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Multi-Institutional Quality Improvement Project to Minimize Opioid Prescribing in Children after Appendectomy Using NSQIP-Pediatric

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Abstract

BACKGROUND: There is wide variation in opioid prescribing after appendectomy in children and adolescents, with recent increases noted in opioid-related pediatric deaths from prescription and illicit opioids. The goal of this project was to minimize opioid prescribing at the

time of discharge for children undergoing appendectomy by using Quality Improvement (QI) methodology.

STUDY DESIGN: Children (18 years of age or less) who underwent appendectomy were evaluated from January to December 2019 using NSQIP-Pediatric at 10 children's hospitals within the Western Pediatric Surgery Research Consortium. Before project initiation, 5 hospitals did not routinely prescribe opioids after appendectomy (protocol). At the remaining 5 hospitals, prescribing was not standardized and varied by surgeon (no-protocol). A prospective multi-institutional QI project was used to minimize outpatient opioid prescriptions for children after appendectomy. The proportion of children at each hospital receiving an opioid prescription at discharge was compared for 6 months before and after the intervention using chi-square analysis.

RESULTS: Overall, 1,524 children who underwent appendectomy were evaluated from January to December 2019. After the QI intervention, overall opioid prescribing decreased from 18.2% to 4.0% ($p < 0.001$), with significant decreases in protocol hospitals (2.7% vs 0.8%, $p = 0.038$) and no-protocol hospitals (37.9% vs 8.8%, $p < 0.001$). The proportion of 30-day emergency room visits did not change after the QI intervention (8.9% vs 9.9%, $p = 0.54$) and mean postintervention pain management satisfaction scores were high.

CONCLUSION: Opioid prescribing can be minimized in children after appendectomy without increasing emergency room visits or decreasing patient satisfaction. Furthermore, NSQIP-Pediatric can be used as a platform for multi-institutional collaboration for successful implementation of QI projects. (*J Am Coll Surg* 2022;234:290–298.

Children and adolescents are a vulnerable population in the opioid epidemic, with recent increases noted in opioid-related pediatric deaths from prescription and illicit opioids.¹ Large variations in prescribing practices exist and overprescribing of opioids for children after operations continues, with more than half of prescribed opioid doses left unused.^{2,3} During the past several years, concepts of opioid stewardship have emerged that emphasize limited use of opioids only when needed.⁴

Appendectomy is the most common operation performed in hospitalized children,⁵ with the vast majority of children undergoing laparoscopic surgery. There is wide variation in opioid-prescribing patterns at the time of discharge for children undergoing appendectomy and opioid use after discharge is associated with an increased risk of emergency room (ER) visits.^{6,7} Retrospective and prospective cohort studies highlight adequate pain control and improved outcomes when eliminating outpatient opioid prescribing for children who undergo appendectomy.^{7,8} Recent studies of an opioid-sparing approach in adult surgical patients report less pain and similar satisfaction compared with patients receiving standard care.⁹ Finally, recently published guidelines identified laparoscopic appendectomy in children as an opportunity for an opioid-free recovery.¹⁰

To address the variation in opioid prescribing after appendectomy in children and adolescents, quality improvement (QI) methodology may offer a framework to improve processes of care and outcomes related to opioid prescribing. The American College of Surgeons (ACS) NSQIP-Pediatric collects clinical data for children undergoing surgery and compares outcomes across participating hospitals, including appendectomy-specific metrics.¹¹ The purpose of this project was to utilize the infrastructure within NSQIP-

Pediatric to implement a multi-institutional QI project aimed at minimizing opioid prescribing for children who undergo appendectomy.

METHODS

Setting and context

This multi-institutional QI project was conducted by the Western Pediatric Surgical Research Consortium (WPSRC) member hospitals, a collaborative of 10 children's hospitals in the western US. This consortium is committed to advancing the care of infants and children through evidence-based research and QI efforts. Collectively, WPSRC hospitals perform approximately 3,500 appendectomies per year. Case volume per hospital ranges from 60 to 900 cases per year and, before project initiation, 5 WPSRC hospitals did not routinely prescribe opioids after appendectomy (protocol) and at the remaining 5 hospitals, prescribing was not standardized and varied by surgeon (no-protocol).

Data for this study were obtained from NSQIP-Pediatric along with the collaboration of the associated Surgical Clinical Reviewers (SCRs) and Surgeon Champions from each member site. NSQIP-Pediatric is a unique but still underutilized quality improvement resource useful in the comparison of multi-institutional postoperative outcomes that can be targeted specifically for appendicitis.¹² It uses a consistent, random sampling algorithm for the selection of children less than 18 years old undergoing appendectomy and other operations at enrolled hospitals to minimize selection bias. For each patient, the full-time NSQIP-trained and audited SCR extracts data on more than 100 uniformly defined clinical variables from meticulous review of the electronic health record. Before conclusion of the data abstraction process for each patient, the SCR contacts the family directly (eg, phone call) with a scripted QI query within 90 days of the operation to capture 30-day outcomes that may not have been evident from medical records alone (eg surgical site infections, ER visits, and hospital readmissions). Sites enrolled in NSQIP-Pediatric are required to maintain a SCR follow-up rate greater than 80%. All abstracted data are uploaded into the NSQIP online portal by the SCR and used for analysis of outcomes. Nine of the 10 institutions in the WPSRC are members of NSQIP-Pediatric. For the 1 hospital not enrolled in NSQIP-Pediatric, patients were identified through random sampling of children who underwent appendectomy during the same time period.

Intervention

Baseline rates of opioid prescribing at discharge and 30-day ER visits from January 1, 2019 through June 30, 2019, were obtained through retrospective review of the electronic health record and NSQIP-Pediatric. The opioid prescribing intervention began July 1, 2019, and continued through December 31, 2019. Before the start date of the intervention period, WPSRC member surgeons educated other surgical faculty and advanced practice providers at each hospital on the importance of minimizing or eliminating opioid prescribing at the time of discharge after appendectomy. At discharge, each hospital provided patients with a standardized information sheet on the use of acetaminophen and ibuprofen for pain relief including a sample dosing schedule (Fig. 1). Discharge instructions were reviewed by a parent representative before distribution to ensure the usability and ease of understanding.

Instructions were also translated into Spanish, because many centers within the WPSRC serve a predominantly Spanish-speaking population. Instructions were incorporated into postappendectomy discharge workflows within each member hospital's electronic health record. If a family did not speak English or Spanish, they received instructions in English and an interpreter reviewed the instructions with the family at discharge. After each postintervention Plan-Do-Study-Act cycle, providers at hospitals with higher opioid-prescribing rates received educational reinforcement in faculty-led lectures that included reports of each institution's overall opioid prescribing alongside other consortium hospitals.

Study of the intervention

The NSQIP-Pediatrics online portal interface allows for customizable field input. For this project, new uniform variables specific to discharge opioid prescribing were created (Supplemental Digital Content 1, available at <http://links.lww.com/XCS/A37>). Participating WPSRC members, Surgeon Champions, and SCRs at each hospital received a data dictionary defining the new variables and a manual describing the steps required for variable creation. SCRs at each site created uniform fields within the NSQIP-Pediatrics portal to capture whether a child was sent home with an opioid prescription (Y/N) and whether they were evaluated in the ER within the 30 days after surgery (Y/N). Beyond the normally scripted follow-up query, SCRs also asked families the following parent satisfaction question: "On a scale of 1 to 5: 1 = 'not satisfied at all,' 5 = 'extremely satisfied,' how satisfied were you with your child's pain management after returning home from hospital?" Other means of healthcare utilization such as outpatient ambulatory visits or phone calls with a chief complaint of postoperative pain were included in the SCR review of the medical records and/or patient phone call to obtain satisfaction scores. Patient data were deidentified locally at each site and rates of opioid prescribing, ER visits, and mean patient satisfaction scores were calculated. Site-specific reports were provided to each member institution at 3-month intervals for a total of 2 Plan-Do-Study-Act cycles.

Measures

The primary outcome measure was the overall percentage of children who received an opioid prescription at the time of discharge. As balancing measures, other metrics were captured alongside the primary outcome to identify unintended consequences of the intervention including 30-day ER visits and parent satisfaction regarding pain management (eTable 1). All ER visits were included, regardless of chief complaint. Parent satisfaction was measured during the postimplementation period only, using a Likert scale where 1 = "not satisfied at all," 5 = "extremely satisfied." Because NSQIP-Pediatric does not routinely capture baseline patient satisfaction scores, there was no comparison group for this balancing measure during the preintervention period. All clinical variables and demographics including race, ethnicity, and insurance status were defined according to the NSQIP-Pediatric Dictionary.¹³ Complicated appendicitis was defined according to NSQIP-Pediatric as any child with an operative report documenting a visible hole in the appendix, a fecalith in the peritoneal cavity outside the appendix, an abscess, and/or diffuse fibrinopurulent exudate in the peritoneal cavity.

Analysis

The proportion of children at each hospital receiving an opioid prescription at discharge was compared for 6 months before (preintervention) and after (postintervention) QI project initiation using chi-square analysis. Patient demographics were compared using bivariate analyses. Categorical variables were reported as frequencies and percentages and analyzed by chi-square or Fisher's exact test where appropriate. Continuous variables were reported as means and standard deviations and analyzed by 2-sample *t*-test or Wilcoxon rank-sum test for nonparametric data. All statistical analyses were conducted with 2-sided significance, $\alpha = 0.05$. Data were analyzed by using SAS software 9.4 (SAS Institute, Inc, Cary, NC).

Ethics

As part of patient QI project using deidentified data, this project did not require Institutional Review Board review according to hospital policy at WPSRC member hospitals. Revised Standards for Quality Improvement Reporting Excellence (SQIRE 2.0) was used to report findings.¹⁴

RESULTS

Overall, 1,524 children who underwent appendectomy were evaluated from January to December 2019. The majority of the cohort was male ($n = 891$, 58.5%), White ($n = 977$, 64.1%), non-Hispanic ethnicity ($n = 789$, 51.8%) with public insurance ($n = 764$, 50.1%; Table 1). Complicated appendicitis was present in 30.4% of the cohort. The preintervention and postintervention groups did not differ significantly by demographics or rates of complicated appendicitis. Children with complicated appendicitis demonstrated a significantly longer median length of stay compared to children with uncomplicated appendicitis (4 days [interquartile range: 3–7] vs 1 day [interquartile range: 1–2], $p < 0.001$).

Figure 2 outlines a run chart tracking the overall percentage of children discharged with an opioid prescription from each hospital for 2019. After the QI intervention, the overall mean proportion of children discharged with an opioid prescription after appendectomy decreased from 18.2% to 4.0% ($p < 0.001$), with significant decreases in protocol hospitals (2.7% vs 0.8%, $p = 0.038$) and no-protocol hospitals (37.9% vs 8.8%, $p < 0.001$; Table 2). Trends for a significant reduction in opioid prescription postintervention were similarly significant when stratified by complicated (8.3% vs 2.2%, $p = 0.003$) and uncomplicated (22.8% vs 4.8%, $p < 0.001$) appendicitis. Mean opioid prescription rates from July to September and October to December 2019 were 4.8% (± 15.5) and 4.4% (± 7.1), respectively. Of note, hospital I cares for a low volume of children with appendicitis. Although the percent of children receiving an opioid prescription increased from July to September ($n = 0/15$, 0%) to October to December ($n = 3/16$, 16%), the change was not statistically significant ($p = 0.226$). The overall proportion of ER visits within 30 days of discharge did not change after the QI intervention (8.9% vs 9.9%, $p = 0.54$). However, a significant increase in 30-day ER visits was observed among complicated appendicitis cases at protocol hospitals (9.8% vs 19.3, $p = 0.034$; Table 3), but there was no increase noted for children with uncomplicated appendicitis in protocol or no-protocol hospitals (Table 4). Mean pain

management satisfaction scores remained high (4.7 ± 0.6 of 5) and did not differ between protocol hospitals and no-protocol hospitals ($p = 0.698$).

There were no missing data for the primary outcome, specifically the prescription of opioids at discharge. Thirty-day ER visit data were missing for 4.9% of the cohort. Parent-reported satisfaction with pain management was missing for 21.6% of the postintervention group.

DISCUSSION

The findings of our multi-institutional QI project demonstrated a significant decrease in the overall percent of children who received an opioid prescription at discharge. Using the NSQIP-Pediatrics platform, we demonstrated that this intervention did not increase 30-day ER visits or result in poor parent satisfaction with pain control. Both protocol and no-protocol hospitals demonstrated a significant decrease in opioid prescribing at discharge. This is the first report using NSQIP-Pediatric for multi-institutional collaboration to expand opioid stewardship efforts for children undergoing appendectomy.

At project inception, the majority of WPSRC members reported that opioids were not routinely prescribed at discharge after an appendectomy. However, after reviewing discharge protocols, we found that half of the hospitals prescribed opioids for some of their patients. In addition, significant decreases in opioid prescriptions were also observed in hospitals that had protocols to minimize opioids at discharge, indicating that nonuniformity of opioid prescribing can occur even with a protocol in place. This observation is consistent with a recent survey of the American Pediatric Surgery Association membership in which more than 40% of surgeons stated they would send a child home with a prescription for opioids after laparoscopic appendectomy for uncomplicated appendicitis.¹⁵ A study by Cairo and colleagues¹⁶ similarly demonstrated variability within individual institutions when prescribing opioids for children after appendectomy. This suggests nonuniformity of discharge pathways within the same institution and the lack of practice awareness between surgeons and prescribers. Recently, the ACS Children's Surgery Verification program outlined specific requirements for the establishment of an Opioid Stewardship Program at Level I and II ACS Children's Surgery Verification-verified surgery centers to go into effect in 2021.¹⁷ Our findings support this national QI initiative to standardize pain management protocols for children who undergo surgery.

Many providers still prescribe opioids after appendectomy for concern of postoperative ER returns for adequate pain control, despite recent reports with higher rates of 30-day ER visits for children receiving opioids.⁷ Efforts to minimize opioid prescribing after surgery may be counter-balanced by provider- and/or hospital-driven pressures to maintain optimal patient satisfaction.^{18,19} In the present study, 30-day ER visits remained unchanged after project initiation, and parent satisfaction was high. The present study is particularly novel in its measurement of parent-reported satisfaction because most studies aimed at expanding opioid stewardship limit surrogates of pain control to unscheduled ER visits or hospital readmissions. In an effort to deliver family-centered care, parent-reported satisfaction should be considered when developing holistic pain management regimens that engage families during postoperative recovery. Although NSQIP-Pediatrics does not capture

parent satisfaction with pain control for comparison, our findings clearly demonstrate that outcomes and pain control are not compromised by an opioid-free recovery provided at discharge.

Notably, there was a significant increase in 30-day ER visits for children with complicated appendicitis discharged from a protocol hospital after the intervention, even though there was no change in the number of children receiving an opioid prescription. Although the present study tracked 30-day ER visits as a balancing measure, an increase in ER visits for children discharged after hospitalization for perforated appendicitis could be secondary to institution-level changes not related to opioid prescribing. For example, a change in antibiotic prescribing or loss of outpatient support staff to triage nonurgent parent phone calls may explain a sudden increase in ER utilization. Thus, healthcare providers using 30-day ER visits as a balancing measure must be cognizant of other institution-wide changes temporally occurring alongside any change in opioid-prescribing practices.

In the present project, children with complicated appendicitis demonstrated relatively lower rates of opioid prescriptions both preintervention and postintervention at both types of hospitals. We also observed a longer length of stay for children with complicated appendicitis, as would be anticipated because of the need for prolonged antibiotics, resolution of fevers, and return of bowel function typically required before discharge. Children recovering from complicated appendicitis may demonstrate functional recovery without opioids before discharge, which may explain the lower rates of opioid prescribing in this subgroup. These findings are encouraging, because they may indicate that healthcare providers could alter their prescribing practices on the basis of observed clinical recovery. Future interventions aimed at minimizing excess opioid prescribing may benefit from incorporating real-time patient-reported pain metrics for patients with shorter hospitalizations.

Multi-institutional collaboration through the WPSRC and establishment of a QI project using infrastructure within the national network of NSQIP-Pediatric were critical to this project. WPSRC members, surgeon champions, and experienced SCRs at each site worked collaboratively to rapidly establish variable creation and informally mentor other SCRs. Consequently, SCRs participated in more than simple data entry to implement the project and troubleshoot with SCRs at other institutions. Engagement was advanced by limiting the number of new opioid-specific variables to optimize workflows and by adhering to a project end date so as not to overburden individual SCRs. Similar efforts to minimize opioid prescribing seen in other adult surgical multi-institutional collaboratives²⁰ highlight the need for an integrated data network, targeted data capture, clinical research personnel, and provider engagement to create sustained, measurable changes to optimize opioid prescribing. Successful implementation of future opioid stewardship efforts outside a collaborative network will require buy-in from hospital leadership, professional societies, and health policy initiatives.

The present project is limited by the nonuniform nature inherent in QI methodology. Local hospital efforts to minimize opioid prescribing likely varied site by site and we are unable to determine whether the lower opioid-prescribing rates were sustained in the year following

project initiation. The present project also had a higher rate of missing data for pain satisfaction. This balancing measure may not be missing at random, and we may have overestimated parent satisfaction with pain control. However, with 80% of families reached after surgery, this rate is within the targeted 30-day follow-up measures for NSQIP. Also, parent-reported satisfaction with pain management was collected as far out as 90 days from surgery which does introduce recall bias into our results. Similarly, pediatric patients did not report their own satisfaction with pain management after surgery, which may diverge from parental perceptions. In addition, more granular metrics of opioid use after surgery such as prescription refill rates and actual amount of opioid medication used were not captured. Incorporation of opioid-specific variables into the NSQIP-Pediatric platform as a nationwide pilot or as a standard metric would further understanding of national trends in opioid prescribing. Moreover, a similar project targeting a pediatric surgery procedure that is associated with significant pain, such as pectus excavatum repair,²¹ may require more customized patient education, prescribing, and procedure-specific follow-up. Finally, the reduction in opioid prescribing observed in this project may have been aided by an overall national decrease in opioid prescribing,²² but the rapidity of reduction was more likely due to project implementation because more than 40% of pediatric surgeons routinely prescribe opioids after laparoscopic appendectomy.¹⁵

CONCLUSION

The findings of this multi-institutional QI project indicate that minimizing or eliminating opioid prescribing at the time of discharge for children undergoing appendectomy is possible without compromising clinical care or resulting in poor parent satisfaction. The ACS NSQIP-Pediatric platform can be utilized to successfully implement multi-institutional QI initiatives. Future efforts to optimize opioid prescribing should emphasize stakeholder engagement and harness information technology infrastructure to facilitate evidence-based pain management strategies for children who receive surgery.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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DISCHARGE INSTRUCTIONS FOR PAIN MANAGEMENT

Your child underwent a laparoscopic appendectomy. It is normal for your child to feel some pain and discomfort as they have just had surgery. Pain is part of the body's healing process. Most children only need Ibuprofen (Motrin, Advil) or Acetaminophen (Tylenol) to help manage their pain for the first 1-2 days after they leave the hospital.

Both Ibuprofen and Acetaminophen are given to your child every 6 hours only if they are in pain.

If your child is in moderate to severe pain, it is OK to allow your child to alternate between taking Ibuprofen and Acetaminophen every 3 hours around the clock for relief.

Example:

- 6am take Ibuprofen
- 9am take Acetaminophen
- 12pm take Ibuprofen
- 3pm take Acetaminophen

Be sure to read the dosing on the bottle carefully and adjust the amount of pain medication that you give to your child based on their weight.

If your child continues to have pain for several hours that is not controlled by the above measures, please call the surgeon on-call at XXXXX Children's Hospital at XXX-XXX-XXXX.

Figure 1.

Standard discharge instructions for pain management.

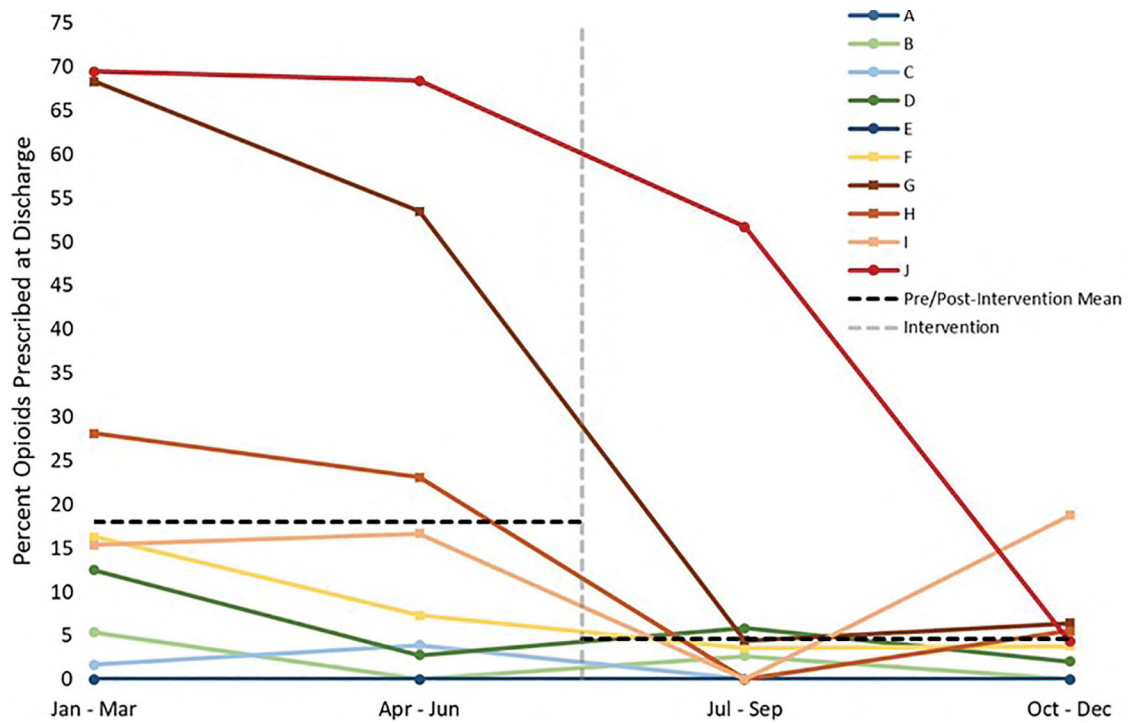


Figure 2. Run chart: percent of children receiving opioids at discharge by hospital (A–J) before and after the quality improvement intervention. No-Protocol Hospitals are highlighted in red/orange/yellow, Protocol Hospitals are highlighted in blue/green.

Table 1.

Cohort Demographics

Variable	Total, N = 1,524	Preintervention, n = 730	Postintervention, n = 794	p Value
Male sex, n (%)	891 (58.5)	435 (59.6)	456 (57.4)	0.393
Race, n (%)				0.694
American Indian or Alaska Native	16 (1.1)	9 (1.2)	7 (0.9)	
Asian	57 (3.7)	25 (3.4)	32 (4.0)	
Black or African American	27 (1.8)	11 (1.5)	16 (2.0)	
Multiracial	2 (0.1)	1 (0.1)	1 (0.1)	
Native Hawaiian or Pacific Islander	6 (0.4)	4 (0.6)	2 (0.3)	
Unknown	439 (28.8)	219 (30.0)	220 (27.7)	
White	977 (64.1)	461 (63.2)	516 (65.0)	
Hispanic ethnicity, n (%)				0.113
Yes	670 (44.0)	340 (46.6)	330 (41.6)	
No	789 (51.8)	363 (49.7)	426 (53.7)	
Unknown	65 (4.3)	27 (3.7)	38 (4.8)	
Insurance, n (%)				
Private	720 (47.2)	333 (45.6)	387 (48.7)	0.222
Public	764 (50.1)	366 (50.1)	398 (50.1)	0.997
Self-pay	14 (0.9)	8 (1.1)	6 (0.8)	0.487
Other	106 (7.0)	64 (8.8)	42 (5.3)	0.008
Complicated appendicitis, n (%)	463 (30.4)	230 (31.5)	233 (29.4)	0.359
Age at surgery, y, mean ± SD	10.6 (3.7)	10.4 (3.8)	10.7 (3.6)	0.044

Table 2.

Overall Rate of Opioid Prescribing at Discharge and Balancing Measures

Variable	Overall					
	Complicated appendicitis n = 463 (30.4%)		Uncomplicated appendicitis n = 1061 (69.6%)			
	Preintervention, n = 230 (%)	Postintervention, n = 233 (%)	p Value	Preintervention, n = 500 (%)	Postintervention, n = 561 (%)	p Value
Discharged with opioid prescription, n (%)	19 (8.3)	5 (2.2)	0.003	114 (22.8)	27 (4.8)	<0.001
30-day ER visit, n (%)	23 (10.1)	35 (15.8)	0.0694	41 (8.4)	37 (7.3)	0.5181
Parent satisfaction score, mean ± SD	–	4.7±0.7	–	–	4.8±0.6	–

ER, emergency room.

Table 3. Rate of Opioid Prescribing at Discharge and Balancing Measures for Complicated Appendicitis

Variable	Complicated appendicitis N = 463 (30.4%)				p Value
	Protocol hospital	Postintervention, n = 122	Preintervention, n = 145	No-protocol hospital	
Discharged with opioid prescription, n (%)	1 (0.8)	1 (0.7)	18 (16.7)	4 (4.6)	0.011
30-day ER visit, n (%)	12 (9.8)	26 (19.3)	11 (10.4)	9 (10.5)	0.984
Parent satisfaction score, mean ± SD	—	4.8±0.6	—	4.6 ±0.9	—

ER, emergency room.

Table 4. Rate of Opioid Prescribing at Discharge and Balancing Measures for Uncomplicated Appendicitis

Variable	Uncomplicated appendicitis N = 1061 (69.6%)					
	Protocol hospitals			No-protocol hospitals		
	Preintervention, n = 286	Postintervention, n = 330	p Value	Pre-intervention, n = 214	Post-intervention, n = 231	p Value
Discharged with opioid prescription, n (%)	10 (3.5)	3 (0.9)	0.045	104 (48.6)	24 (10.4)	<0.001
30-day ER visit, n (%)	25 (8.7)	18 (6.4)	0.294	16 (7.8)	19 (8.3)	0.851
Mean parent satisfaction score, mean ± SD	–	4.8±0.5	–	–	4.7 ±0.7	–

ER, emergency room.