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Provider education decreases opioid prescribing after pediatric umbilical hernia repair☆

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ABSTRACT

Purpose: To improve opioid stewardship for umbilical hernia repair in children.
Methods: An educational intervention was conducted at 9 centers with 79 surgeons. The intervention highlighted the importance of opioid stewardship, demonstrated practice variation, provided prescribing guidelines, encouraged non-opioid analgesics, and encouraged limiting doses/strength if opioids were prescribed. Three to six months of pre-intervention and 3 months of post-intervention prescribing practices for umbilical hernia repair were compared.
Results: A total of 343 patients were identified in the pre-intervention cohort and 346 in the post-intervention cohort. The percent of patients receiving opioids at discharge decreased from 75.8% pre-intervention to 44.6% ($p < 0.001$) post-intervention. After adjusting for age, sex, umbilicoplasty, and hospital site, the odds ratio for opioid prescribing in the post- versus the pre-intervention period was 0.27 (95% CI = 0.18–0.39, $p < 0.001$). Among patients receiving opioids, the number of doses prescribed decreased after the intervention (adjusted mean 14.3 to 10.4, $p < 0.001$). However, the morphine equivalents/kg/dose did not significantly decrease (adjusted mean 0.14 to 0.13, $p = 0.20$). There were no differences in returns to emergency departments or hospital readmissions between the pre- and post-intervention cohorts.
Conclusions: Opioid stewardship can be improved after pediatric umbilical hernia repair using a low-fidelity educational intervention.
Type of Study: Retrospective cohort study.
Level of Evidence: Level II.

The opioid crisis is considered a nationwide public health emergency [1]. In 2016, 11.5 million people misused prescription opioids and 42,000 people died from overdosing on opioids [2]. In the past ten years, legal prescription opioid sales and opioid overdose deaths have both quadrupled [3]. According to the Centers for Disease Control and Prevention, more than 1,000 people are treated in emergency departments each day for misuse of legally prescribed opioids [4]. Furthermore, 116 people die every day due to opioid overdoses or poisonings [2], surpassing motor vehicle accidents as the leading cause of accidental death in the United States [5]. Due to increases in opioid prescriptions, approximately 40% of all overdose deaths are attributed to a prescription opioid [2].

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Recent evidence suggests that the opioid crisis is not only affecting adults, but also children, with the number of pediatric hospitalizations for opioid poisonings and overdoses growing markedly [6,7]. The number of pediatric opioid hospitalizations requiring intensive care unit admission nearly doubled during the past decade, increasing from 797 in 2004 to 1,504 in 2015 [7]. Hospitalization rates were highest in older adolescents, but the greatest increase in hospitalizations over time occurred among children less than 5 years [6,7]. Based on this new evidence, additional efforts are needed to reduce opioid exposure in children.

Surgeons have a unique opportunity to mitigate the opioid crisis because of their ability to limit a patient's initial exposure to opioids. Many opioid abusers obtain their first prescription from a surgeon [8], and one study showed that 30.4% of adults on long-term opioid therapy at a pain clinic received their first opioid prescription from a surgeon [9]. Also, nearly 5% of previously opioid naïve pediatric patients will have persistent opioid use after a commonly performed surgical procedure [10]. Currently, wide variation exists in opioid prescribing practices for pediatric surgery [10,11]. Among a national sample of pediatric patients undergoing umbilical hernia repair, approximately 52% filled postoperative opioid prescriptions. Some of the prescriptions were for prolonged courses, including 50% with a duration ≤3 days (50%), 46% 4–10 days, and 4% > 10 days [12]. Unused prescription opioids are often not properly discarded and thus available for diversion and misuse.

Implementing prescribing guidelines is one promising strategy to reduce opioid overprescribing among surgeons. Two recent studies developed procedure-specific prescribing guidelines and disseminated this information to adult providers at their institutions [13,14]. In both instances, there were substantial declines in the number of pills prescribed at discharge and no increases in refill requests. We hypothesized that a similar low-fidelity intervention for pediatric surgeons performing umbilical hernia repair would result in decreased opioid prescribing.

1. Material and methods

1.1. Educational intervention

To reduce opioid overprescribing and prescribing variability for umbilical hernia repair, an opioid educational intervention, targeting pediatric surgeons, was conducted at 9 children's centers across the United States, representing 79 surgeons. The intervention was comprised of 4 educational components: (1) emphasizing the importance of opioid stewardship, (2) presenting data on surgeon-specific prescribing frequency and dosing, highlighting practice variation, (3) presenting evidence-based, procedure specific prescribing guidelines, and (4) encouraging non-opioid analgesics. In terms of prescribing guidelines, surgeons were encouraged to prescribe non-opioid analgesics such as ibuprofen and acetaminophen. If opioids were needed, surgeons were encouraged to use fewer doses and decrease the strength of doses. The intervention was delivered via Microsoft PowerPoint presentations at all participating children's centers between January and August 2018. Surgeons participating in the study were identified through the Pediatric Surgical Research Collaborative (PedSRC, www.pedsrc.org) and served as liaisons to his/her home institution to present the study/intervention. The educational sessions lasted approximately 30 minutes to 1 hour and were incorporated into division meetings, grand rounds presentations, or education forums targeting attending surgeons, physician extenders, and fellows/residents/trainees. The slides were shared with key team members who were absent from the educational intervention, and site leads made efforts to communicate the study goals with these team members on an individual basis. To determine if the intervention decreased overprescribing, 3-6 months of pre-intervention and 3 months of post-intervention prescribing practices were compared.

1.2. Sample selection

Using institutional databases, patients who either underwent umbilical hernia repair 3-6 months prior to the intervention or 3 months after the intervention were identified. Umbilical hernia repair was selected as a procedure of interest based on the prevalence of this procedure at sites and informal assessment of sites confirming practice variation in the prescription of opioids. To be included in the sample, patients had to be 0–18 years at the time of surgery and undergo outpatient umbilical hernia repair during the study timeframe at one of the voluntarily participating sites. Patients were excluded if they underwent an additional procedure at the same time as umbilical hernia repair.

1.3. Data collection

Once the umbilical hernia repair patient sample was identified, patient charts were retrospectively reviewed to collect information on patient age, sex, and weight. Operative details including hernia size, performance of umbilicoplasty, and name of the attending surgeon were also collected. Discharge summaries were then reviewed for medication types (opioid or non-opioid analgesic). If opioids were prescribed, then the number of doses and the strength of the dose (ME/kg/dose) were recorded. Medication refills, returns to the emergency department, and readmissions were also documented. Each site used baseline data in the educational intervention to provide surgeon-specific practices. After the post-intervention data were collected, patient identifiers were removed and replaced with a randomly assigned study number to be shared with the data-coordinating site.

1.4. Data analysis

Descriptive statistics were performed on all study variables. Unadjusted differences between pre- and post-intervention prescribing practices were tested using Chi squared or Wilcoxon rank sums tests, as appropriate. The outcomes of interest included (1) percentage of patients receiving an opioid prescription, (2) number of doses prescribed, and (3) prescription strength (ME/kg/dose). Overall estimates for all three outcomes were modeled using generalized linear mixed models with site, age, sex, and umbilicoplasty as fixed effects and site as a random effect. The doses and ME/dose/kg outcomes were calculated for patients who received opioids and log transformed. All data analysis was performed in SAS 9.4. Overall institutional board approval was obtained from Children's Healthcare of Atlanta (IRB# 17-181) and by each individual participating center as per local requirements.

2. Results

2.1. Patient characteristics

A total of 343 patients who underwent umbilical hernia repair were identified in the pre-intervention cohort and 346 in the post-intervention cohort. The number of umbilical hernia repair patients varied by institution (Table 1). The median patient age was 5 years (IQR = 3) in the pre-intervention cohort and 5 years (IQR = 2) in the post-intervention cohort ($p = 0.03$). Also, 174 (50.7%) patients in the pre-intervention cohort and 150 (43.4%) patients in the post-intervention cohort were female ($p = 0.05$). Umbilicoplasty, patient weight, and hernia size did not significantly differ between the pre- and post-intervention cohorts.

2.2. Prescribing practices

The primary outcome of interest was the percentage of patients receiving an opioid prescription after umbilical hernia repair. The baseline percentage of patients receiving opioid prescriptions at discharge varied from 22.2% to 100% across the 9 centers (Table 2). Across all centers, the

Table 1
Pediatric umbilical hernia patient characteristics and prescribing practices, pre- and post-intervention to improve opioid prescribing stewardship.

	Pre (n = 343)	Post (n = 346)	*P*-value †
Number of patients per site, n (%)			<**0.001**
Site 1	20 (5.8)	18 (5.2)	
Site 2	9 (2.6)	21 (6.1)	
Site 3	19 (5.5)	10 (2.9)	
Site 4	11 (3.2)	26 (7.5)	
Site 5	132 (38.5)	115 (33.2)	
Site 6	11 (3.2)	27 (7.8)	
Site 7	33 (9.6)	28 (8.1)	
Site 8	78 (22.7)	52 (15.0)	
Site 9	30 (8.8)	49 (14.2)	
Age (years), median (IQR)	5 (3)	5 (2)	**0.03**
Sex, n (%)			
Female	169 (49.7)	196 (56.7)	0.05
Male	174 (50.7)	150 (43.4)	
Weight (kg), median (IQR)	21.1 (9.7)	20.5 (7.9)	0.07
Hernia size (cm), median (IQR)	1.5 (1)	1.5 (1)	0.87
Umbilicoplasty, n (%)	35 (10.2)	44 (12.7)	0.30
Prescribed opioids, n (%)	260 (75.8)	154 (44.6)	<**0.001**
Number of doses, median (IQR)*	12 (10)	10 (7.52)	<**0.001**
ME/kg/dose, median (IQR)*	0.13 (0.05)	0.11 (0.09)	0.15
Other pain meds, n (%)	148 (43.2)	189 (54.6)	**0.003**
Refill, n (%)	0 (0.0)	1 (0.3)	0.32
Return to ED, n (%)	12 (3.5)	9 (2.6)	0.49
Readmission, n (%)	1 (0.3)	0 (0.0)	0.31

IQR = Interquartile range, kg = kilogram, cm = centimeter, n = number.
* Among patients who were prescribed opioids.
† Bivariate tests used to assess differences between pre- and post-intervention cohorts.

proportion of patients receiving opioids significantly decreased from 75.8% in the pre-intervention cohort to 44.6% in the post-intervention cohort (p<0.001) (Table 1). Regardless of pre-intervention opioid use, all hospitals demonstrated improved opioid stewardship with the magnitude of the decrease in percent of patients prescribed opioids ranging from 24.3% to 100% (Table 2, Fig. 1). After adjusting for age, sex, umbilicoplasty, and hospital site, the odds ratio for opioid prescribing in the post-intervention period versus the pre-intervention period was 0.27 (95% CI = 0.18-0.39; p-value < 0.001, Table 2).

The second outcome of interest was the number of doses prescribed to patients receiving opioid prescriptions. Among patients receiving opioids, the number of doses prescribed significantly decreased after the intervention (adjusted mean 14.3 to 10.4 doses, p<0.001, Table 3). The change was most evident for the center that began with the highest number of doses, dropping from 18.2 to 10.3 adjusted average doses. Adjusting for age, sex, umbilicoplasty, and hospital site, the odds ratio of the number of doses in the post-intervention period versus the pre-intervention period was 0.75 (95% CI = 0.67-0.84, p-value <0.001, Table 3). Among the entire cohort of patients, the total number of prescribed opioid doses per patient decreased from 9.16 (3143 doses/343 patients) to 3.95 (1367 doses/346 patients) post-intervention).

The third outcome of interest was the ME/kg/dose among patients receiving an opioid prescription. The ME/kg/dose did not significantly decrease after the intervention (adjusted mean 0.14 to 0.13, p = 0.20, Table 3). Adjusting for age, sex, umbilicoplasty, and hospital site, the ratio of ME/kg/dose in the post-intervention period versus the pre-intervention period was 0.95 (95% CI = 0.89–1.03, p-value = 0.20, Table 3). There were no differences in returns to emergency departments, hospital readmissions, or prescription refills between the pre- and post-intervention cohorts (Table 1).

3. Discussion

Our results suggest that opioid stewardship may be, in part, improved after pediatric umbilical hernia repair using a provider-based educational intervention. Educating pediatric surgeons on opioid stewardship and providing prescription recommendations is a feasible method to decrease opioid overprescribing and prescribing variability. The percentage of patients receiving an opioid prescription at discharge significantly decreased from 75.8% to 44.6%, and the adjusted mean doses from 14.3 to 10.4.

Ultimately, this intervention decreased the number of excess opioids available to the community for potential misuse. We estimated that 56.5% less opioids (doses/patient) were prescribed after the intervention, similar to the intervention accomplished by Hill et al. [13]. Previous literature on both pediatric and adult populations showed that most opioids prescribed after surgery remain unused, resulting in excess medication in the community available for diversion. In one study, parents of children undergoing surgery administered only 9.2% of the prescribed opioids [15]. Another study found that an average of 52.2 opioid doses were prescribed to tonsillectomy patients at one hospital, but only 8.4 doses were administered [16]. Similarly, an average of 33.6 doses of opioids were prescribed for musculoskeletal procedures, but only 4 doses were administered to children [16]. This highlights the lack of an evidence base for prescribing opioids [17] and emphasizes the extent of opioid overprescribing for pediatric patients in the United States [18]. These excess doses are available for later misuse, and many patients intend to use leftover pills in the future and typically store opioids in unsecure locations [19,20]. For instance, 37% of high school seniors who are non-medical users of opioids reported obtaining pills from their own reserve of unused prior prescriptions [21].

Similar beneficial effects have been demonstrated when an educational intervention on the topic of opioid prescribing was implemented by a group of adult surgeons. They were able to significantly decrease the number of opioid pills prescribed for five common adult operations [13], reducing the total number of pills prescribed by 53% when compared to the number that would have been prescribed before the intervention. In a later intervention, the same authors found that most patients did not use optimal doses of NSAID's and acetaminophen together. This suggests that better pre-operative pain counseling might improve opioid reduction efforts [13]. Similarly, another intervention in which prescribing guidelines for laparoscopic cholecystectomy were disseminated found significant decreases in the amount of opioids prescribed by surgeons [14]. Our results suggest that educational

Table 2
Percent of pediatric umbilical hernia patients receiving an opioid prescription by site, pre- and post- intervention to improve opioid prescribing stewardship.

Site	Pre	Post	Percent Decrease	Adjusted Odds Ratio (95% CI)	*P*-value
1	17/20 (85.0%)	11/18 (61.1%)	28.1%	0.29 (0.06–1.56)	0.15
2	2/9 (22.2%)	1/21 (4.8%)	78.6%	0.66 (0.01–38.22)	0.83
3*	9/19 (47.4%)	0/10 (0.0%)	100.0%	0 (Not estimable)	**0.02**
4	6/11 (54.6%)	4/26 (15.4%)	71.8%	0.09 (0.01–0.66)	**0.004**
5	97/132 (73.5%)	64/115 (55.7%)	24.3%	0.44 (0.26–0.76)	0.06
6	4/11 (36.4%)	1/27 (3.7%)	89.8%	0.08 (0.01–1.09)	**0.02**
7	77/78 (98.7%)	37/52 (71.2%)	27.9%	0.03 (0–0.25)	**0.001**
8*	33/33 (100.0%)	18/28 (64.3%)	35.7%	0 (Not estimable)	<**0.001**
9	15/30 (50.0%)	18/49 (36.7%)	26.5%	0.62 (0.24–1.62)	0.32
Total	260/343 (75.8%)	154/346 (44.5%)	41.3%	0.27 (0.18-0.39)	<**0.001**

* For Site 3 and Site 8, it was not possible to calculate an adjusted p-value; thus the p-values presented for those two sites were based on unadjusted analyses. The p-values for the remainder of the sites were adjusted for age, sex, and umbilicoplasty.

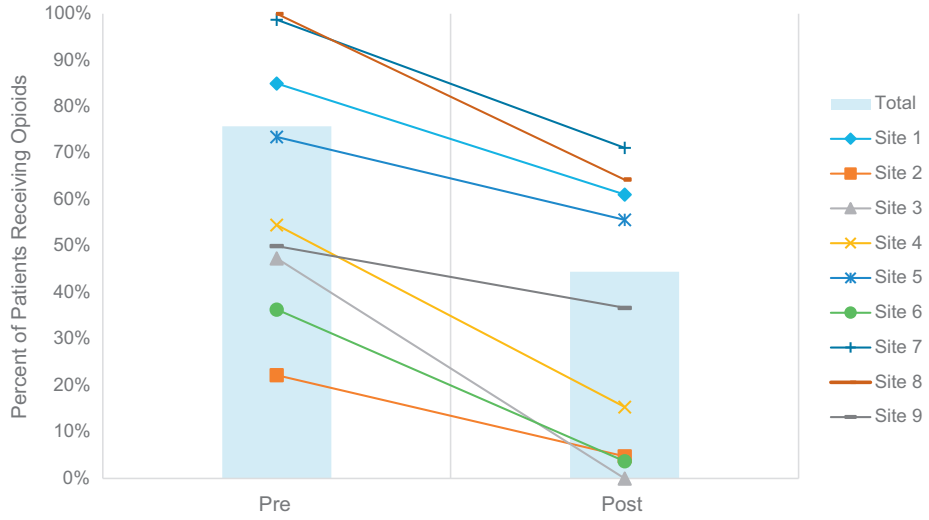

Fig. 1. Trends in percent of pediatric umbilical hernia patients receiving an opioid prescription by site, pre- and post-intervention to improve opioid prescribing stewardship.

interventions may significantly change surgeons' prescribing practices among pediatric populations as well. Furthermore, there were no significant changes in refills, readmissions, or returns to the emergency department between the pre- and post-intervention cohorts.

There are several limitations to this study. We focused on a single procedure that is commonly performed and has variation in practice patterns surrounding opioid use. The positive findings of this study support efforts to expand the intervention to a broader expanse of procedures and populations. In addition, inclusion of 9 children's centers across the country suggests generalizability of findings to multiple settings. Another limitation is that we were unable to follow patients postoperatively to measure pain scores, but instead used medication refills and hospital revisits as a proxy for successful pain control. Furthermore, there are national trends where opioid stewardship is happening with or without an intervention, and we did not have control sites where trends were monitored and compared to the intervention cohort. Despite all hospitals demonstrating some improvement, it is evident that adoption varied by center and surgeon. While some hospitals decreased the proportion of patients receiving an opioid prescription to a greater degree, other hospitals focused more on reducing the number of doses prescribed. Efforts to establish optimal prescribing guidelines are needed and may be informed by studies such as this one that includes wide variation in baseline practice.

4. Conclusions

Pediatric surgeons appear receptive to modification of opioid prescribing after umbilical hernia repair with a low-fidelity educational intervention that provides recommendations for non-opioid prescribing alternatives.

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Table 3
Number of doses and dose strengths for pediatric umbilical hernia patients receiving an opioid prescription by site, pre- and post- intervention to improve opioid prescribing stewardship.

Site	Pre-intervention Adjusted mean (95% CI)	Post-intervention Adjusted mean (95% CI)	Adjusted ratio (95% CI)	*P*-value
Doses				
1	18.18 (14.35–23.04)	10.30 (7.68–13.81)	0.57 (0.40–0.81)	**0.002**
2	9.46 (4.87–18.37)	10.83 (4.34–27.02)	1.14 (0.37–3.53)	0.81
3	9.42 (6.85–12.97)	N/A	N/A	-
4	13.80 (9.40–20.25)	9.62 (6.01–15.40)	0.70 (0.39–1.26)	0.23
5	21.00 (18.04–24.45)	14.44 (12.01–17.36)	0.69 (0.54–0.87)	**0.002**
6	10.73 (6.74–17.09)	11.16 (4.47–27.84)	1.04 (0.38–2.87)	0.94
7	11.10 (9.33–13.21)	8.69 (6.89–10.96)	0.78 (0.6–1.02)	0.07
8	16.63 (14.41–19.18)	12.12 (10.17–14.46)	0.73 (0.61–0.87)	**0.001**
9	17.54 (13.58–22.65)	13.59 (10.72–17.24)	0.78 (0.56–1.06)	0.12
Total	14.34 (11.80–17.42)	10.43 (8.51–12.79)	0.73 (0.65–0.81)	<**0.001**
ME/kg/dose				
1	0.12 (0.11–0.14)	0.07 (0.06–0.09)	0.57 (0.45–0.72)	<**.001**
2	0.19 (0.12–0.29)	0.65 (0.36–1.17)	3.45 (1.66–7.17)	**0.001**
3	0.17 (0.14–0.21)	N/A	N/A	-
4	0.07 (0.05–0.09)	0.07 (0.05–0.09)	0.98 (0.67–1.44)	0.94
5	0.14 (0.12–0.15)	0.12 (0.11–0.13)	0.87 (0.75–1.01)	0.07
6	0.13 (0.10–0.18)	0.15 (0.08–0.27)	1.14 (0.59–2.20)	0.70
7	0.11 (0.10–0.12)	0.10 (0.09–0.12)	0.95 (0.80–1.13)	0.53
8	0.11 (0.10–0.12)	0.12 (0.10–0.13)	1.06 (0.94–1.19)	0.32
9	0.21 (0.18–0.25)	0.23 (0.20–0.27)	1.10 (0.89–1.35)	0.38
Total	0.14 (0.13–0.15)	0.13 (0.12–0.14)	0.95 (0.89–1.03)	0.20

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