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Opioid stewardship in pediatric surgery: Approaching zero

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ABSTRACT

Introduction: In response to the opioid epidemic, we hypothesized that adequate pain control can be achieved with few, if any, opioid prescriptions at discharge following pediatric surgical procedures.
Methods: All records for patients 0–15 years old who underwent pediatric surgical operations from December 2017 through May 2018 were reviewed. Opioids prescriptions, emergency department (ED) visits, and hospital readmissions were recorded. Postoperative pain was assessed on a scale from 0 to 10 via phone call within three days of discharge.
Results: 352 patients underwent 394 surgical procedures. Three patients were prescribed opioids at discharge. There were no pain-related readmissions. One patient returned to the ED owing to pain. 116 unique pain scores were obtained from 114 patients: score 0 ($n = 69$, 59%), 1–3 ($n = 31$, 27%), 4–5 ($n = 11$, 9%), 6–8 ($n = 5$, 4%), and 9–10 ($n = 0$, 0%). There was a positive association between pain and increasing age ($r = 0.26$, $p = 0.005$). No patients who underwent hernia repair reported a pain score greater than 3.
Conclusions: Adequate pain control at discharge after pediatric general surgical procedures can be achieved for most children with scheduled nonopioid medications only. A limited supply of opioids for analgesia after discharge may benefit small subset of patients. This strategy would help reduce opioid prevalence in the community.
Type of study: Retrospective cohort study.
Level of evidence: Level III.

The opioid epidemic continues to be a significant public health concern in North America. In the past 18 years, 399,230 people have died from drug overdose in the United States. In 2017 alone, 70,237 deaths were because of drug overdoses [1]. Of those deaths, 47,600 were because of opioids, making this drug class the leading cause of death (67.8%) from drug overdose in the United States that year [1]. As the epidemic continues to affect the lives of hundreds of thousands of people in North America, clinicians need to be conscientious stewards of these potentially harmful medications.

The good intentions of healthcare providers to mitigate pain have resulted in overprescription of opioids without fundamental evidence of improved pain management [2]. Further, there is little evidence to suggest that opioids result in improved pain management compared to nonopioid regimens. Studies in patients, including children, undergoing surgical procedures consistently demonstrate wide variations in opioid prescribing without any clear benefit to those who receive opioids compared to those who do not [2,3]. Further, a study on pain management of pediatric fractures found no difference in pain control between morphine and ibuprofen, yet children who received morphine had more adverse reactions such as nausea and vomiting [4]. Additionally, patients are often prescribed opioids at discharge despite not receiving any of these medications 24 h prior to leaving the hospital [5]. Many patients do not fill or utilize opioid medications when prescribed after surgical procedures [6].

Initiatives have begun to enhance opioid stewardship after surgery [5,7–9]. Despite successful quality improvement projects to reduce opioid prescribing, many children continue to have unnecessary exposure to opioids [10]. In a recent multicenter prospective study, opioid prescribing after umbilical hernia repair was reduced by 41%, yet nearly 45% of children were still sent home with an opioid prescription after the successful intervention [9].

In an effort to improve opioid stewardship at our own institution, our pediatric surgeons chose to review our opioid prescribing patterns and determine if pain is being adequately managed after discharge with minimal use of these medications. Herein, we explored whether a pain management algorithm with scheduled, multimodal, nonopioid

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medications can eliminate the need for opioid prescriptions and still effectively treat pain after discharge from pediatric general surgical procedures. This regimen includes routine usage of acetaminophen, ketorolac in the inpatient setting, and ibuprofen at home. We hope this manuscript will help others improve opioid stewardship and empower clinicians to significantly curb opioid prescriptions following surgical procedures in children.

1. Material and methods

1.1. Study design and data collection

This study was reviewed by the Institutional Review Board at the University of Rochester and considered exempt. Informed consent was not required.

We reviewed the electronic medical records of all patients who underwent inpatient and outpatient procedures by the Division of Pediatric Surgery at the University of Rochester Medical Center (Golisano Children's Hospital), a 190 bed tertiary care facility, from December 2017 through May 2018.

Retrospective electronic chart review included type of operation performed, Current Procedural Terminology (CPT) code, surgeon, context of the operation (scheduled outpatient, scheduled inpatient, or emergency inpatient), medications prescribed at discharge (i.e., opioid and nonopioid pain medications), visits to the emergency department (ED), and readmissions to hospital. All data collection was done via electronic medical record review. Patients who died during their hospital stay were excluded from the analysis.

Our surgeons routinely utilize local anesthetic (0.25% bupivacaine infiltrated into the wound). Regional blocks are utilized infrequently at the anesthesiologist's discretion. Unless contraindicated, or they were already pain-free, all patients were instructed to take acetaminophen and ibuprofen on a scheduled basis for 2–3 days after discharge (and as needed after) from outpatient and inpatient procedures for pain control. Prescriptions for these medications were provided at the parent or guardian's request.

Patients who stayed in hospital for more than 24 h after surgery (i.e., those who underwent scheduled or emergency inpatient procedures) were called by one of the administrative assistants from the Division of Pediatric Surgery within three days of discharge. Assessments of pain were completed using a standardized form (Appendix 1). Patients that stayed in the hospital for less than 24 h (i.e., those who underwent scheduled outpatient procedures) were called by the perioperative surgical center's nursing staff for a similar assessment within the same time frame. Ratings of pain in both assessments were based on the following ordinal scale: 0, 1–3, 4–5, 6–8, or 9–10. These ratings were obtained from the parent or guardian as a proxy measure reflecting on the patient's status over the past few days. When possible parents were encouraged to additionally ask patients how they felt with regards to pain. If there was no response on first follow-up attempt, a minimum of two other attempts was made during work hours within the week of surgery.

Some patients had more than one procedure performed during the study period. This included patients who had multiple procedures during a single hospitalization (e.g., exploratory laparotomy followed by multiple dressing changes in the operating room) as well as those that had multiple procedures over multiple hospitalizations (e.g., inguinal hernia repair followed by a gastrostomy tube insertion a few months later). The total number of procedures was captured and reported. For the purposes of analysis between groups of patients, however, we used the index procedure for each individual. Common procedures such as umbilical and inguinal hernia repair were further subanalyzed to assess for pain management.

1.2. Statistical analysis

Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) Version 26.0. Sex, context, and pain scores were presented as counts and frequencies. Differences between patient groups for categorical variables were tested using chi-squared tests. Age was computed using the difference between date of surgery and date of birth. Length of stay after inpatient procedures was reported as median and range. Differences in age and inpatient length of stay between groups were examined using independent t-tests.

The relationship between type of surgery (appendectomy versus other) and postdischarge pain was explored using chi-squared tests. The relationship between age (as a continuous variable) and pain (as an ordinal variable: 0, 1–3, 4–5, 6–8, 9–10) was explored using a nonparametric Spearman's rank correlation coefficient. P-values less than 0.05 were considered statistically significant.

2. Results

2.1. Baseline characteristics

In the study period, 352 patients underwent 394 operations by four pediatric general surgeons (surgeon 1: 143 cases, surgeon 2: 128 cases, surgeon 3: 113 cases, and surgeon 4: 10 cases). Three patients died in the hospital before discharge and were excluded from analyses. The types of operations included the wide breadth of pediatric general surgery practice (Fig. 1).

Patient characteristics are summarized in Table 1. There were no differences between patients who did and did not provide pain scores in terms age ($p = 0.13$) and sex ($p = 0.93$). These groups were different, however, in terms of the context of the procedure. Patients who provided a pain score were more likely to have undergone an emergency inpatient procedure (53% versus 31%) and less likely to have had a scheduled outpatient procedure (30% versus 50%) ($p < 0.001$).

The percentage of patients who completed a pain score included 34/153 (22%) of those who underwent a scheduled outpatient procedure; 19/63 (30%) who underwent a scheduled inpatient procedure; and 61/136 (45%) who underwent an emergency inpatient procedure ($p < 0.001$).

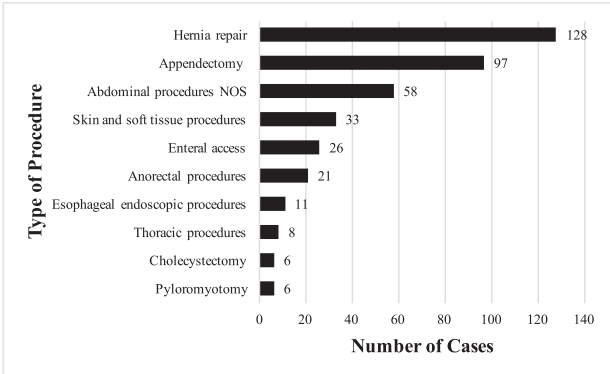


Fig. 1. Types of procedures performed over the six-month period. Hernia repair includes inguinal, umbilical, and other ventral hernia repairs. Appendectomy includes laparoscopic and open appendectomy when appendectomy was the primary procedure (not incidental). Abdominal procedures not otherwise specified (NOS) include operations for gastroschisis, omphalocele, intussusception, malrotation, spontaneous intestinal perforation, necrotizing enterocolitis, congenital diaphragmatic hernia, urachal cyst, peritoneal dialysis, abdominal tumors, biliary atresia, and Hirschsprung disease. Skin and soft tissue procedures include operations for abscess, benign lesions, lymphadenopathy, foreign body, hidradenitis, pilonidal disease, complex wounds, and vascular access. Anorectal procedures include anorectal exam under anesthesia, rectal biopsy, and chemodenervation of the internal anal sphincter, as well as operations for perineal abscess, fistula-in-ano, and anorectal malformations. Thoracic procedures include tube thoracostomy, thoracoscopic and open decortication, lobectomy, and sternal bar removal.

Table 1
Baseline characteristics.

Characteristic	Pain scores available ($n = 114$)	Pain scores not available ($n = 238$)	p-value[a]
Age, years			
Mean	6.70	5.81	0.13
(Standard deviation)	(5.22)	(5.19)	
Range	0–16.07	0–15.90	
Gender, n (%)			
Male	66 (58%)	139 (58%)	0.93
Female	48 (42%)	99 (42%)	
Context			
Scheduled outpatient	34 (30%)	119 (50%)	<0.001
Scheduled inpatient	19 (17%)	44 (19%)	
Emergency inpatient	61 (53%)	75 (31%)	

[a] Based on chi-squared tests for categorical data and independent t-tests for continuous data.

Length of stay after emergency and scheduled inpatient procedures ($n = 199$) ranged from less than 24 h to 427 days. Median length of stay was 2 days for patients who provided a pain score and 4 days for those who did not ($p = 0.001$).

2.2. Opioid prescriptions at discharge

Of the 352 patients included in the study, only three were given opioid prescriptions at the time of discharge. One patient was a 13-year old boy who was provided a prescription for 15 tablets of oxycodone (5 mg) five days after exploratory laparotomy for excision of a retroperitoneal schwannoma and ureteral stent placement. Another patient was a 12-year old girl who was prescribed ten tablets of oxycodone (5 mg) two days after a laparoscopic left salpingooophorectomy, right salpingectomy, lysis of adhesions, and repair of a serosal injury of the ascending colon. The pediatric surgeon assisted with repair of the colon injury only. The patient was discharged and given an opioid prescription by the gynecology service. The third patient was a five-month old boy who was discharged from the neonatal intensive care unit on a methadone taper 32 days after gastrostomy tube insertion for oral aversion.

2.3. Opioid prescriptions after discharge

One patient, a 13-year old girl who underwent laparoscopic appendectomy for nonperforated appendicitis, returned to the ED with pain after being discharged from the hospital without a prescription for opioids. She returned to the ED two days later with postoperative pain and was prescribed three 5 mg tablets of oxycodone by the ED physician. The service was not able to reach the family for a postoperative pain score. There were no pain-related hospital readmissions.

2.4. Pain scores after discharge from hospital

114 of 352 patients completed at least one pain score (32% response rate). Two of these patients completed two pain scores because they underwent different procedures during two separate hospitalizations. This resulted in a total of 116 pain scores: 69 (59%) reported a pain score of 0; 31 (27%) reported 1–3; 11 (9%) reported 4–5; and 5 (4%) reported 6–8. Zero patients reported a pain score of 9–10 (Fig. 2).

Of the 16 patients with a pain score greater than 3, one was prescribed opioids at discharge (Table 2). Nine patients had undergone appendectomy for uncomplicated appendicitis (8 laparoscopic and 1 open) (Table 2). Pain greater than 3 appeared to be higher following appendectomy (19%) compared to other procedures (9%) but this trend was not statistically significant ($p = 0.11$). There was, however, a positive association between pain and increasing age ($r = 0.26$, $p = 0.005$). The highest rates of pain greater than 3 were observed in preteens aged 10–12 years (Fig. 3).

In further subanalysis, pain scores were reported after 29 of 128 hernia repairs. No patients reported a pain score greater than 3. After umbilical hernia repair 7 patients reported a score of zero and 6 patients had a score of 1–3. After inguinal hernia repair, 13 patients had a score of zero, with one patient reporting a score of 1–3. Two patients who underwent ventral/epigastric hernia repair had a score of zero. None of these patients were prescribed opioids at discharge.

2.5. Usage of local and regional anesthesia

Out of the 114 patients with a reported pain score, 105 patients received local anesthesia and two patients received a regional block. There is no trend or statistically significant relationship between amount of local and pain scores, ANOVA ($p = 0.47$) or Spearman's rank correlation coefficient ($p = 0.96$).

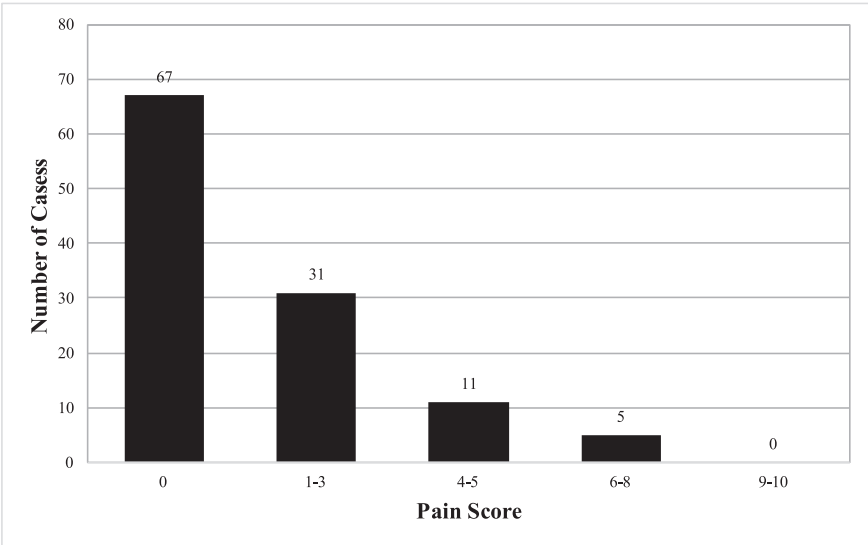


Fig. 2. Pain scores after discharge from hospital following pediatric surgical procedures.

Table 2
Characteristics of patients with inadequate pain control (score greater than 3).

Patient	Age (years)	Discharge diagnosis	Procedure	Postoperative days in hospital	Pain score
1	7	Uncomplicated appendicitis	Open appendectomy	0	4–5
2	12	Uncomplicated appendicitis	Laparoscopic appendectomy	1	4–5
3	12	Uncomplicated appendicitis	Laparoscopic appendectomy and right paratubal cyst excision	1	4–5
4	10	Uncomplicated appendicitis	Laparoscopic appendectomy	1	4–5
5	10	Uncomplicated appendicitis	Laparoscopic appendectomy	1	4–5
6	11	Uncomplicated appendicitis	Laparoscopic appendectomy	2	4–5
7	10	Magnet ingestion with bowel injury	Exploratory laparotomy, enterectomy, removal of foreign bodies	2	4–5
8	0	Ileocolic intussusception	Laparoscopic reduction of intussusception	2	4–5
9	13	Retroperitoneal abdominal schwannoma	Exploratory laparotomy with resection of retroperitoneal mass	4	4–5
10	0	Morgagni hernia	Open diaphragmatic hernia repair	4	4–5
11	4	Hemothorax	Thoracotomy and decortication	8	4–5
12	7	Gastrocutaneous fistula	Gastrocutaneous fistula closure	0	6–8
13	10	Uncomplicated appendicitis	Laparoscopic appendectomy	1	6–8
14	12	Uncomplicated appendicitis	Laparoscopic appendectomy	1	6–8
15	12	Uncomplicated appendicitis	Laparoscopic appendectomy	1	6–8
16	2	Ileocolic intussusception	Laparoscopic reduction of intussusception	1	6–8

Note: All patients who underwent appendectomy had appendicitis confirmed on pathologic examination of the specimen. Patient 2 was thought to have viral gastroenteritis after discharge. Patient 7 had high functioning autism. Patient 8 continued to have viral symptoms for several days after discharge from the hospital. Patient 9 was given fifteen tablets of oxycodone 5 mg at discharge.

3. Discussion

Given the current opioid crisis in North America, it is important to establish best practices for postoperative pain management while preventing a surplus of addictive medications from reaching patients, their families, and the communities they live in. This single-institution, retrospective study demonstrates that adequate and safe pain management can be achieved with scheduled, multimodal, nonopioid medications (such as routine acetaminophen and ibuprofen) for the majority of patients. However, there was a subset of patients for whom this regimen did not adequately manage their pain. Overall, this regimen minimizes the need for prescription opioids upon discharge, thereby preventing these medications from reaching the community at large.

Our pediatric surgeons routinely use local anesthesia and recommend using scheduled acetaminophen and ibuprofen (when not contraindicated) for the first 2–3 days after discharge from surgical procedures. A discussion between the surgeon and patient's family regarding expectations of postoperative pain and its management is an important part of our update to the family immediately after any operation. This conversation is reinforced at the time of discharge after inpatient stays. The surgeon stresses the importance of scheduled acetaminophen and ibuprofen regardless of patient pain status for 2–3 days after discharge. Further, the expectation that our patients report adequate pain control with this regimen without opioids is normalized for families. Other nonopioid methods of pain management such as gabapentin, anxiolytics, muscle relaxants, heat/cold application, acupuncture, music therapy, virtual reality and other forms of distraction, are not consistently recommended in our practice.

With this regimen, we have found that opioids are not needed at discharge after outpatient procedures. While opioids are helpful in the inpatient setting after more invasive procedures that require inpatient stay, we have found that by the time children are otherwise ready for discharge, the vast majority no longer require opioid medications. Excluding one patient discharged home from by the gynecology service and another patient discharged from the neonatal intensive care unit on a sedation wean, our group discharged only one patient home with any opioid medication after nearly 400 procedures over a six-month period.

The strengths of this study are in the demonstration that low rates of opioid prescriptions after children's surgical procedures are possible while still maintaining adequate pain control for the majority of

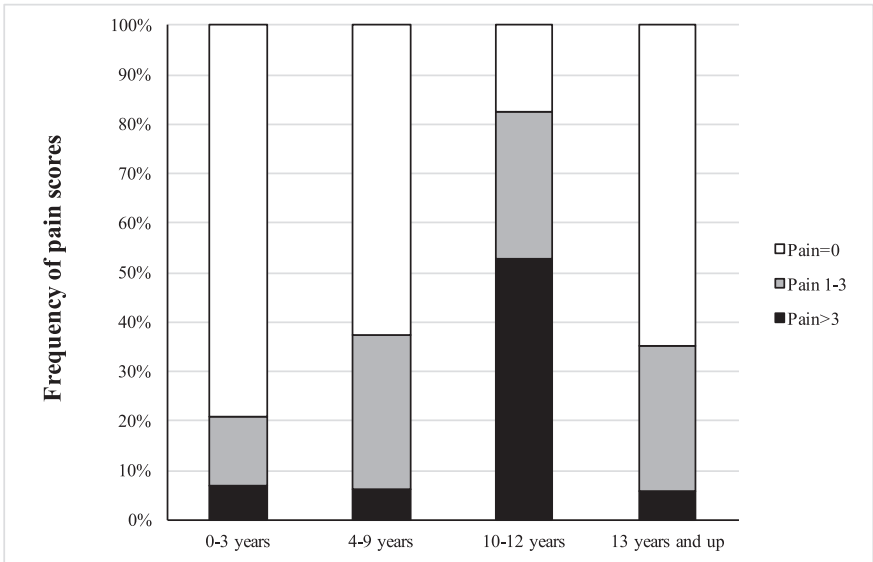


Fig. 3. Association between pain score and age group.

patients. Our postoperative surveys allow for an at home assessment of patients' pain and an opportunity for patients or their families to express any concern that postoperative pain had not been adequately managed. Further, our results are generalizable across the discipline of pediatric general and thoracic surgery, as our data included these procedures. No patient that underwent umbilical, inguinal, or ventral/epigastric hernia repair reported inadequate pain control. These procedures represent an important subset for targeted opioid stewardship; they are "low hanging fruit" in that they are common procedures, are perceived to be less pain inducing, and, therefore, can be adequately managed without opioids in a more noncontroversial way.

As a caveat, our group did not perform any primary operations for chest wall deformity during the study period (there was one sternal bar removal). These operations are known to cause significant postoperative pain and much has been written about pain management after these procedures [11–14]. Consequently, novel pain management techniques including regional anesthesia, intercostal nerve cryoablation, ketamine infusion, and enhanced recovery pathways have been described in this patient population [11–14]. This may represent a group of patients that would benefit from opioid pain medications after discharge, though the authors are aware of centers using strictly nonopioid medication regimens at discharge when combined with cryoablation at the time of surgery.

We also found that postoperative pain scores varied with age. In general, pain scores were higher in older patients. Older age has been found to be associated with increased probability of opioid medication usage, prescription fills and refills, and persistent postoperative opioid use [15–17]. Interestingly, the highest pain scores in our cohort were seen in patients aged 10 to 12 years. While this is congruent with the notion that older children may have more pain, we cannot explain why patients 13 and older were not affected similarly. Perhaps there is something about the perception or expectation of pain in children in this age range that makes them more likely to experience or report higher pain scores; alternatively, this could represent a chance finding within our study cohort.

Of the patients who reported a pain score, 13% had a score greater than 3. While this finding raises the concern that their pain was not controlled, we do not know if their pain would have been improved by the addition of opioids. Indeed, one patient with a pain score greater than three was one of three patients prescribed opioids at discharge. We also cannot be sure that all patients followed our instructions to take scheduled acetaminophen and ibuprofen to minimize pain. Because most families chose to use these medications over the counter (as opposed to by prescription), we are not able to reliably audit usage of nonopioid pain medications. Authors have found that many patients can be effectively managed without opioid medications after laparoscopic appendectomy [18–20]. Nevertheless, there may be a subset of patients who would benefit from a small amount of opioid medications at discharge. This may be particularly important as we strive to discharge children home earlier after surgical procedures, such as same day discharge after appendectomy and cholecystectomy. Similarly, reports in pediatric orthopedic surgery and otolaryngology do not demonstrate any benefit of opioids compared to nonopioid medications for minimizing fracture pain and postoperative pain after lower acuity procedures [4,21,22].

Of the 16 patients with suboptimal pain control, two children had persistent viral symptoms, which may have contributed to continued postoperative pain refractory to the multimodal pain medication regimen. Another child had autism, which may have made caretaker pain assessment less reliable. A fourth patient, the only patient our service discharged with an opioid prescription, reported a pain score of 4–5. While it is possible that his pain score would have been higher without any opioid medication, it is also possible that his pain score was unaffected by the use of opioids at home. Pain scores, whether self-reported or parent-reported, are subjective. Pain varies depending on a patient's pain tolerance and perception of pain. Therefore, the use of pain scores as a standardized variable remains a limitation in pain assessment and management.

Another limitation to this study is its retrospective nature and the absence of assessment before and after an intervention. Nevertheless, the purpose of this retrospective study is to share a model that can be adopted as a best practice for pain management after children's surgery. There have been several studies showing a significant decline in the number of opioids being prescribed at discharge after divisional interventions [7,9]. However, there is still a significant amount of opioids being prescribed for common procedures that can be adequately managed with multimodal, nonopioid pain management regimens. We believe it is our responsibility to share this model for others to emulate when designing initiatives to reduce the use of postoperative opioid prescriptions.

Another limitation of this study is the response rate to our postoperative survey. Indeed, only 114 of 352 patients (32%) provided a pain score over a six-month period. This happened despite the fact that our administrative team attempted to contact each family at least three times, with each attempt on a separate day. Furthermore, families we were able to contact were more likely to have undergone an emergency procedure compared to those who could not be reached, which could introduce sampling bias.

The differences found in survey participation between outpatient and inpatient procedures are likely because of variation in the process for contacting families postdischarge. We believe our administrative staff is more diligent when attempting to contact families to administer the postoperative follow-up survey than our perioperative-nursing staff, resulting in a higher response rate after inpatient emergency surgeries than after outpatient procedures. The effect this bias could have on our results is not clear. While inpatient surgeries might be expected to result in more postoperative pain, patients are discharged earlier after outpatient surgeries and might experience more of their postoperative pain at home. In the former case, our results may overestimate postoperative pain at home, while in the latter, we may be underestimating our patients' pain after discharge.

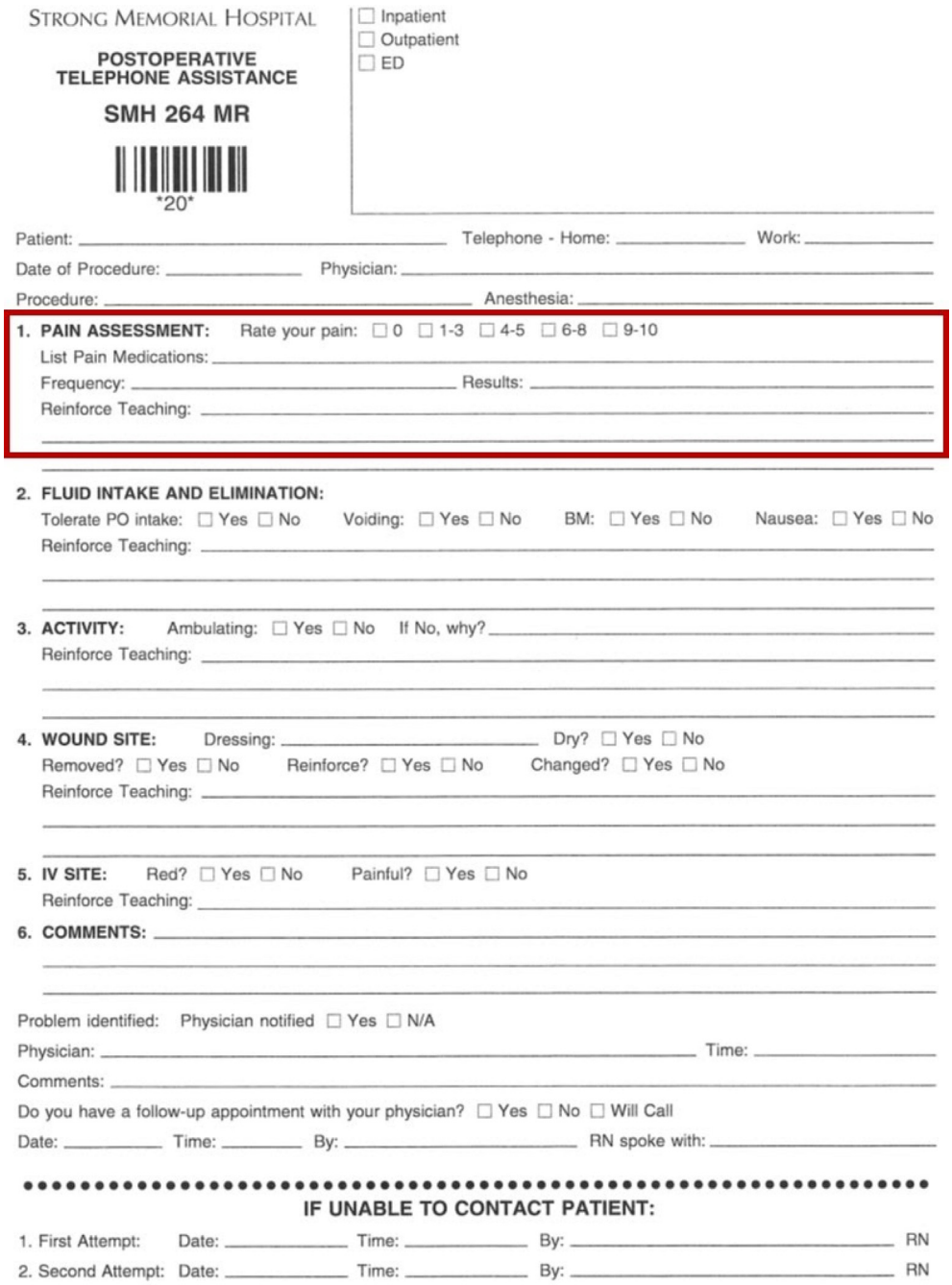
Similarly, another limitation of this study is the variation in the postoperative survey interviewer and possible bias that comes along with telephone interviews. Though our perioperative-nurses and administrative staff utilize the same survey (Appendix 1), variation in interview styles may exist and, thus, impact patient and parent reports.

Despite these limitations, we would expect any patient who was experiencing significant pain to have called our office or returned to the ED or clinic. We only had one patient return to the ED because of pain during the study period. As the only pediatric surgical group practicing in the only children's hospital in our metropolitan area, it is unlikely that patients went elsewhere for postoperative pain concerns. Nevertheless, it is possible that they were seen by providers outside of our group.

3.1. Conclusions

In summary, we believe this retrospective study is a "proof of concept" that a regimen of scheduled, multimodal, nonopioid pain medications at discharge can safely and adequately ameliorate pain after most pediatric surgical procedures. We believe that this report will help other pediatric surgeons develop best practices to optimize opioid stewardship after surgery and prevent unnecessary exposure of opioids to children and our communities. We are now in the process of designing a prospective, observational study using self-reported "pain journals" for patients undergoing same-day procedures, such as hernia repair, as well as emergency inpatient cases, such as laparoscopic appendectomy for uncomplicated appendicitis. We hope that this effort will better capture the self-reported experiences of surgical patients discharged home without opioid prescriptions and mitigate children being lost to follow-up.

Appendix 1 Form used to assess postoperative pain within three days of discharge. The box highlights the pain scale



STRONG MEMORIAL HOSPITAL

POSTOPERATIVE TELEPHONE ASSISTANCE

SMH 264 MR

"20"

☐ Inpatient
☐ Outpatient
☐ ED

Patient: _____ Telephone - Home: _____ Work: _____

Date of Procedure: _____ Physician: _____

Procedure: _____ Anesthesia: _____

1. **PAIN ASSESSMENT:** Rate your pain: ☐ 0 ☐ 1-3 ☐ 4-5 ☐ 6-8 ☐ 9-10
   List Pain Medications: _____
   Frequency: _____ Results: _____
   Reinforce Teaching: _____

2. **FLUID INTAKE AND ELIMINATION:**
   Tolerate PO intake: ☐ Yes ☐ No Voiding: ☐ Yes ☐ No BM: ☐ Yes ☐ No Nausea: ☐ Yes ☐ No
   Reinforce Teaching: _____

3. **ACTIVITY:** Ambulating: ☐ Yes ☐ No If No, why? _____
   Reinforce Teaching: _____

4. **WOUND SITE:** Dressing: _____ Dry? ☐ Yes ☐ No
   Removed? ☐ Yes ☐ No Reinforce? ☐ Yes ☐ No Changed? ☐ Yes ☐ No
   Reinforce Teaching: _____

5. **IV SITE:** Red? ☐ Yes ☐ No Painful? ☐ Yes ☐ No
   Reinforce Teaching: _____

6. **COMMENTS:** _____

Problem identified: Physician notified ☐ Yes ☐ N/A

Physician: _____ Time: _____

Comments: _____

Do you have a follow-up appointment with your physician? ☐ Yes ☐ No ☐ Will Call

Date: _____ Time: _____ By: _____ RN spoke with: _____

IF UNABLE TO CONTACT PATIENT:

1. First Attempt: Date: _____ Time: _____ By: _____ RN
2. Second Attempt: Date: _____ Time: _____ By: _____ RN

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