Journal of Pediatric Surgery 55 (2020) 2442–2447

Contents lists available at ScienceDirect

Journal of Pediatric Surgery

journal homepage: www.elsevier.com/locate/jpedsurg

Association of caregiver-reported education with locked storage and disposal of prescription opioids after children's surgery☆

Kenneth R. Sloss [a], Gracia Vargas [a], Chad M. Brummett [a,b], Michael J Englesbe [a,c], Jennifer F. Waljee [a,c], Samir Gadepalli [c], Calista Harbaugh [a,c,*]

[a] Michigan Opioid Prescribing Engagement Network, University of Michigan, Ann Arbor, MI
[b] Department of Anesthesiology, University of Michigan Medical School, Ann Arbor, MI
[c] Department of Surgery, University of Michigan Medical School, Ann Arbor, MI

ARTICLE INFO

Article history:
Received 6 November 2019
Received in revised form 24 April 2020
Accepted 29 April 2020

Key words:
Patient education
Opioid
Storage
Disposal
Pediatric
Surgery

ABSTRACT

Purpose: This study aimed to assess whether caregiver-reported storage and disposal education were associated with locked opioid storage and disposal of leftover opioids after children's surgery.
Methods: Caregivers of children <18 years who were prescribed an opioid were surveyed 7–21 days after surgery at an academic children's hospital (4/1/2018–3/31/2019) on opioid-related education and management practices (54% response rate). Multivariable logistic regression models were estimated for locked storage and disposal of leftover opioids as functions of storage and disposal education, adjusting for demographics, procedure, prescription characteristics, and postoperative day at time of survey.
Main Findings: Among 606 respondents, storage education was reported by 366 (60.4%) and locked storage by 111 caregivers (18.3%). Caregivers who reported verbal storage education (aOR 3.01 (95% CI 1.52–5.94); p = 0.001) or both written and verbal storage education (aOR 2.18 (95% CI 1.30–3.68); p = 0.003) were more likely to lock opioids in storage. Among 451 caregivers with leftover opioids, disposal education was reported by 226 (50.1%) and disposal by 111 caregivers (24.6%). There was no association between verbal and/or written disposal education with disposal.
Conclusion: Caregivers infrequently reported education, locked storage, and disposal of leftover opioids after children's surgery. Education may improve locked opioid storage, but additional strategies are needed to increase disposal.
Type of Study: Treatment.
Level of Evidence: Level III.

From 1999 to 2016, opioid-related overdoses rose by 250% among children and adolescents [1]. Acute pain after surgery or injury is the most frequent indication for opioid prescribing to pediatric patients [2–4]. Opioids are commonly prescribed in excess of need, with approximately 60% of opioids prescribed to pediatric patients after surgery remaining unused (leftover) [5–7]. Yet, only 1 in 3 adults with children in the home report locking opioids in storage and only 1 in 10 dispose of the leftover opioid [5,8–10]. Excess opioids that are kept unsecured and undisposed in the home can lead to accidental ingestion among young children and diversion for intentional misuse or self-harm among adolescents [11–13].

Efforts to improve opioid storage and disposal practices after hospital discharge have focused on delivery of storage and disposal education; yet, little is known about the translation of education to behavior among caregivers of pediatric patients. Although educational interventions on storage and disposal reported in the literature have shown improvement in storage and disposal practices, these targeted adult rather than pediatric surgeries [14–17]. The perceived risk of opioids in the home may be different when considering the risk of unlocked and undisposed medications to an adult versus a younger or older child. For example, adults may be more likely to lock opioids in storage in homes with young children as compared to older children [8]. Moreover, education alone may not be effective if perceived barriers to secure storage and disposal of leftover opioids outweigh the perceived benefits [8]. An understanding of whether caregiver education translates to locked opioid storage and opioid disposal among pediatric patients is needed to inform ongoing clinical and legislative effort – should efforts continue to focus on delivery of education or should they redirect to address barriers?

☆ Meeting Presentation: Scientific Forum of the American College of Surgeons Clinical Congress 2019; Tuesday October 29, 2019; San Francisco, CA.

* Corresponding author at: Michigan Opioid Prescribing Engagement Network, 1500 E. Medical Center Drive, Taubman Center 2110, Ann Arbor, MI 48109-5346. Tel.: +1 248 895 9858; fax: +1 734 936 5725.
E-mail address: calistah@med.umich.edu (C. Harbaugh).

https://doi.org/10.1016/j.jpedsurg.2020.04.022
0022-3468/

This study aimed to evaluate whether caregivers who reported verbal and/or written education on opioid storage and leftover opioid disposal were more likely to store prescribed opioids in a locked location and dispose of the leftover medications when no longer needed after their children underwent an operation. We hypothesized that locked opioid storage would be more common among caregivers who recalled receiving instruction on how to properly store opioid medications and that disposal of leftover medications would be more common among caregivers who recalled instruction on how to dispose of leftover medication.

1. Material and methods

This study was deemed exempt from full review as part of a multidisciplinary quality improvement project by the University of Michigan Institutional Review Board (HUM00143264).

1.1. Patient population and setting

Operative schedules were screened to identify patients aged less than 18 years who underwent an eligible procedure by one of six pediatric surgical subspecialty departments (Otolaryngology, Pediatric Surgery, Urology, Orthopedic Surgery, Plastic Surgery, and Oral Maxillofacial Surgery) at C.S. Mott Children's Hospital (a tertiary academic children's hospital) or one of Michigan Medicine's two affiliated outpatient surgical centers from April 1, 2018 to March 31, 2019. Eligible procedures included the following for each surgical subspecialty: Otolaryngology (tonsillectomy and/or adenoidectomy), Pediatric Surgery (appendectomy, umbilical or epigastric herniorrhaphy, inguinal herniorrhaphy and/or hydrocelectomy, circumcision), Urology (inguinal herniorrhaphy and/or hydrocelectomy, orchidopexy, circumcision), Orthopedic Surgery (open or percutaneous fracture fixation of the forearm or supracondylar humerus, upper extremity hardware removal), Plastic Surgery (cleft lip or palate repair, craniosynostosis repair), and Oral Maxillofacial Surgery (orthognathic surgery). Patients were initially screened for exclusion if they had an inpatient admission >7 days, had no contact information available in the electronic medical record, or were enrolled in an ongoing randomized controlled trial relating to opioid education or pain management (Fig. 1).

Pain journals were distributed at discharge to inform eligible caregivers of the quality improvement project and on which to record analgesic administration. Caregivers were contacted at 7–21 days after surgery by telephone or at the scheduled follow-up clinic appointment by the study team to minimize recall bias as time passed after surgery. Verbal consent was obtained prior to survey administration. The follow-up survey was completed by phone or in-person using the survey as a script, or by email if parents requested or did not speak English (Qualtrics; Provo, UT; 2018). No financial incentive was provided.

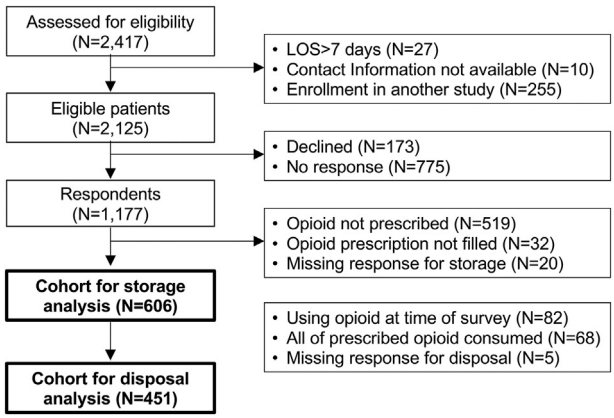

Fig. 1. Flow diagram of the study population.

Patient demographics (age, race, and gender as identified by the caregiver), procedure type, and opioid prescription characteristics were collected from the electronic medical record at the time of surgery. Eligible procedures were assigned to one of the following categories: Head & Neck (Otolaryngology, Plastic Surgery, Oral Maxillofacial surgery procedures), Orthopedic, or Abdominal/Genitourinary (Pediatric Surgery or Urology procedures).

1.2. Caregiver survey

The pediatric survey instrument was adapted from previously published surveys of adult opioid use and pain control [18]. The pediatric survey was reviewed by surgeon champions from the pediatric surgical subspecialty services, cognitively tested among four parents of postoperative inpatients, and pilot tested for 7 days prior to initiation of data collection. All questions were delivered in a multiple choice format, assessing: (1) where the opioid medication was stored; (2) whether the storage location was locked; (3) if their child was still taking the opioid at the time of the survey; (4) whether there was leftover medication; (5) whether the leftover medication was disposed; (6) how they disposed of the leftover medication (if they reported disposal) or how they would dispose of leftover medication (if they did not have leftover medication or did not dispose of leftover medication); (7) whether they received education on how to store the opioid medication at home; and (8) whether they received education on what to do with leftover medication. Storage and disposal education were reported as: no education, written education only, verbal education only, or both written and verbal education. Timing of response was calculated as the number of days after the operation in which the survey was completed.

1.3. Storage and disposal education

An ongoing multidisciplinary QI project was initiated at our institution in April 2018 which aimed to reduce postoperative opioid prescribing, ensure adequate pain control for recovery, and improve the safety of pediatric postoperative pain management [7]. A multidisciplinary stakeholder team consisting of attending pediatric subspecialty surgeons, surgical trainees, advanced practice providers, clinic and postanesthesia care unit nurses, pharmacists, child life specialists, injury prevention specialists, and administrators met monthly to develop educational tools, share implementation protocols, and review survey data. The stakeholder team identified locked storage and disposal of leftover medications as opportunities to improve the safety of postoperative opioid use. Several patient education tools on safe storage and disposal were created and disseminated via stakeholders to their respective units. These included patient education documents available through the University of Michigan Patient Education Clearinghouse on safe opioid use in children (http://www.med.umich.edu/1libr/PainSteeringCommittee/OpioidsChildren.pdf) and disposal of medications at home (http://www.med.umich.edu/1libr/Pharmacy/MedicationDisposal.pdf) which could be provided at discharge, plastic bags in which to put discharge supplies with a graphic conveying safe medication storage and disposal instructions, and educational worksheets for to provide interactive counseling at the outpatient pharmacy. All perioperative education was delivered by the surgical, anesthesia, and pharmacology teams per protocols developed by each stakeholder within the stakeholder group to encourage buy-in and participation.

1.4. Statistical analysis

Among eligible caregivers, caregivers were excluded if the caregiver declined participation or was unable to be contacted. Among responding caregivers, patients were excluded if they did not receive a discharge opioid prescription, did not fill their discharge opioid prescription, or did not specify storage method (Fig. 1).

Descriptive statistics were calculated using proportions for categorical variables and means with standard deviations for continuous variables. Two primary analyses were performed using bivariate analyses for unadjusted comparisons and fitting multivariable logistic regression models for adjusted comparisons with respect to the two primary outcomes, locked storage and disposal by the time of survey. First. caregiver-reported locked storage was assessed as a function of caregiver-reported storage education among all respondents who were prescribed an opioid at discharge. Second, caregiver-reported disposal of leftover opioids was assessed as a function of caregiver-reported disposal education among respondents who were no longer administering opioid to their child and had leftover medication, adjusted for patient demographics, surgical service, prescription characteristics, and days after surgery at time of survey. Because the majority of caregivers who did not dispose of leftover opioids reported that they planned to, a secondary analysis was then performed by fitting a multivariable logistic regression to assess the association of caregiver-reported plan to dispose as a function of caregiver-reported disposal education among respondents who were no longer administering opioids to their child, had leftover medication, and did not dispose of it yet. All multivariable analyses were adjusted for patient demographics (age, gender, race), procedure type, prescription characteristics (pill versus liquid, number of doses), and timing of response. All analyses were performed in Stata 15 (College Station, TX) with two-tailed significance $p < 0.05$.

2. Results

Among 2417 patients screened, 2125 met initial inclusion criteria and their caregivers were contacted to complete the postoperative survey. Among patients meeting inclusion criteria, 1177 caregivers responded (55.4% response rate). Among 1177 respondents, 519 patients were not prescribed an opioid (45.4%), 32 caregivers did not fill the prescription (2.8%), and 20 caregivers had missing storage responses (1.8%), resulting in 606 caregivers for the final cohort (Fig. 1). The final cohort had mean age 5.5 (SD 3.8) years and 245 patients (40.4%) were female (Table 1).

2.1. Caregiver-reported storage and disposal education

Among 606 respondents in the final cohort, 240 respondents denied receiving any storage education (39.6%), whereas 86 respondents reported receiving only written storage education (14.2%), 65 respondents reported receiving only verbal storage education (10.7%), and 215 respondents reported receiving both written and verbal storage education (35.5%). Similarly, among 606 respondents, 303 respondents denied receiving any disposal education (50.0%), whereas 63 respondents reported receiving only written disposal education (10.4%), 69 respondents reported receiving only verbal disposal education (11.4%), and 171 respondents reported receiving both written and verbal disposal education (28.2%). There was a significant association between caregiver-reported storage and disposal education ($p < 0.001$).

2.2. Association between caregiver-reported storage education with caregiver-reported locked opioid storage

Locked storage was reported by 111 caregivers (18.3%). Caregiver-reported storage locations were: medicine cabinet (219 respondents, 36.1%), kitchen cabinet (169 respondents, 27.9%), out in the open/on a counter (76 respondents, 12.5%), a closet (20 respondents, 3.3%), purse or other bag (12 respondents, 2.0%), a drawer (8 respondents, 1.3%), or another location (102 respondents, 16.8%).

In unadjusted analysis (Fig. 2), locked opioid storage was less commonly reported by caregivers that did not report receiving storage education (29 of 240, 12.1%), as compared to caregivers who reported storage education that was written (15 of 86 respondents, 17.4%), verbal (19 of 65 respondents, 29.2%), or both written and verbal (48 of 215 respondents, 22.3%; $p = 0.003$). In multivariable logistic regression (Table 2), caregivers who reported verbal storage education (aOR 3.01 (95% CI 1.52–5.94); $p = 0.001$) or both written and verbal storage education (aOR 2.18 (95% CI 1.30–3.68); $p = 0.003$) were more likely to also report storing prescribed opioids in a locked location as compared to caregivers who reported receiving no education.

Table 1
Respondent characteristics.

Characteristic	No. (%)
Age, mean (SD)	5.5 (3.8)
Female gender	245 (40.4)
Race	
White or Caucasian	476 (78.6)
Black or African American	46 (7.6)
Other	66 (11.2)
Unknown	16 (2.6)
Procedure type	
Head & neck	501 (82.7)
Orthopedic	41 (6.8)
Abdominal or genitourinary	64 (10.6)
Caregiver-reported storage education	
No education	240 (39.6)
Written only	86 (14.2)
Verbal only	65 (10.7)
Both written and verbal	215 (35.5)
Caregiver-reported disposal education	
No education	303 (50.0)
Written only	63 (10.4)
Verbal only	69 (11.4)
Both written and verbal	171 (28.2)
Storage location	
Medicine cabinet	219 (36.1)
Kitchen cabinet	169 (27.9)
Out in the open/On a counter	76 (12.5)
A closet	20 (3.3)
Purse or other bag	12 (2.0)
A drawer	8 (1.3)
Other	102 (16.8)
Locked storage	111 (18.3)
Disposal[a]	111 (24.6)

[a] Among 451 respondents with leftover medication that was no longer being administered to the child.

2.3. Association between caregiver-reported disposal education with caregiver-reported opioid disposal

Among 606 respondents who received an opioid prescription, 82 patients were still taking the opioid prescribed at the time of survey (13.5%), 68 patients took all of the prescribed medication (11.2%), and 5 caregivers had missing disposal responses (0.8%). This resulted in 451 respondents with leftover opioids for disposal analysis.

Among the 451 respondents with leftover opioids, 225 respondents denied receiving any disposal education (49.9%), whereas 479 respondents reported receiving only written disposal education (10.9%), 52 respondents reported receiving only verbal disposal education (11.5%), and 125 respondents reported receiving both written and verbal disposal education (27.7%). Disposal of leftover opioids by the time of survey administration was reported by 111 of 451 respondents (24.6%).

In unadjusted analysis (Fig. 2), disposal of leftover opioids was not associated with disposal education: no education (57 of 225 respondents, 25.3%), only written education (11 of 49 respondents, 22.5%), only verbal education (10 of 52 respondents, 19.2%), or both written and verbal education (33 of 125 respondents, 26.4%; $p = 0.75$). In multivariable logistic regression (Table 3), there was no significant association between caregiver-reported opioid disposal with caregiver-reported written disposal education (aOR 0.92 (95% CI 0.43–1.99);

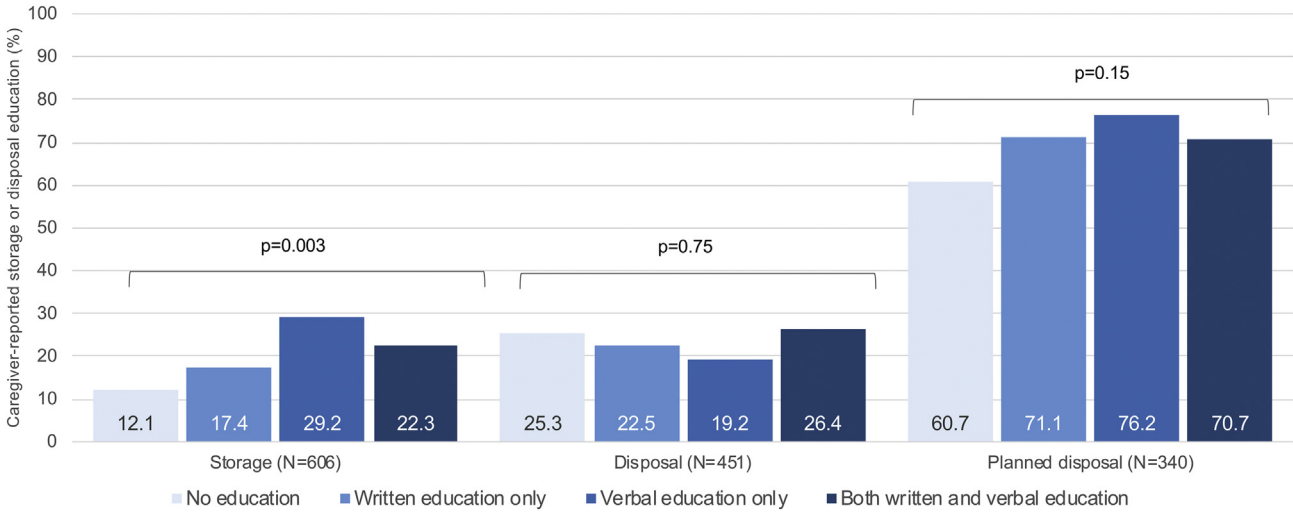

Fig. 2. Unadjusted association of locked storage, disposal, and plan to dispose with relevant opioid-related education. Caregivers of children <18 years who were prescribed an opioid analgesic after surgery were asked whether they received written and/or verbal education on storage and disposal of opioids and whether the opioid was stored them in a locked location, whether they disposed of leftover, and whether they planned to dispose if they had not already. The y-axis represents the percent of caregivers reporting locked storage, disposal, and plan to dispose.

p = 0.83), verbal disposal education (aOR 0.90==59 (95% CI 0.26–1.35); p = 0.21), or both written and verbal disposal education (aOR 1.15 (95% CI 0.68–1.95); p = 0.61) as compared to caregivers who reported no education.

2.4. Association between caregiver-reported disposal education with caregiver-reported plan to dispose

Among the 340 respondents with leftover opioids who did not dispose of the unused medications, the reasons cited were: I plan to but haven't yet (226 respondents, 66.5%), my child may need it again (148 respondents, 43.5%), I don't know how to safely get rid of it (24 respondents, 7.1%), I wasn't told to dispose of it (16 respondents, 4.7%), or I paid for it and don't want to waste it (1 respondent, 0.3%).

In unadjusted analysis (Fig. 2), plan to dispose of leftover opioids was not associated with disposal education whether no education was reported (102 of 168 respondents, 60.7%), only written education was reported (27 of 38 respondents, 71.1%), only verbal education was reported (32 of 42 respondents, 76.2%), or both written and verbal education was reported (65 of 92 respondents, 70.7%; p = 0.15). In multivariable logistic regression (Table 3), there was no significant association between caregiver-reported plan to dispose with caregiver-reported written disposal education (aOR 1.58 (95% CI 0.70–3.56); p = 0.27), verbal disposal education (aOR 2.10 (95% CI 0.92–4.77); p = 0.08), or both written and verbal disposal education (aOR 1.77 (95% CI 0.99–3.17); p = 0.06) as compared to no caregiver-reported disposal education.

Table 2
Association of caregiver-reported storage education with caregiver-reported locked storage (N = 606).

Covariate	Storage (N = 606)[a]	
	aOR (95% CI)	p-Value
Age (per 1 year increase)	0.93 (0.86–0.99)	0.03
Female (Reference: Male)	0.80 (0.50–1.27)	0.34
Race (Reference: White or Caucasian)		
Black or African American	0.50 (0.19–1.32)	0.16
Other	1.03 (0.52–2.04)	0.92
Unknown	0.67 (0.15–3.08)	0.61
Procedure type (Reference: Head & neck)		
Orthopedic	1.21 (0.47–3.14)	0.69
Abdominal or genitourinary	1.53 (0.67–3.49)	0.32
Pill (Reference: Liquid)	0.45 (0.09–2.27)	0.34
Number of doses (per 10 doses increase)	0.90 (0.68–1.19)	0.46
Response time (per 1 postoperative day increase)	0.98 (0.93–1.03)	0.50
Storage education (Reference: No education)		
Written only	1.68 (0.83–3.37)	0.15
Verbal only	3.01 (1.52–5.94)	0.001
Both written and verbal	2.18 (1.30–3.68)	0.003

[a] Hosmer-Lemeshow: p = 0.42; c-statistic: 0.66.

2.5. Preferred methods of opioid disposal

Among 111 respondents who disposed of their leftover opioids, the most common methods for disposal: flush down toilet/sink (58 respondents, 52.3%), take to an authorized pharmacy (20 respondents, 18.0%), or throw away in trash as is (15 respondents, 13.5). There were significant differences between actual disposal methods as compared to the preferred disposal methods if a caregiver had not disposed of the leftover opioids (Fig. 3). Flushing leftover opioids were more commonly reported as a method of completed disposal than as part of a plan to dispose (52.3% vs. 20.9%; p < 0.001). In contrast, fewer respondents disposed of opioids by taking them to an authorized location than as a planned method: authorized pharmacy (18.0% vs. 39.4%; p < 0.001), law enforcement agency (5.4% vs.17.1%; p = 0.002), and takeback drive (3.6% vs. 11.2%; p = 0.02).

3. Discussion

In this study of caregiver-reported opioid storage and disposal practices among pediatric patients after surgery, fewer than one in four caregivers locked opioid pain medications safely in storage or disposed of unused opioid pain medications after children's surgeries when no longer needed. Only one in three caregivers reported receiving any education on storage and disposal, suggesting a critical need to improve either the consistency or effectiveness of delivery of education in the perioperative period. Caregivers who recalled any verbal education on storage, with or without written education, were more likely to lock opioid pain medications when storing, emphasizing the need to engage multidisciplinary clinicians throughout the perioperative pathway in storage education delivery. However, caregivers who recalled education on disposal were not more likely to dispose of the leftover medications when no longer needed. This suggests that efforts targeted only at improving

Table 3
Association of caregiver-reported disposal education with caregiver-reported disposal and planned disposal.

	Disposal (N = 455)[a]		Plan to dispose (N = 343)[b]	
Covariate	aOR (95% CI)	p-value	aOR (95% CI)	p-value
Age (per 1 year increase)	0.97 (0.91–1.05)	0.47	0.97 (0.90–1.04)	0.37
Female (Reference: Male)	1.17 (0.74–1.87)	0.50	0.86 (0.53–1.41)	0.55
Race (Reference: White or Caucasian)				
Black or African American	1.09 (0.46–2.57)	0.84	0.30 (0.12–0.74)	0.01
Other	0.91 (0.41–2.01)	0.81	0.90 (0.41–1.97)	0.78
Unknown	1.67 (0.49–5.63)	0.41	4.65 (0.54–39.99)	0.16
Procedure type (Reference: Head & neck)				
Orthopedic	0.99 (0.39–2.53)	0.99	0.53 (0.29–1.36)	0.19
Abdominal or genitourinary	0.41 (0.13–1.29)	0.13	2.65 (0.86–8.14)	0.09
Pill (Reference: Liquid)	0.85 (0.20–3.52)	0.81	1.14 (0.29–4.56)	0.85
Number of doses (per 10 doses increase)	0.95 (0.71–1.25)	0.69	0.82 (0.61–1.08)	0.16
Response time (per 1 postoperative day increase)	1.16 (1.10–1.22)	<0.001	1.13 (1.05–1.21)	0.001
Disposal education (Reference: No education)				
Written only	0.92 (0.43–1.99)	0.83	1.58 (0.70–3.56)	0.27
Verbal only	0.59 (0.26–1.35)	0.21	2.10 (0.92–4.77)	0.08
Both written and verbal	1.15 (0.68–1.95)	0.61	1.77 (0.99–3.17)	0.06

[a] Hosmer-Lemeshow: p = 0.32; c-statistic = 0.69.
[b] Hosmer-Lemeshow: p = 0.37; c-statistic = 0.69.

the delivery of education on opioid storage and disposal to caregivers of children prescribed an opioid after surgery may be insufficient.

In contrast to the current study in pediatric patients, prior studies have demonstrated that specific educational interventions are associated with both improved opioid storage and disposal rates among adults [14–17]. For example, educational pamphlets on opioid weaning, storage, and disposal showed an improvement from 5% to 27% in opioid disposal after surgery among adult patients [14]. Similarly, adult palliative care patients who received written education materials and personalized counseling on safe opioid use, storage, and disposal were more likely to keep opioids locked and less likely to have unused medications at home [16]. Few studies have previously associated the association between education recall and opioid-related behavior. Buffington et al. found that patients who recalled education regarding the importance of disposal and appropriate methods for opioid disposal reported more than two-fold higher rates of opioid disposal [17]. However, despite any improvements with education across all studies, opioid storage and disposal rates remained inadequate and consistent with our findings: locked storage rates with education ranged from 14 to 23% and disposal rates with education ranged from 27 to 62% [14,16,17].

Potential explanations for the lack of association identified between caregiver-reported disposal education with actual disposal or plan to dispose in the future include competing motivations or perceived barriers to disposal. The Health Belief Model explains that individuals are more likely to engage in a preventive health behaviors (such as disposal) if they believe they can perform the behavior (self-efficacy) and if the perceived risks of not performing the behavior outweigh the perceived risks or barriers to performing it [19,20]. For example, McDonald et al. showed that adults in households with children were twice as likely to store opioids safely as efficacy and worry increased, but half as likely to store opioids safely as perceived barriers increased [8]. Similar to this study, we found that younger age of the child was associated with higher rates of locked storage. Within the context of disposal, concern for a child accidentally finding and ingesting the unused opioids was ranked sixth among 10 potential influencing factors for disposal in prior work [17]. In contrast, the leading motivations to keep unused opioids were in case the patient or someone else needs the medication immediately available for pain in the future [17,21]. Caregivers may perceive greater risk from not having pain medications immediately available for their child in the future as compared to the risks of accidental ingestion or diversion of unused opioid medications in the home.

Despite the timeliness of these findings in the urgency to combat the opioid crisis, our study had several limitations. First, this was a single center, non-randomized study and exclusion of patients without contact information or enrolled in a concurrent trial may introduce bias. Yet, this is the largest and only study to date to our knowledge that explicitly explores the association of caregiver-reported education with locked storage and disposal of opioid pain medications after children's surgeries. Second, we measured caregiver recall of education, rather

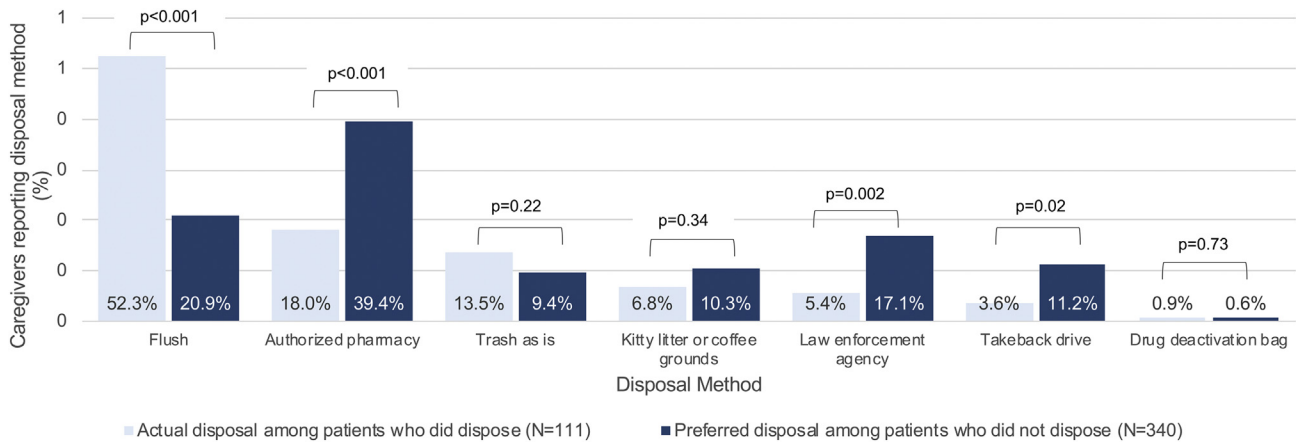

Fig. 3. Actual or preferred method of opioid disposal. Caregivers who disposed of leftover opioids were asked how they disposed of the medication and caregivers who did not dispose of leftover but planned to were asked how they would dispose of the medication. Disposal methods were not mutually exclusive, thus respondents could select all methods that applied.

than actual delivery of caregiver education. Ineffective education is less likely to be recalled, even if delivered. As a result, we may overestimate the effect of education as compared to if we had measured education delivery. However, caregiver-recalled education provides important insight into whether learned knowledge translates to behavior. Third, we did not measure caregiver access to disposal mechanisms which may have moderated the association of caregiver-reported education with actual disposal. For example, some caregivers may have pharmacies, law enforcement agencies, or takeback events near their homes which facilitate disposal, whereas others have geographic or transportation barriers limiting use of disposal facilities. This may explain the suggested trend towards association between disposal education with plan to dispose, but not with actual disposal. Fourth, a longer time course of follow-up may have resulted in increased rates of disposal and plan to dispose. Futures studies on the topic of disposal should consider an extended time course and future interventions should focus on earlier disposal of excess opioids. Fifth, the availability of sociodemographic data was limited. Factors such as family income, number of children in the household, educational status, and language barriers likely play roles in the efficacy of caregiver education and must be addressed in future studies.

In effect, although education is necessary and should be delivered consistently, it may be insufficient to improve safe opioid storage and disposal. Future work must seek to understand motivations and address perceived barriers to storage and disposal. Incentives have been suggested: more than 80% of patients would be more likely to use a drug take-back service if provided compensation [17,22]. New drug deactivation bags or solutions may also be an effective way to improve the convenience, and engagement, with opioid disposal [23]. Although such solutions may come at a cost for institutions, it is our duty as pediatric clinicians to ensure the safety of the care we deliver, including the medications we prescribe. It is in the best interest of clinicians, institutions, and society to enhance the consistency of education on locked opioid storage and disposal of unused opioid pain medications to caregivers so that we can all work to reduce the risks to children after surgery.

Funding

This work was funded in part by Blue Cross Blue Shield of Michigan. The funding body was not involved in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; or the decision to submit the manuscript for publication.

Declaration of competing interest

Drs. Brummett, Englesbe, and Waljee receive funding from Substance Abuse and Mental Health Services Administration (SAMHSA), the Michigan Department of Health and Human Services, and the University of Michigan Precision Health Initiative. The content is solely the responsibility of the authors and does not necessarily represent the official views of SAMHSA or the Michigan Department of Health and Human Services. Dr. Waljee also receives research funding from the Agency for Healthcare Research and Quality (K08 1K08HS023313–01), the American College of Surgeons, and the American Foundation for Surgery of the Hand. Dr. Waljee serves as an unpaid consultant for 3 M Health Information systems. Dr. Brummett reports a patent for peripheral perineural dexmedetomidine licensed to University of Michigan and is a consultant for Heron Therapeutics, Inc. (Redwood City, CA); not related to the present work. Dr. Brummett received research funding from Neuros Medical Inc. (Willoughby Hills, Ohio), not related to the current work.

References

[1] Gaither JR, Shabanova V, Leventhal JM. US National Trends in pediatric deaths from prescription and illicit opioids, 1999-2016. JAMA Netw Open. 2018;1(8):e186558.
[2] Volkow ND, McLellan TA, Cotto JH, et al. Characteristics of opioid prescriptions in 2009. JAMA. 2011;305(13):1299–301.
[3] Groenewald CB, Rabbitts JA, Gebert JT, et al. Trends in opioid prescriptions among children and adolescents in the United States: a nationally representative study from 1996 to 2012. Pain. 2016;157(5):1021–7.
[4] Chung CP, Callahan ST, Cooper WO, et al. Outpatient Opioid Prescriptions for Children and Opioid-Related Adverse Events. Pediatrics. 2018;142(2).
[5] Monitto CL, Hsu A, Gao S, et al. Opioid prescribing for the treatment of acute pain in children on hospital discharge. Anesth Analg. 2017;125(6):2113–22.
[6] Voepel-Lewis T, Wagner D, Tait AR. Leftover prescription opioids after minor procedures: an unwitting source for accidental overdose in children. JAMA Pediatr. 2015;169(5):497–8.
[7] Harbaugh CM, Vargas G, Streur CS, et al. Eliminating unnecessary opioid exposure after common children's surgeries. JAMA Surg. 2019;154(12):1154–5.
[8] McDonald EM, Kennedy-Hendricks A, McGinty EE, et al. Safe storage of opioid pain relievers among adults living in households with children. Pediatrics. 2017;139(3).
[9] Bicket MC, Long JJ, Pronovost PJ, et al. Prescription opioid analgesics commonly unused after surgery: a systematic review. JAMA Surg. 2017;152(11):1066–71.
[10] Garren B, Lawrence M, McNaull P, et al. Opioid-prescribing patterns, storage, handling, and disposal in postoperative pediatric urology patients. J Pediatr Urol. 2019(18):30383–8 pii: S1477–5131.
[11] Gaither JR, Leventhal JM, Ryan SA, et al. National trends in hospitalizations for opioid poisonings among children and adolescents, 1997 to 2012. JAMA Pediatr. 2016;170(12):1195–201.
[12] Allen JD, Casavant MJ, Spiller HA, et al. Prescription opioid exposures among children and adolescents in the United States: 2000–2015. Pediatrics. 2017;139(4).
[13] McCabe SE, West BT, Boyd CJ. Leftover prescription opioids and nonmedical use among high school seniors: a multi-cohort national study. J Adolesc Health. 2013;52(4):480–5.
[14] Rose P, Sakai J, Argue R, et al. Opioid information pamphlet increases postoperative opioid disposal rates: a before versus after quality improvement study. Can J Anaesth. 2016;63(1):31–7.
[15] McCauley JL, Back SE, Brady KT. Pilot of a brief, web-based educational intervention targeting safe storage and disposal of prescription opioids. Addict Behav. 2013;38(6):2230–5.
[16] de la Cruz M, Reddy A, Balankari V, et al. The impact of an educational program on patient practices for safe use, storage, and disposal of opioids at a comprehensive cancer center. Oncologist. 2017;22(1):115–21.
[17] Buffington DE, Lozicki A, Alfieri T, et al. Understanding factors that contribute to the disposal of unused opioid medication. J Pain Res. 2019;12:725–32.
[18] Howard R, Waljee J, Brummett C, et al. Reduction in opioid prescribing through evidence-based prescribing guidelines. JAMA Surg. 2018;153(3):285–7.
[19] Glanz K, Rimer B, Viswanath K. Health behavior and health education: Theory, research, and practice. San Francisco CA: Jossey-Bass; 2008; 45–51.
[20] Becker MH, Haefner DP, Kasl SV, et al. Selected psychosocial models and correlates of individual health-related behaviors. Med Care. 1977;15(5 SUPPL):27–46.
[21] Garbutt JM, Kulka K, Dodd S, et al. Opioids in adolescents' homes: prevalence, caregiver attitudes, and risk reduction opportunities. Acad Pediatr. 2019;19(1):103–8.
[22] Maughan BC, Hersh EV, Shofer FS, et al. Unused opioid analgesics and drug disposal following outpatient dental surgery: a randomized controlled trial. Drug Alcohol Depend. 2016;168:328–34.
[23] Brummett CM, Steiger R, Englesbe M, et al. Effect of an activated charcoal bag on disposal of unused opioids after an outpatient surgical procedure: a randomized clinical trial. JAMA Surg. 2019;154(6):558–61.