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Trends in perioperative opioid and non-opioid utilization during ambulatory surgery in children

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ABSTRACT

Background: In the midst of our national opioid crisis, recommendations have encouraged judicious stewardship of opioid prescription through the expanded use of non-opioid analgesic medications. This study aims to characterize trends in perioperative pain medication use for children undergoing ambulatory operations.

Methods: A cross-sectional, retrospective review was conducted using the Pediatric Health Information System. Patients younger than 18 years of age who underwent ambulatory surgery during 2010 to 2017 by one of five surgical subspecialties (otolaryngology, general pediatric, plastic or reconstructive, orthopedics, and urology) were included. Medications were identified using Current Procedural Terminology codes based on billing information for 18 commonly used analgesics along with the route of administration during their encounter.

Results: A total of 1,795,329 patients with a median age of 10 years were identified, of whom 84.3% received an opioid or non-opioid analgesic. Opioid use in the perioperative setting for ambulatory procedures decreased during the study period from 74.9% to 66.9% as a proportion of total analgesic prescriptions. Among opioids commonly used, intravenous morphine decreased the most from 19.8% to 15.4%, and intravenous hydromorphone and oral oxycodone use remained largely unchanged. Conversely, non-opiate medications increased, specifically intravenous ketorolac from 8.4% to 13.6%, and intravenous acetaminophen use increased from 0% to 8.5%. Intravenous acetaminophen use more than doubled between 2013 and 2017 (3.4% to 8.2%) and was accompanied by a decrease in oral acetaminophen use (14.4% to 9.3%).

Conclusion: Overall, perioperative opioid utilization appears to be decreasing in favor of non-opioid analgesics. Other trends, such as increased intravenous acetaminophen, raise concerns for the cost effectiveness of perioperative analgesia and resource utilization.

Introduction

Ambulatory operations constitute a large proportion of pediatric surgical practice. According to the National Center for Health Statistics of the Centers for Disease Control and Prevention, approximately 48.3 million ambulatory operations were performed across all ages in 2010.[1] Operative techniques and perioperative management, including multimodal analgesic regimens, have contributed to the increase in types of operations being offered as outpatient procedures.[2]

Management of pain is a critical component necessary for same-day discharge. Several studies report that approximately 44% to 93% of pediatric patients experience pain in the immediate postoperative period.[3–5] Therefore, historically, opioids have been the mainstay modality used to treat postoperative pain.[3,6–10] With the desire to avoid potential adverse events from opioid medications, such widespread use has come under more strict scrutiny. This study aims to characterize the trends of opioid and non-opioid utilization in the perioperative period for ambulatory operations in pediatric patients for the years 2010–2017.

Methods

The Pediatric Health Information System (PHIS) database comprises administrative billing data from 49 tertiary children's

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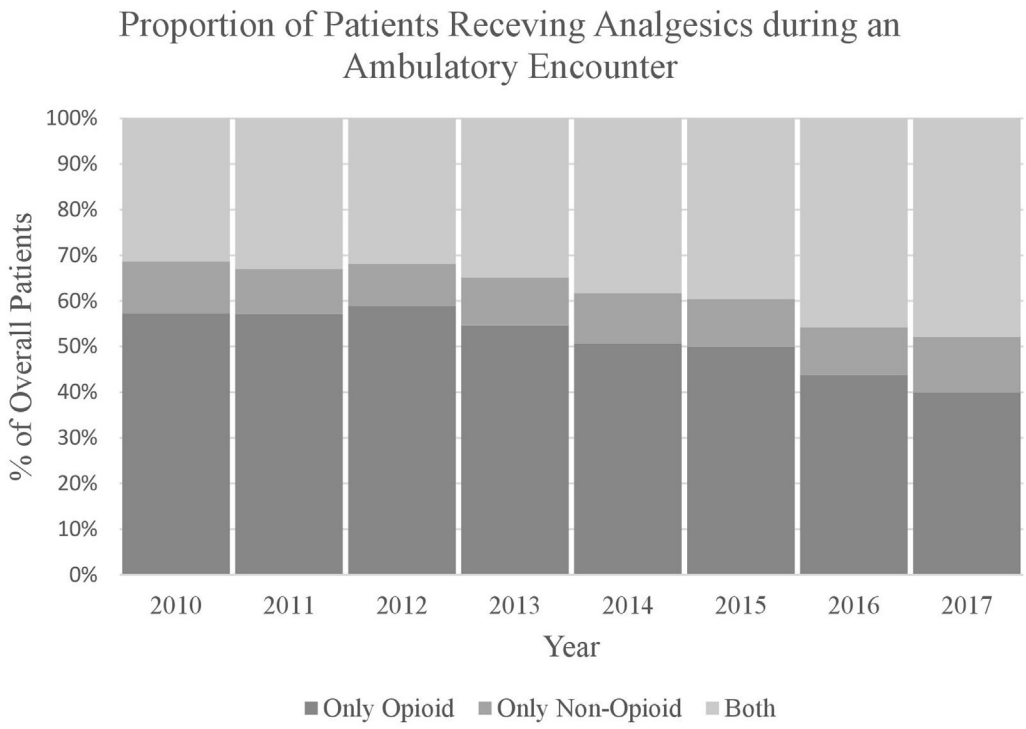

Fig 1. The proportion of patients who had received only an opioid, non-opioid, or both during ambulatory encounter across all departments.

hospitals. The PHIS is believed to capture approximately 20% of all pediatric hospitalizations in the United States.[11]

Inclusion and exclusion criteria

Patients receiving an ambulatory or same-day discharge operation from any of the 49 tertiary children's hospitals were analyzed. All patient encounters with children <18 years of age from January 1, 2010, through December 31, 2017, were included. Ambulatory operations were identified through the use of the patient-type objects variable. Patients with a duration of stay >1 day were excluded from the analysis in an attempt to isolate ambulatory cases. All analgesic medications prescribed during each encounter were identified (preoperatively, intraoperatively, and postoperatively) via drug codes of the Current Procedural Terminology (Supplementary Material 1). The five subspecialties of interest were otolaryngology, general pediatric, plastic or reconstructive, orthopedics, and urology.

Statistical analysis

A descriptive statistical analysis was performed on patient demographic and medication data. All data analysis was conducted in Microsoft Excel (Microsoft Corp, Redmond, WA) and Python 3.0 (Python Software Foundation, Wilmington, DE). In addition, all medications were included as explanatory variables in a linear regression analysis with time as the independent variable. This study was approved by the institutional review board and human subject's research committee of the Ann and Robert H. Lurie Children's Hospital of Chicago.

Results

During 2010 to 2017, a total of 1,795,329 patients were identified as undergoing ambulatory operations across 5 surgical specialties. Of those patients, 84% (n = 1,519,658) received an opioid or non-opioid analgesic. Patients had a median age of 10 years and were 62% male.

The majority of patients were Caucasian (66%), followed by African American (14%) and Asian (2%). Public or private insurance payers processed 53% and 43% of claims, respectively. Otolaryngology accounted for 50% of the ambulatory operations. Pediatric general surgery, urology, and orthopedic services represented similar proportions of cases within this sample of data (15%, 16%, and 13%, respectively). Plastic surgery represented 6% of the patient population (Table I).

During the study period, opioid use in the perioperative setting for ambulatory procedures decreased from 74.7% to 66.8% as a proportion of total in hospital prescriptions (Figs 1 and 2). The percentage of patients who received only an opioid decreased significantly during the study period from 57% to 40%. The proportion of patients who received a multimodal regimen, including a non-opioid and an opioid medication, increased from 31% to 48%. Patients receiving only non-opioid analgesia remained largely unchanged.

Thirteen analgesic medications were excluded (alfentanil, aspirin, butorphanol, gabapentin, hydromorphone, ketamine, methadone, nalbuphine, naproxen, remifentanil, sufentanil, tramadol, buprenorphine) because they are prescribed infrequently (<1,000/year). For the remaining 15 queried analgesics (Table II), 4 had a significant increase and 4 trended downward. Among the most commonly prescribed opioids, morphine decreased the most from 19.8% to 15.5% (P < .001; Fig 2). Notably, oxycodone prescriptions demonstrated the most recent downward trend. For example, between 2010 and 2015, the use of oxycodone remained fairly stable from 3.3% to 4.3%; however, from 2015 to 2017, the use of oxycodone decreased somewhat to 2.8%. Other opioids, such as intravenous (IV) hydromorphone and IV fentanyl, increased from 1.9% to 3.8% and 28.5% to 32.5%, respectively. An increase in non-opioid prescriptions also was observed (Fig 2). IV ketorolac use increased from 8.3% to 13.6%, and IV acetaminophen use increased

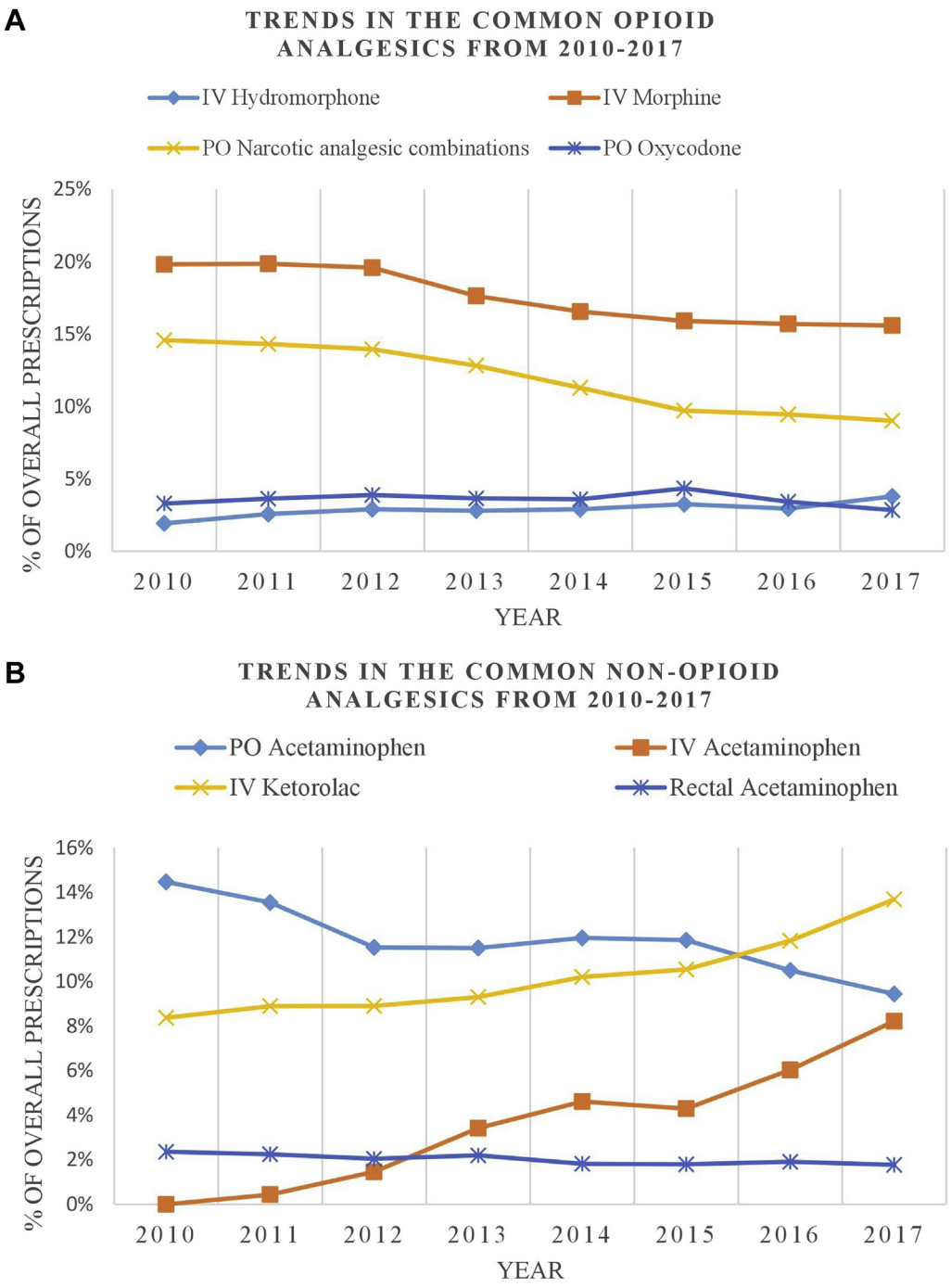

Fig 2. (*A*) Trends over time for common opioid medications in the pediatric ambulatory surgery setting. (*B*) Trends over time for common, non-opioid analgesic medications in the pediatric ambulatory surgery setting.

from 0% to 8.2%. Most notably, IV acetaminophen administration more than doubled between 2013 and 2017, and a decrease in oral acetaminophen use was observed (14.5% to 9.4%; Table II).

Trends were similar when stratified across surgical specialties. For example, morphine had the greatest decrease among opioid analgesics, which was most notable for orthopedics (22.2% to 12.7%). The trend demonstrating increased use of ketorolac and IV acetaminophen also remained present when stratified by surgical specialty. Trends were consistent when stratified by region of the United States (Northeast, South, Midwest, and West).

Discussion

Non-opioid pain medication use in the perioperative setting of ambulatory surgery care became somewhat more popular as adverse effects of opioid analgesics have come under increasing public scrutiny. Studies have reviewed outpatient prescriptions and have found similar recent decreases in opioid utilization.[12,13] Our study contributes to the emerging body of evidence demonstrating current trends in opioid and non-opioid use in the perioperative setting for pediatric ambulatory surgical procedures. Our study

Table I
Patient demographics and volume of surgical specialties 2010 to 2017 ($N = 1,519,658$)

Patient characteristics	Patients (n)	Percent
Sex		
Male	940,037	61.9
Female	579,621	38.1
Ethnicity		
Non-Hispanic	971,221	64
Hispanic/Latino	221,642	15
Unknown	326,795	21
AAP age classification*		
Infants and neonates (≤1 year)	164,934	11
Early childhood (>1 and ≤5 years)	576,776	38
Late childhood (≥6 and ≤12 years)	557,248	37
Adolescence (≥13 and ≤17 years)	220,700	14
Race		
White	1,009,220	66
African American	207,732	14
Asian	34,415	2
Pacific Islander	2,368	<1
American Indian	4,275	<1
Multiple	14,122	<1
Other/unknown	247,517	17
Insurance		
Public	807,488	53
Private	656,971	43
Other/unknown	48,406	4
Surgical service	**Operations (n)**	**Percent**
Otolaryngology	763,413	50
Pediatric general surgery	230,422	15
Plastic reconstructive	84,557	6
Urology	247,565	16
Orthopedic	197,411	13

* American Academy of Pediatrics (AAP).

Table II
The overall number of perscriptions ($N = 3,138,752$) for each of the common analgesics*

Common analgesics	N	Correlation	P value
Overall			
Opioid	2,277,107	−0.92	.39
Nonopioid	861,645	0.92	.39
Opioids			
Fentanyl—parenteral	959,310	0.92	< .001
Hydromorphone—parenteral	89,727	0.88	< .001
Morphine—parenteral	554,631	−0.95	< .001
Narcotic combination—oral	377,678	−0.97	< .001
Oxycodone—oral	113,605	−0.20	.642
Nonopioid			
Acetaminophen—oral	375,602	−0.90	< .001
Acetaminophen—parenteral	105,174	0.98	< .001
Acetaminophen—rectal	63,701	−0.88	.003
Ketorolac—parenteral	315,567	0.94	< .001

* Linear corelation or pearson correlation coefficent and P value are displayed.

demonstrates a change in trends of opioid and non-opioid pain management during an ambulatory surgery encounter.

We observed that overall opioid use trended downward. In that context, IV morphine and oral narcotic combinations had the greatest proportional decrease, and the use of more short-acting opioids, such as IV fentanyl and hydromorphone, increased. The overall decrease in the use of opioid medication we observed follows trends noted in several publications studying practice trends in the emergency department and beyond.[14,15] We expect this trend to continue in part because of the restrictive regulations enacted by the US Drug Enforcement Agency as a means to decrease opioid production for 2018 by 20%.[16] In addition, the American Society of Health-System Pharmacists reports shortages in opioids, which may play role in the current trends.[17] As a result, we believe anesthesia and surgical providers and their patients would benefit from a multimodal analgesia strategy to treat postoperative pain.

Notable in these results was the identification that oral acetaminophen decreased in favor of IV acetaminophen. Since approval in 2010, IV acetaminophen has become the most prescribed non-opioid analgesic; however, the efficacy of IV acetaminophen remains under study. Industry-funded studies tout the opioid-sparing effect of IV acetaminophen.[18–20] In contrast, other studies demonstrate no clinical difference or advantage when comparing IV acetaminophen with oral or rectal acetaminophen in pediatric postoperative patients.[21–24] IV acetaminophen costs considerably more than oral or rectal dosing, which raises concerns about the cost effectiveness of increased IV acetaminophen utilization of IV acetaminophen.

The opioid epidemic affects primarily adults but also has an increasing impact on children and adolescents. Between 1999 and 2016, the proportion of children and adolescents who died from prescription and illicit opioid prescribing increased nearly threefold. Overdose death rates mostly affect adolescents aged 15 to 19 years, but increases are also visible among younger children.[25] In addition, pediatric hospitalizations related to opioid poisonings and opioid-related admissions to critical care units are increasing.[26] Beyond implication for pediatric patients, unused opioid prescriptions are often stored in the home and provide an opportunity for diversion and abuse by family or friends.[27]

Our analysis has several limitations. First, this was a retrospective analysis that can be subject to selection bias. Second, findings are based on only the 49 participating children's hospitals, therefore limiting generalizability. Any study using claims data relies heavily on accurate coding for fidelity. Large databases, such as PHIS, lack the granularity to evaluate more detailed outcomes of interest. For example, we were unable to examine doses administered. This limitation is important when calculating milligram morphine equivalents for comparisons of opioid administration. Another important limitation to note is the inability to capture whether pain was adequately controlled from these analgesic regimens. Last, there is no definitive way to determine whether the drugs were administrated preoperatively, intraoperatively, or postoperatively, and therefore all findings have been described as perioperative. This is especially important when considering IV administration.

In conclusion, in the ambulatory pediatric perioperative setting, overall opioid utilization appears to be decreasing somewhat in favor of non-opioid analgesics. In part, this trend, although somewhat small, may be attributed to the increasing use of IV acetaminophen and ketorolac. The increase in IV acetaminophen utilization raises issues related to cost effectiveness and efficacy.

Conflict of interest

The authors have indicated that they have no conflict of interest regarding the content of this article.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at https://doi.org/10.1016/j.surg.2019.04.005.

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