies indicate that postoperative pain is poorly managed with more than 30% of children having moderate to severe pain. In a busy outpatient clinic contact between healthcare professionals and the family is increasingly limited calling for a global and efficient pain management regime.
Objective: The aim of this prospective observational cohort study was to determine postoperative pain intensity following day surgery in children after our structured intervention for pain management.
Methods: A number of interventions in an effort to address barriers to effective postoperative pain management after day surgery were identified in the literature. By introducing our concept *structured intervention*, we aimed to address the majority if not all these barriers. Accordingly, we adapted postoperative pain management to each child using a multimodal approach consisting of surgery-specific analgesia with weight appropriate doses of acetaminophen and ibuprofen. Analgesics were handed out to the parents in formulations accepted by child and parent and after thorough information to the parents.
Results: Two hundred and forty-five children were scheduled for surgery during the 3-month period of which 149 children were available for analysis. The postoperative pain as assessed by the parents with a the Short Form of the Parents' Postoperative Pain Measure (PPPM-SF) was well managed exhibiting a median pain score of 4 on postoperative day 0 (POD0) and median 1 on postoperative day 1 (POD1) and a numeric rating scale (NRS) median pain score of 2 on POD0 and median 1 on POD1. We found a highly significant correlation between the PPPM-SF and the NRS scores.
Conclusion: After thorough information of the parents we have successfully implemented a surgery-specific regime of primarily around-the-clock dosing of drug formulations acceptable for the specific child with dispensed medication ready available for the family.

Introduction

Ambulatory surgery forms a large and an increasing part of pediatric surgical practice. Several studies indicate that pain following ambulatory surgery in children often is poorly managed (1–14). At home the responsibility for administration of analgesics lies with the parents/caregiver. In a busy outpatient clinic, contact between healthcare professionals and the family is increasingly limited calling for a global and efficient pain management regime.

Few studies address the quality of pain management following ambulatory surgery. Most of these studies are carried out in children following tonsillectomy, surgery with moderate to severe pain for several days. Only few studies have addressed pain at home after minor general surgery (7). We therefore carried out a quality study in 2013 to examine pain management in the first postoperative day following ambulatory minor general surgery. In accordance with other studies (7), we found a significant number of children having moderate to severe pain: More than 30% of children had moderate to severe pain after minor ambulatory surgery as herniectomy and orchiopexia (S. Walther-Larsen, unpublished data).

Dorkham *et al.* (15) have suggested a number of interventions in an effort to address barriers to effective postoperative pain management at home following discharge which encompass improved information, improved medical regimens, and the provision of tools to aid parents to the pain management of their children.

Accordingly we wanted to adapt postoperative pain management to each child using a structured multimodal approach consisting of surgery-specific analgesia (around-the-clock and/or *as-needed* administration) following department standards of weight appropriate doses of acetaminophen and ibuprofen. Analgesics were handed out to the parents in formulations accepted by child and parent and after thorough information of the parents. By introducing our concept *structured intervention*, we accordingly aimed to address the majority if not all barriers available for intervention.

The aim of this study was thus prospectively to determine postoperative pain intensity following day surgery in children after structured intervention for pain management.

Methods

Study design

The study was designed as a prospective observational cohort study. The Research Ethics Committee for the Capital Region of Denmark was consulted for assessment of the study and concluded that this study did not need approval as no patients were submitted to investigational actions or imposed any behavioral changes. Informed consent was obtained for anesthesia and surgery from the parents of all the children.

The study was undertaken during a period of 3 months from September to December 2014 in pediatric patients after general surgery in a Danish University Hospital.

Inclusion criteria were: The child, >1 year of age and American Association of Anesthesiologists Class I–II, was scheduled for minor outpatient surgery and the parents/caregivers accepted a follow-up phone call on the second postoperative day. Exclusion criteria were: Children with cognitive impairment or known allergy, hypersensitivity or contraindications to anesthetic, or analgesic medications and families with significant language barriers.

Preoperative preparation

Children were scheduled for minor general surgery during the 3-month study period. After informed consent for anesthesia and surgery the family arrived in the preoperative area. A postanesthesia care unit (PACU) nurse informed the parents about the postoperative pain management strategy and an individual plan was designed for each child regarding route of administration postoperative analgesics according to the child's age, cognitive developmental level, and former experience of administering medicine to the child (rectally or orally as a tablet, elixir or melt tablet). Oral administration was recommended when feasible. This plan was noted for subsequent prescription and dispensation of postoperative pain medication.

Anesthetic technique

Eutectic mixture local anesthetics (EMLA) cream was applied to the dorsum of the hands at least 1 h before induction with intravenous propofol or by mask induction with incremental doses of sevoflurane. Anesthesia was maintained with propofol or sevoflurane supplemented with fentanyl 2–5 $\mu g \cdot kg^{-1}$ as needed. All children received acetaminophen (15 $mg \cdot kg^{-1}$ intravenously perioperatively or 15 $mg \cdot kg^{-1}$ orally immediately postoperatively) and ibuprofen (10 $mg \cdot kg^{-1}$ rectally perioperatively or orally immediately postoperatively). We aimed to avoid rectal administration in children above 4–5 years. Analgesia was supplemented in all children by regional analgesics according to surgery: Ilioinguinal block for unilateral procedures in the groin, caudal block for bilateral subumbical surgery, and penile block or caudal block for penile

surgery. The blocks were performed with weight appropriate bupivacaine 2.5 mg·cc^{-1} and mixed with lidocaine 10 mg·cc^{-1} for faster effect at the discretion of the attending anesthesiologist. The ilioinguinal block was performed under ultrasound guidance, the caudal and penile block with common landmark technique.

In the PACU, analgesics were administered to reach a NRS or FLACC score <3 by intravenous opioids (fentanyl 1–2 μg·kg^{-1}).

Analgesics

The parents were told to use a fixed schedule of pain medication in weight appropriate doses for the first 24 h after surgery.

Acetaminophen: Prescribed dose in all the children no matter type of surgery was 60 mg·kg^{-1}·24 h^{-1} orally or 100 mg·kg^{-1}·24 h^{-1} rectally divided into four daily doses (ATC-*around-the-clock*).

Ibuprofen: Prescribed dose was adjusted according to surgery. In 'major pain surgery' (circumcision and orchiopexia), the dose prescribed was 30 mg·kg^{-1}·24 h^{-1} (orally or rectally) divided into three to four daily doses ATC. If a child needed more than two administrations of opioids in the PACU, we considered surgery to fall in to the category 'major pain surgery' followed by a prescription of ATC ibuprofen no matter type of surgery.

In case of 'minor pain surgery' (herniectomi and other minor surgery), the prescription was ibuprofen 10 mg·kg^{-1} orally or rectally 'as needed' (*prn*) up to two times per 24 h. 'As needed' was to the parents defined as a NRS score >3 at rest. The children and parents decided themselves whether to use tablets, suppositories or elixir and the anesthesiologist calculated doses of analgesics for each child on a weight basis according to the preoperative plan. Information regarding doses of analgesics and administration times was also provided in writing, e.g. at 3 p.m., 9 p.m, 3 a.m, and 9 a.m. administer 500 mg of acetaminophen orally.

If the children complained of pain, or were thought to be in pain *after* the first 24 h the parents were advised to administer acetaminophen as needed (prn) up to four times a day.

Assessment of pain

At home the children's pain intensity was assessed by the parents using the Short Form of the Parents' Postoperative Pain Measure (PPPM-SF) (0–10) (16) and numeric rating scale (NRS) (0–10). These scales are validated instruments for measuring children's (0–12 years of age) pain intensity (16,17).

Before discharge from hospital the parents received instructions on how to use both scales. We handed out a copy of PPPM-SF (Table 1) and NRS (Figure 1) and asked the parents to assess their child's pain at home at two times after discharge: in the evening (postoperative day 0, POD0) and in the following morning (postoperative day 1, POD1).

A follow-up phone call was done by one of the investigators (GBA, SMF, or TP) on the postoperative day 1 and the pain scores as well as the amount of analgesics administered to the child was registered.

Data analysis

Pain scores are presented as median and range. The Box-and-whisker plot was used to graphically show the distribution of pain scores. The lower hinge, median, and upper hinge of the box correspond to 25%, 50%, and 75% percentiles, respectively. Statistical analysis was performed using Kendall's Tau Rank Correlation coefficient to estimate and test the correlation between pain scores from the Parents' Postoperative Pain Measure-Short Form (PPPM-SF) and the NRS.

Wilcoxon signed-rank test for matched pairs was used to assess differences in pain scores POD0 and POD1 with both the PPPM-SF and the NRS. Statistical significance was defined as $P < 0.05$.

The software package STATISTICA, Statsoft, Inc. (StatSoft Scandinavia AB, Uppsala, Sweden) was used for statistical calculations.

Results

Two hundred and forty-five children were scheduled for surgery during the 3-month period and eligible for inclusion. Figure 2 shows the study enrollment and the rea-

Table 1 Instructions and response options for the Short Form of the Parents' Postoperative Pain Measure (PPPM-SF)

	Yes	No
Whine or complain more than usual		
Play less than usual		
Not do the things she/he normally does		
Act more worried than usual		
Act more quiet than usual		
Have less energy than usual		
Eat less than usual		
Hold the sore part of his/her body		
Groan or moan more than usual		
Want to be close to you more than usual		

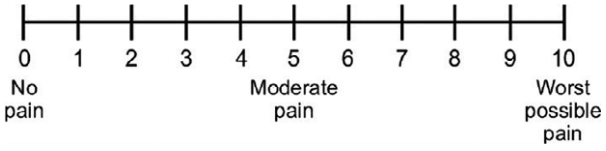

Figure 1 Numeric Rating Scale.

sons for exclusion. One hundred and seventy-seven children were included of which 149 children were available for analysis (16% did not answer our call, giving a response rate of 84%). Gender, age and weight are presented in Figure 2 and type of surgery is presented in Table 2. The mean age was 7 years, the majority was boys.

Pain intensity

The Box-and-whisker plot (Figure 3) shows the distribution of both PPPM-SF and NRS pain scores POD0 and POD1 with a PPPM-SF median pain score of 4 (range 0–10) POD0 and median 1 (range 0–10) POD1 after surgery and a NRS median pain score of 2 (range 0–8) POD0 and median 1 (range 0–6) POD1.

Kendall′s Tau rank test revealed a highly significant correlation between the PPPM-SF and the NRS scores both POD0 and POD1 ($r = 0.48$, $P < 0.0001$ and $r = 0.48$, $P < 0.0001$) and both PPPM-SF scores and NRS scores were significantly lower POD1 compared to POD0 after surgery ($P < 0.0001$) (Wilcoxon signed-rank test). Severe pain (NRS/PPPM-SF ≥7) was found in 4.7–24.2% (7/149–36/149) of the children on POD0, and in none to 6.7% (0/149-10/149) of the children on POD1.

Table 2 Type of surgery

	N = 149
Orchidopexy	*N* = 72
Phimosis	*N* = 37
Inguinal hernia repair	*N* = 26
Laparoscopy for undescended testicle	*N* = 2
Umbilical hernia repair	*N* = 2
Other minor surgery	*N* = 10

Analgesics

Ninety-seven percent of the children received acetaminophen ATC in the first postoperative day (144/149). Seventy-two percent of the children received ibuprofen ATC in the first postoperative day (108/149) and 19% (28/149) were offered ibuprofen *prn*. The doses of acetaminophen and ibuprofen administered were close to doses recommended in departmental guidelines (Table 3). When given acetaminophen, in 89% (128/144) of children it was administered as tablets or elixir. When given ibuprofen ATC, in 89% (96/108) of children it was given as tablets or elixir.

Discussion

In the present prospective observational cohort study, we measured postoperative pain after minor general sur-

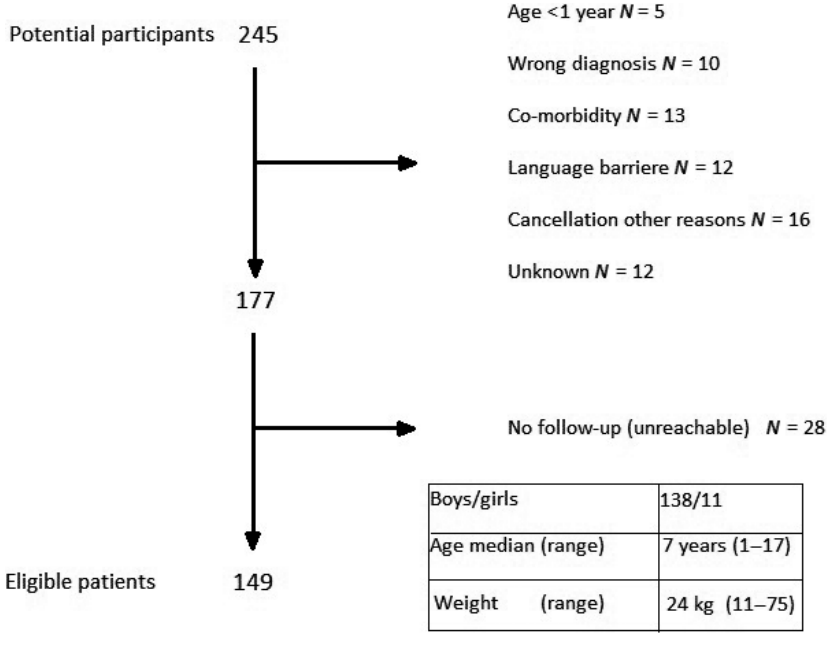

Figure 2 Flowchart of included and excluded patients.

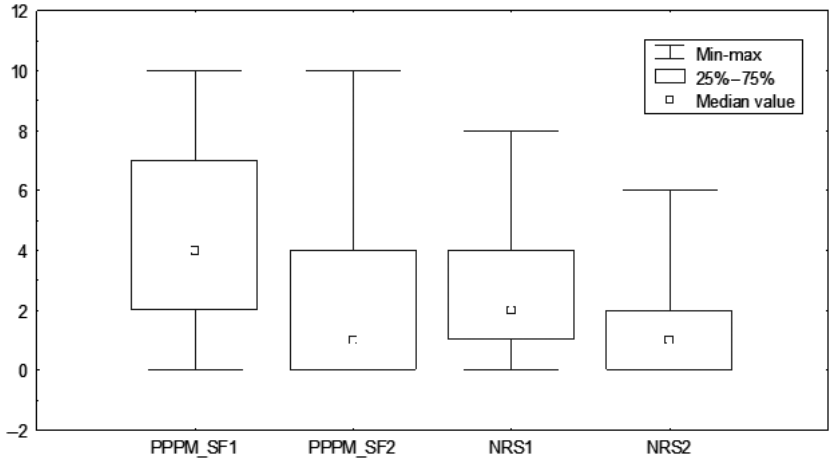

Figure 3 Postoperative pain, Short Form of the Parents' Pain Measure (PPPM-SF), and numeric rating scale (NRS) day 1 and 2.

gery. After our structured intervention, the pain was very well managed by the parents resulting in low overall pain scores during the first 24 h.

Several studies indicate that pain following ambulatory surgery in children is poorly managed. In a study by Hegarty (5), approximately 40% of the children experienced moderate to severe pain. In a study of pain after orchiopexy or herniectomy nearly one-third had moderate to severe pain at home (7). In a Finnish study, 36% of children were assessed as having moderate to severe postoperative pain after discharge (6). In a study by Shum, pain scores were significant higher at home compared to in-hospital care (1).

Surgery-specific regime

There are reasons to believe that pain management following ambulatory surgery in children has to be tailored to the type of surgery (2,4,7). Several studies indicate a high incidence of moderate to severe pain following surgery like tonsillectomy (8), adeno-tonsonsillectomy (14), orchidopexia (7), and circumsicision (2; S. Walther-Larsen, unpublished data). In contrast herniectomy (7) is followed by less severe pain after discharge. As a consequence we tailored our pain management to the type of surgery, i.e., supplementing ATC acetaminophen with ATC administration of ibuprofen for children after orchdopexia, penile operations, and in children experiencing significant pain immediately postoperatively (receiving >2 doses of opioids in the PACU).

Table 3 ATC (around-the-clock) administration of acetaminophen and ibuprofen. Daily doses in mg·kg $^{-1}$ divided into four doses

ATC dosing	*N*	Departmental guidelines (mg·kg^{-1}·day^{-1})	Administered (mg·kg^{-1}·day^{-1}) Median (range)
Suppositories			
Acetaminophen	16	100	88 (60–132)
Ibuprofen	12	30	28 (18–33)
Elexir			
Acetaminophen	61	60	56 (36–68)
Ibuprofen	43	30	30 (18–42)
Tablets			
Acetaminophen	67	60	56 (40–64)
Ibuprofen	53	30	27 (15–45)

Drug formulations acceptable for the specific child

Especially in children compliance in relation to accepting the formulation of medicine is important (18). As a consequence on arrival to the preoperative area a plan was made for an individual way of administering postoperative analgesics according to the child's age, cognitive developmental stage, and former experience of administering medicine to the child. As oral formulations compared to rectal administration improve absorption of acetaminophen (19), we urged the parents to administer tablets (older children) or elixir (younger children) in favor of suppositories. In our sample of children around 90% had oral formulations of pain medicine.

Around-the-clock (ATC) dosing

In pain management WHO recommends ATC administration of analgesics. In outpatient setting, several studies have addressed this issue. In a study by Rømsing (12), recommended doses of acetaminophen given ATC did not provide sufficient pain relief in children following tonsillectomy presumably because mono therapy with acetaminophen is insufficient for pain relief following tonsillectomy (3,8). In a recent systematic review, the intervention with the largest

effect size was instruction in ATC dosing, either alone or in combination with nurse coaching (20). In our study, we were able to implement ATC in the administration of acetaminophen and ibuprofen in 89% of children.

Improved information of the parents

Several studies have addressed communicative issues to improve pain management by the parents in an outpatient setting (5,6,18). In Sutter's (8) study, nurse coaching did not impact parent's adherence to ATC dosing. One study revealed insufficiency of instructions to the parents related to postoperative pain behaviors at home (9). Simmons found that nurses' knowledge deficit and poor communication with the parents created obstacles to effective pain management (21). In our study parents were thoroughly instructed by trained PACU nurses orally and in writing.

Dispensed medication ready available for the family

We decided to dispense pain medication prescribed for the individual child and found an excellent adherence by the parents: Ninety-seven percent of children received acetaminophen ATC in the first postoperative day, 72% of children received ibuprofen ATC in the first postoperative day (108/149), and 19% (28/149) were offered ibuprofen *prn* (Table 3). This is in contrast to the poorly retained analgesia advice found in the study by Hegarty (5). Same result was found in the study of Sutters (8) in which nurse coaching did not impact adherence to ATC dosing (8). We believe that thorough information and access to formulations of analgesics acceptable for the specific child (although time and money consuming) increases parental adherence to ATC (and prn) regime prescribed for the child.

Pain assessment by the parents

Pain is subjective and especially in the studied age group [mean age 7 years (1–17)] pain is difficult to assess for both professionals and parents. In older children, self-assessment is recommended. In younger children, most studies of parental pain assessment have used global ratings of pain, e.g., NRS. In our study, we decided to instruct the parents in using the NRS scale for assessment but also as a tool in cases with prn prescription of analgesics. For scientific purpose, we added PPPM-SF (16,17) and found a significant correlation between NRS and PPPM-SF ($r = 0.48$) apparently not found in other studies so far. In future studies of parental assessment and management of pain PPPM-SF could turn out to be a valuable tool, both in research and clinical care.

Some limitations of the study need to be addressed. We decided not to include a control group. A control group would have led to less detailed information to the parents about surgery-tailored, child-specific formulated ready available dispensed pain medication and it was therefore considered unethical (22). Instead we investigated the quality of pain management of structured interventions for the entire group of ambulatory children following general surgery in a prospective observational cohort.

We dispensed ATC acetaminophen and/or ibuprofen to all children included, we have not investigated if the regime is excessive. After 24 h, the advice to the parents was only to administer as-needed doses of acetaminophen. Accordingly maximum four doses of ibuprofen and acetaminophen (over-the-counter drug in Denmark) were given during a 24-h period. We find this regimen justified as untreated pain seems to have immediate as well as long-term negative consequences in children.

Pain was assessed in the first 24 postoperative hours after minor pediatric surgery and so this study does not describe the pain course beyond the first day. An extended structured analgesic regime is indicated for pain management after surgery with suspected significant and prolonged pain, e.g., tonsillectomy. Further studies are needed to design structured pain management covering the entire spectrum of ambulatory pediatric surgery.

Dorkham *et al.* (15) have suggested a number of interventions which encompass parental factors, child factors, medication factors and system factors to aid parents to the pain management of their children. Instead of addressing only one of many barriers to effective pain management following day surgery in children, we decided to implement as many interventions as feasible. In this study we found that our multimodal approach compared to literature improved pain management in children after ambulatory surgery.

Conclusion

To improve pain management of children after ambulatory surgery, we found in this sample of patients low pain scores assessed by the parents by our structured intervention: After thorough information of the parents we implemented a surgery-specific regime of primarily ATC dosing of drug formulations acceptable for the specific child with dispensed medication ready available for the family.

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Conflict of interest

The authors report no conflict of interest.

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