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Epidemiology Review: Consumer Opioid Disposal Literature Scan and Search Results

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Subject:	Consumer Opioid Disposal Practices Literature Scan and Review Results
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1 EXECUTIVE SUMMARY

One of the four FDA priorities contained in the Substance Use-Disorder Prevention that Promotes Opioid Recovery and Treatment (SUPPORT) for Patients and Communities Act (SUPPORT Act, signed Oct 2018) is to decrease exposure and prevent new addiction to opioids. Specifically, the Act enables FDA to require that opioids be dispensed to certain patients with safe disposal packaging or a safe disposal system that would render the drug non-retrievable if FDA determines that doing so may mitigate a serious risk of an adverse drug experience occurring from abuse or overdose. Along with this authority, however, FDA must consider the potential patient access and healthcare system burdens associated with using this authority. To help establish a baseline for community knowledge and to gain insight into how best to implement this new authority, the CDER workgroup on opioid disposal asked the Division of Epidemiology (DEPI) to perform a literature search identifying peer-reviewed articles that discussed or compared patient use of (e.g., opioid disposal rates) and/or preferences regarding prescription opioid disposal methods.

The literature was searched for opioid or controlled substance disposal methods or products, as well as studies that evaluated patient or consumer opioid disposal practices or behaviors. The initial search went from January 1, 2015 to March 11, 2020. Based on the increasing volume of articles, and to ensure that any findings were relevant in the rapidly changing prescription opioid landscape, the search primarily focused on reports published in 2019 and 2020. Once articles were identified, the abstracts were scanned to categorize articles and determine if further examination was warranted. Once categorized as articles of interest based on this scan, full articles (where available) were abstracted for relevant information and reviewed.

Forty-eight observational investigations were abstracted. Just over half of the articles calculated the percentage of participants who discarded their leftover prescription opioids (i.e., opioid disposal rate). Most of the studies focused on hospital-based providers and patients who had a surgical procedure; three articles had community-based populations. Opioid disposal rates ranged from 5% to 83%, depending on the study; the community-based studies had rates between 33% and 44%. Only three studies had opioid disposal rates greater than 50%. Seven surveys focused on providers, and investigators reported that between one-quarter and one-third of providers discussed opioid disposal with their patients with any frequency.

There were nineteen interventional studies in which usual care was compared to enhanced patient and/or provider education, text message reminders, standardized prescriptions, and/or provision of an opioid disposal product. All of the studies included in the review reported that compared to usual care, provision of an opioid disposal product significantly increased the opioid disposal rate. Enhanced patient education (with or without text message reminders) also increased opioid disposal rates, but not to the same extent. The results were not universal, as one study did not show an increase in opioid disposal rate associated with patient education. Studies examining use of a standardized prescription were equivocal; one study found an increase in disposal rate, but one did not.

Study strengths included recruiting study participants during hospital-based encounters, which allowed for prescription verification, and aided follow-up. The majority of studies focused on patients undergoing a specific procedure, minimizing that source of variability. Limitations included authors not always reporting the patient's prior exposure to opioids or the time between surgery or discharge and follow-up, and not always indicating if disposal rates were based on the entire study population or limited to individuals with leftover medication. In addition, the specifics of pre-encounter opioid exposure and post-encounter prescription information were not always provided. It was not always clear whether patients had other conditions that might require opioid therapy, nor was it clear even within the same study, whether patients had the same baseline access to opioid disposal options. None of the provider surveys were in community-based medical personnel, and the interventional studies did not include patients with chronic pain.

In sum, there was wide variation in opioid disposal rates seen across the studies reviewed, with no apparent trends in opioid disposal rates within or across study type, patient population (e.g., adult, pediatric, gender), or surgical procedure. This could be due to many factors that may have varied across studies, for example, the inclusion of patients who may have had other prescriptions for opioid analgesics indicated for other conditions (beyond the one being studied), the follow-up time(s) selected by the investigators, and/or patient access to opioid disposal options at the start of the study. These factors were not consistently reported across all studies, so their relative importance (or lack thereof) could not be ascertained in this literature review. Better characterization of patient history regarding prior opioid use and baseline disposal options, as well as more consistent reporting of characteristics such as opioid-naïve status, follow-up interval, and the number of pills dispensed would be helpful in discerning if there are trends in opioid disposal rates within certain subgroups of patients.

Despite this variation, however, this review provided some insights that are relevant to the Agency's questions on consumer opioid disposal practices. Increased patient education is associated with increased disposal rates, but further study would be needed to determine the optimal method or combination of methods – pamphlet or brochure, verbal reinforcement, and/or text message reminders. It is also not clear if these methods will be effective for patients with chronic pain, since all of the interventional studies were done in populations with either emergency department or surgical encounters, which may be more associated with acute pain.

With regard to patient opioid disposal practices, providing a method for home disposal increases the disposal rate above that seen after providing patient education; however, no studies compared consumer use or preference for different opioid home disposal options. In addition, while results of these studies were positive, all studies were relatively small (500 participants or less) and drawn from a single institution. Of note, several national chain pharmacies are providing drug disposal kiosks and/or disposal bags, depending on location, but we are not aware of any published, peer-reviewed evaluations of these large-scale interventions.

In sum, while the literature review was able to address some important basic questions and provide valuable background information, the workgroup remains interested in assessing consumer preferences among opioid disposal products and determining optimal patient and/or provider educational approach to increase the current prescription opioid disposal rates. To help

achieve this goal, the work group solicited a series of proposed projects in the November 2020 Broad Agency Announcement, specifically to:

- Better understand the importance of various disposal product features (e.g., cost, ease of use, time to drug neutralization, etc.),
- Identify and evaluate appropriate endpoints for studies assessing opioid disposal options, and to
- Measure and compare the extent of patient opioid (and other medication) disposal across various disposal options and when providing or not providing patient education on opioid disposal.

In conjunction with the Duke-Margolis Center for Health Policy, the workgroup is planning a public meeting for summer 2021 to discuss opioid disposal issues. Depending on the feedback received from these efforts, the workgroup will also consider other pathways to gather the data needed to make an informed decision on what products and educational practices to recommend.

2 BACKGROUND

One of the four FDA priorities contained the Substance Use-Disorder Prevention that Promotes Opioid Recovery and Treatment for Patients and Communities Act (SUPPORT Act, signed Oct 2018) is to decrease exposure and prevent new addiction to opioids. Specifically, the Act enables FDA to require that opioids be dispensed to certain patients with safe disposal packaging or a safe disposal system that would render the drug non-retrievable[1] if FDA determines that doing so may mitigate a serious risk of an adverse drug experience occurring from abuse or overdose. Along with this authority, however, FDA must consider the potential patient access and healthcare system burdens associated with using this authority.

To help establish a baseline for community knowledge of opioid disposal options and practices, and to gain insight into the feasibility of including an opioid disposal system with a dispensed prescription, the CDER working group for the SUPPORT Act disposal provisions asked the Division of Epidemiology (DEPI) to perform a literature search to identify peer-reviewed articles that discussed or compared prescription opioid disposal methods and that examined patient opioid disposal practices and preferences. This document summarizes the initial literature scan and search strategies and results of the literature review, as well as some of the gaps in research and remaining unanswered questions of interest to the Agency.

3 METHODS

3.1 LITERATURE SCAN

The purpose of the literature scan was to identify the extent of the literature on consumer opioid disposal products. The workgroup was particularly interested in articles that evaluated or compared the chemical methods used in opioid disposal products, as well as articles that evaluated patient preferences or practices regarding opioid disposal. Prior to completing a

[1] Non-retrievable is defined as "the condition or state which a controlled substance shall be rendered following a process that permanently alters that controlled substance's physical or chemical condition or state through irreversible means and thereby renders the controlled substance unavailable and unusable for all practical purposes." (21 CFR 1300.05)

detailed article abstraction, the titles and abstracts from candidate articles were reviewed for relevancy, and the results of this scan were presented to the workgroup and CDER management.

Two different searches were performed to achieve these initial goals. The first targeted previously identified opioid or controlled substance disposal products (e.g., IQ Solutions 2017, Pinto 2019), including the chemical methods that are used in these products when available (e.g., activated charcoal, Fuller's earth). PubMed, EMBASE, Google, and Google Scholar were used for this search.

A second search focused on articles that compared consumer use and/or preference between opioid disposal products, or that examined opioid disposal issues in any manner. It was run in both EMBASE and PubMed for articles published between January 1, 2015 and March 11, 2020. The final title/abstract search used the following terms:

(medication OR prescription OR opioid OR controlled substance)

AND disposal

NOT waste

Two important observations emerged from developing this search string. First, when the term "method" was included initially, relevant articles were not retrieved. When that term was removed, however, the search results contained articles of interest. As the literature is developing, the term "method" is used to describe the chemical or other process by which the medication is neutralized. The terms "practices" or "behaviors" refer to consumer or provider opioid disposal actions. Note that while these terms generally identified papers germane to the goal of this project, they were not included in the final string since they caused the search to be too restrictive. Second, without specifying "NOT waste", a plethora of articles on medication neutralization in groundwater and the environment were retrieved. Again, while this is an important area, it is not the focus of this specific literature scan and search.

A cursory review of the retrieved articles revealed that the majority focused on the disposal of unused opioids in various patient populations. To ensure the widest capture of articles, a supplementary search that added the term "unused" was run in both PubMed and EMBASE.

Since most articles were published in 2019 and 2020, further examination focused on those years. Titles and abstracts were scanned to determine if the article discussed opioid disposal methods. Based on this information, articles were initially categorized by author, year, study type, study population, and disposal question. Study type, study population, and disposal question were defined as in Table 1.

Table 1. Study Category Definitions

Study Category	Category Definition
Study Type	
Survey	Assessed knowledge and/or behavior; did not necessarily ask about patient or provider actions.

Evaluation	Assessed an intervention, usually educational. Also used for studies where the population could not be easily identified (e.g., take-back events, NPDS)
Opinion	Editorial or opinion piece. Also used for expert panel results.
Review	Document review. Could include literature, drug labels, legislation, or news articles.
Study Population	
Patients	Generally surgical patients, but could also include patients in specific circumstances (e.g., patients visiting emergency departments [EDs], college students)
Parents/Caregivers	Parents or caregivers of pediatric patients.
Providers	Either individual providers or facilities (e.g., hospitals, long-term care)
Disposal Question	
Practices	Asks what actions or behaviors patients take regarding disposal.
Provider Practices	Asks about knowledge/best practices for individual providers or institutions.
Knowledge	Asks about patient knowledge or attitudes, but not necessarily behavior.
Informational	Provides guidance, opinion, or recommendation.

Studies were also summarized with attention to any discussion or comparison of opioid disposal techniques as presented in the study abstract.

3.2 LITERATURE REVIEW

When the results of the literature scan were presented to the working group and CDER leadership, they agreed that further investigation of the emerging evidence on patient use of and preferences for opioid disposal options was needed. To start with, all of the articles identified in the literature scan were abstracted and summarized. In addition, the search string was re-run for the original time period as a quality control check, and an additional search extended the time frame to include March 11 – September 25, 2020. Any newly identified articles were added to the results.

4 RESULTS

4.1 LITERATURE SCAN

The literature scan described the types of studies published on opioid disposal methods. See Section 4.2, below, for detailed results from the literature.

4.1.1 Patient Opioid Disposal Practices Literature

The overall EMBASE search yielded 286 articles, while the PubMed search found 210 (Table 2). The EMBASE results were reviewed first, and 81 of the 286 articles were included as potentially relevant. The PubMed search results, after eliminating articles already identified in EMBASE, found fifteen articles in 2019 and seven in 2020.

Table 2. Consumer opioid disposal literature search results.

Database	2019	2020	Total
EMBASE	60 selected (N=218)	19 selected (N=67)	81 selected (N=286)
PubMed	15 selected (N=182)	7 selected (N=28)	22 selected (N=210)

Approximately 60% of the included articles were surveys (N=59 of 102 total articles). Just over twenty percent (N=23) were evaluations, with 9 opinion pieces and 11 reviews included. Table 3 provides a more detailed breakdown of the studies that discussed opioid disposal.

Table 3. Study Type and Population for articles discussing opioid disposal

Study Type/Population	2019	2020	Total
Evaluation			
Not Specified	2	1	3
Parents/Caregivers	2	1	3
Patients	11	5	16
Providers	1		1
Opinion			
Not Specified	9		9
Review			
Not Specified	10	1	11
Survey			
Parents/Caregivers	4	4	8
Patients	24	12	36
Providers	13	2	15
Total	76	26	102

The study populations were mostly patients or providers, although a few were parents or caregivers of pediatric patients. Surveys were mostly done in pre- or post-operative, opioid-naïve patients, or with providers that regularly performed surgery. Most of the studies focused on a specific surgical procedure, although there were single articles that included patients visiting emergency departments, or patients with chronic pain, cancer, or opioid use disorder. In the surveys, respondents were generally asked about any opioid counseling received, the amount of opioid prescribed and used, and if they were aware of proper opioid disposal techniques.

Provider studies included both practicing professionals and residents, and students. Practicing professionals were asked about their usual pre- and post- operative opioid counseling, including disposal. Students and residents could also be asked about any training they had received or would be willing to receive regarding best practices for opioid prescribing.

Evaluations generally assessed the effect of educational interventions on opioid consumption and disposal for patients, or pre- and post-operative opioid counseling for providers, although some provider surveys were focused on the institution, not the individual practitioner. The patient studies compared groups of patients undergoing similar surgical procedures, half of whom

received the intervention, and half of whom did not. After surgery, information on pain level, opioid use, and opioid disposal were gathered in interviews. For practitioner evaluations, changes in opioid prescribing and counseling practices were assessed after the educational intervention.

There were three evaluations that did not have a specific population – two enumerated medications returned during take-back events, and one was an analysis of calls to the National Poison Data Center.

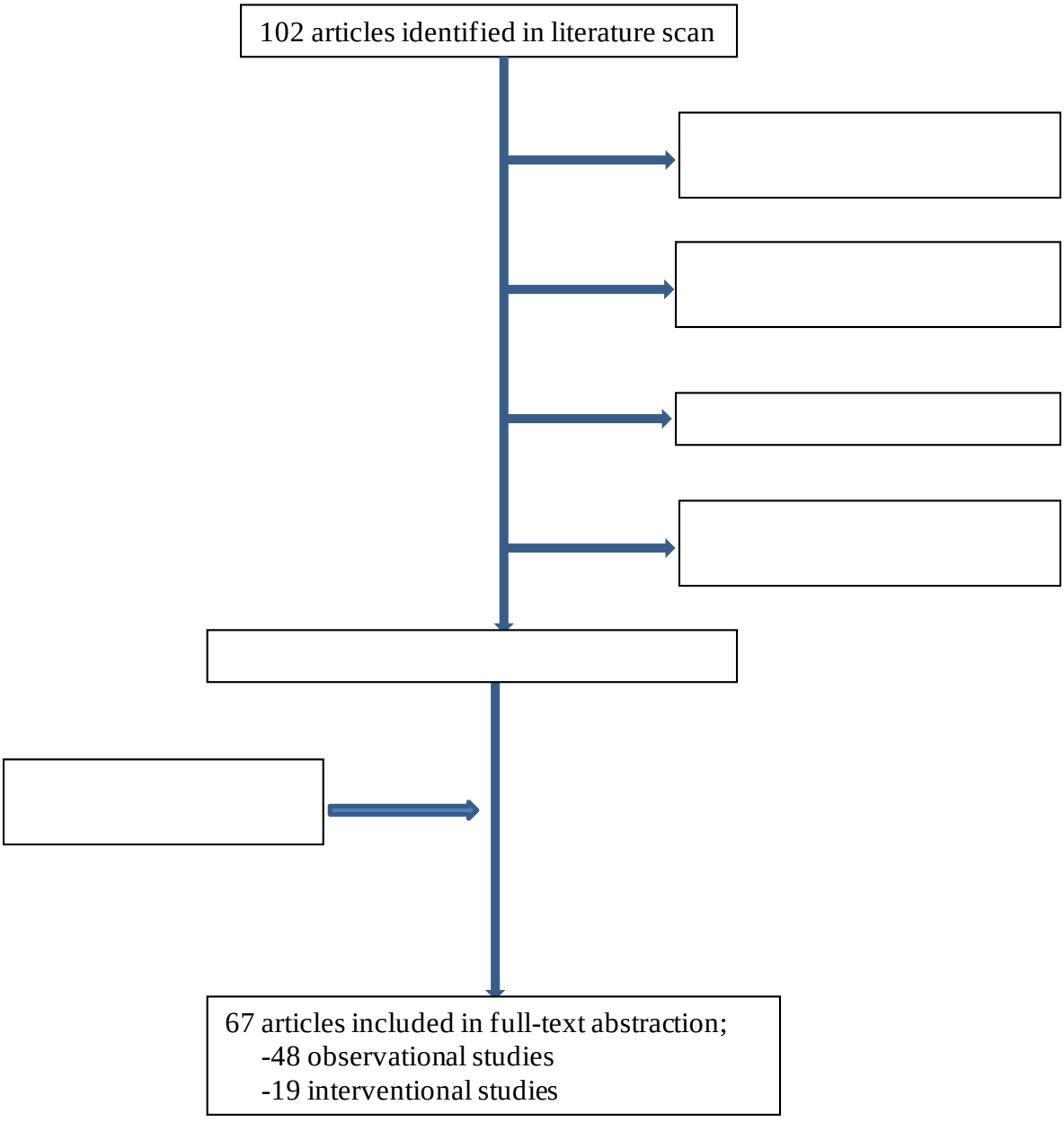
Opinion and review articles discussed a variety of issues, including best practices for prescribers and pharmacists, and institutions, suggestions for future legislation, and a review of media messages related to opioid disposal practices.

The majority of articles suggested that most patients did not dispose of opioids properly. Further, educational interventions tended to increase opioid disposal rates. Very few articles discussed specific disposal methods (e.g., throw in trash, flush, etc.), and none of the reports compared consumer opioid disposal products. Although the literature in this area is rapidly expanding, most of the studies to date have been baseline assessments of opioid disposal practices and rates.

4.2 LITERATURE REVIEW

All articles identified in the literature scan were abstracted for the literature review. Figure 1 summarizes the abstraction process. Forty-two articles were excluded: twenty-six did not report any further disposal information (including opinion and review pieces), seven were conducted outside the U.S., five were duplicates, and four described provider disposal practices. When the search was updated, seven new articles were identified, for a total of 48 observational and 19 interventional reports.

Figure 1. Literature Search Article Disposition.



4.2.1 Observational Studies (Appendix A)

Forty-eight articles describing observational studies were abstracted. One of the main purposes in examining these articles was to provide a to provide a baseline percentage of the number of study participants who disposed of their excess prescribed opioid medications (i.e., the opioid disposal rate). These studies also included surveys of provider (i.e., physician, pharmacist, or healthcare facility) efforts to promote proper patient opioid disposal practices, as well as take-

back event results. The investigations varied widely in follow-up time; some studies contacted patients two days after discharge, while others had a window of two years, and surveys generally inquired about pain levels, unused opioids, and disposal practices.

Overall, twenty-six studies reported on patient opioid disposal rates, generally after surgical procedures. The lowest rates were reported by Holst (2020), who surveyed 153 patients post-lung surgery approximately one month after discharge and had a disposal rate of 5%, Sada (2020) who reported the same disposal rate in 91 patients post-thyroid surgery at approximately 30 days post-discharge, and Arwi (2019), who reported an average rate of 5% across five investigations of opioid use in patients with any surgical or inpatient encounters. Huang (2019) also reported that "few" surgical patients had disposed of leftover opioids but given the small study size (N=16), did not calculate rates. Patel (2019) found a rate of 8% in 126 patients' post-robotic prostate surgery. Three studies (Mishra (2019), Knight (2019), Pruitt (2019)) reported rates between 10% and 20% in populations of patients undergoing urologic (N=91), hernia (N=195) or general (N=862) surgery. Three other surveys reported disposal rates between 20% and 30% - Baker (2020) reported a rate of 25% in 75 patients post-vasectomy, Newberry (2019) reported a 29% disposal rate in 364 patients after nasal surgery, and Patel (2019) reported a 26% disposal rate in 35 patients after open prostate surgery. The highest disposal rate of 46% was reported by Choo (2019), who surveyed 64 patients between 4 and 9 months after undergoing a tonsillectomy.

Four studies (Lovecchio 2019, Bicket 2019, Kunkel 2019, Premkumar 2019) examined disposal rates in patients undergoing joint or spine surgery. Opioid disposal rates ranged from 26% in 112 patients approximately 6 weeks post-knee replacement surgery (Premkumar 2019) to 53% in 140 patients approximately 6 months after joint or spine surgery (Bicket 2019).

Six of the twenty-six studies (Madden 2020, Garren 2019, Engster 2019, Hunsberger 2019, Sloss 2019, Sloss 2020) focused on parents of pediatric or adolescent patients. There was a very wide range of disposal rates, from a low of 6% in 115 parents of pediatric patients' post-surgery (Hunsberger 2019) to 80% in 243 parents of adolescents with an opioid prescription (Engster 2019).

The last five of the twenty-six studies were done in non-surgical populations. Holub (2019) reported that approximately 61% of 178 individuals who visited an ED disposed of opioids, while Prentice (2019) reported that 2 of 30 women who were delivering babies had disposed of their opioid medications. Buffington (2019) surveyed 152 patients with chronic pain as well as individuals who had been prescribed an opioid in the last two years and found that 33% had disposed of their leftover opioid medications. Gregorian (2020) studied 500 patients with acute or chronic pain within 3 months of being surveyed and found that of 140 respondents (28%) with medication left over, 25 individuals (17.9%) had disposed of their medication. Finally, Varisco (2020), in a cross-sectional survey of 400 patients with chronic pain, found that 44% had disposed of an opioid in the past year, mostly using either household garbage (29%) or a hazardous waste facility (31%).

Six observational studies quantified patients' opioid disposal plans instead of actual patient behavior. Bouzaher (2020) surveyed 255 patients visiting an orthopedic provider and found that

14% were willing to return the drugs to the pharmacy, 16% would return them to a police station or through a take-back program, and 17% would use a drop box. McEntee (2019) found that 18% of 99 women who were going to have a hysterectomy had an "acceptable" opioid disposal plan, although the number of patients with any type of disposal plan was not reported. Garbutt (2019), in a survey of community-based pediatric practices found that 26.1% of 700 parents intended to get rid of leftover opioids. Glogovac (2019) studied 50 patients who were post-arthroscopic knee surgery and found that 30% planned to dispose of excess opioids. Finally, both Shi (2019) and Arora (2020) surveyed individuals who visited an ED. Shi (2019) found that 30% of 98 patients planned to dispose of their opioids, while Arora (2020), who spoke to young adults, found that 83.5% of 91 participants were willing to dispose of opioids properly.

Knowledge associated with prescription drug or opioid disposal was assessed in four studies; one in a student population and three in clinical patients. Abraham (2020) surveyed 190 high school students and found that approximately 65% did not know how to dispose of opioids. Shahi (2020) examined 142 parents and caregivers of pediatric patients with burn injuries; 27% reported receiving opioid disposal education. Finally, Theisen (2019) and Sheth (2020) both studied patients post-surgery. None of the 155 patients who had a prostate or kidney operation reported receiving disposal education (Theisen 2019). Sheth (2020) conducted a systematic review of opioid use after arthroscopic shoulder, hip, or knee surgery. Five of the studies (348 patients) asked about opioid disposal behavior; 36% of patients reported receiving pre-operative disposal instructions or were aware of proper disposal methods.

Five articles reported on prescriber promotion or facility knowledge of and practices related to opioid disposal counseling (Ahn 2019, Kattail 2019, Klimczak 2020, Tse 2019, Levy 2019). Klimczak (2020) found that approximately 22% of 50 otolaryngology residents provided disposal counseling; Kattail (2019) obtained similar results when surveying 127 orthopedic providers. Ahn (2019) found that 35% of 102 pediatric urologists provided counseling. Tse (2019) reported that compared to surgical residents, surgical attending providers had greater knowledge of opioid disposal regulations (22 providers were included; percentages not reported). Levy (2019) surveyed 199 providers attending the Enhanced Recovery After Surgery Conference; 29% of respondents reported that their institutions promoted safe opioid disposal at patient discharge.

Kneuss (2019) contacted 52 hospice directors and found that all had written policies related to opioid disposal and provided the information to patients. All respondents reported disposing of unused opioids, 84% at the discontinuation of therapy. Iobst (2019) contacted police stations (N=431), pharmacies (436 chain and 422 independent), and children's hospitals (N=188) and asked about their take-back policies. Sixty percent of police stations and 11% of hospitals were willing to take back unused opioids, along with 7% of chain and 24% of independent pharmacies. Finally, Selekman (2020) called pharmacies in California to determine the accuracy of the opioid disposal information they provided. Of the 204 pharmacies that responded to the survey, 19% provided correct disposal information. When the respondents were queried about the presence of a take-back program, 82 (11%) reported having one.

Three studies provided insight into opioid disposal practices even though they did not focus on clinic populations. Moustarah (2020) categorized products returned through a take-back event.

Opioids were present in 74% of the batches of medications dropped off, and in 87.5% of batches from participants with youth in the household. Shealy (2019) tabulated take-back events between 2013 and 2017 in rural South Carolina. During this time, the percentage of potentially abused medications[2] out of the pharmaceuticals returned went from 8.6 to 13.3%. Within that category, opioids and dextromethorphan were the most common products returned. Schwartz (2020) surveyed methadone clinic directors within the catchment area for a state poison control center regarding medication safety practices, including disposal. Medication safety education was always provided; for clients given take-home doses, the education was reinforced periodically. The education emphasized that unused medicine should be disposed of safely; the preferred method was returning medication to the clinic. Finally, Kearney (2019) did community assessment of cultural barriers to opioid disposal including 136 participants. Findings included a language barrier to understanding disposal materials, lack of knowledge of take-back events, lack of transportation, infrequent occurrence of events, and the presence of police were all deterrents to participation in these events.

4.2.2 Interventional Studies (Appendix B)

Nineteen interventional studies were also abstracted. These were mostly controlled trials assessing the effects of various efforts to reduce overprescribing and/or increase opioid disposal rates among individuals who usually had a medical procedure. Interventions included patient education, standardized prescriptions, electronic reminders, or the provision of a take-home disposal method.

Seven studies included a take-home disposal method as one of the interventions. Brummett (2019) randomized patients post-surgery to receive an educational pamphlet (N=75), an opioid disposal bag (N=70), or usual care (N=63) at discharge. Education increased the disposal rate by approximately 5% compared to usual care (from 28.6% to 33.3%), but the provision of a disposal bag increased the rate to 57.1%. The odds ratio (adjusting for patient pre-operative characteristics) was 3.8 (95% confidence interval (CI) 1.7 – 8.5). Stokes (2020) selected a convenience sample of patients after elective surgery to receive a disposal kit and education vs. usual care. Fifty-four percent of patients who received a disposal kit (28 of 52 patients) planned to dispose of their excess opioids, while 34.5% of patients who did not receive a kit (81 of 234 patients) planned to dispose of theirs. When asked about their planned mode of opioid disposal, 82% of those who received a disposal kit planned to use it, while 11% of those who did not receive a disposal kit planned to use one. Among patients who did not receive an opioid disposal kit, the majority (47.5%, N=38) planned to dispose of any excess at an opioid disposal kiosk. Lawrence (2019) randomized 181 parents or caregivers of pediatric patients to receive either an opioid drug disposal bag (N=92) or usual care (N=89). Among families with leftover opioids, 85.7% of those who received a disposal kit (N=66) compared to 56.2% of the usual care group (N=50) reported disposing opioid (difference in proportions 20.8%, 95% CI 7.6% - 34.0%). Voepel-Lewis (2020) examined disposal behavior in parents of pediatric patients who were post-surgical. The study compared provision of a disposal bag, enhanced education, or usual care. Five hundred seventeen parents participated, and 93% (N=481) reported having leftover medications. Prompt disposal behavior was higher in parents who received both a disposal bag

[2] Included androgens, central nervous system stimulants, barbiturates, benzodiazepines, loperamide, dextromethorphan, opioid analgesics, and hypnotics. (from https://www.drugabuse.gov/drug-topics/commonly-used-drugs-charts, accessed 2/23/2021)

and enhanced education (38.5%), a disposal bag (33.3%), or enhanced education (31%) compared to the usual care group (19%, $p \leq 0.02$).

The final three studies that examined the effects of providing a disposal method (disposal bags) to patients were not able to calculate disposal rates. One of the studies (Ramel 2020) used a historical control group while two (Hite 2020, Adler 2020) did not report baseline disposal rates. Ramel (2020) provided the Deterra drug disposal system to two hundred patients post-surgery and surveyed 149 of them three to four weeks post-discharge. One-hundred six of the patients had opioids left over, and of those, 29 (27.4%) had disposed of their medications; 23 of those patients had used the provided Deterra disposal system. While this was an improvement over the 10% disposal rate for the historical control group, the authors did not report on any statistical tests or comparisons, so it is not clear if this improvement was statistically significant. Hite (2020) conducted a pre/post intervention analysis involving standardized prescribing, patient education, and the provision of a take-home disposal bag in a group of women after breast surgery. After the intervention was implemented, 17 of the 66 patients included reported disposing their opioids using the bag. Finally, Adler (2020) assessed the feasibility of providing a return envelope for opioids to children and adolescents undergoing outpatient surgery. The authors found that 19% (64 of 331) of patient families included in the study returned the envelope. Since this was a feasibility study, additional disposal methods were not explored.

Liu (2020) conducted a prospective cohort study that employed patient education and a buyback program to educate patients on proper drug disposal and motivate them by using a small ($5/pill, up to $50) monetary incentive. Of the 578 eligible patients, 171 (29%) returned their unused pills as part of the study. Individuals who returned their medication were older and more likely to be opioid naïve compared to those who did not return their excess medications.

Five studies tested the effectiveness of education and messaging on opioid disposal. Egan (2020) examined four different messages in a group of 491 of Kentucky and North Carolina residents. One message focused on risk, one on worry, and two on encouragement. Messages associated with risk and encouragement increased respondents' confidence in knowing how to properly dispose of excess opioid medications. Jacobs (2019) distributed an educational brochure to 41 of 95 consecutive vascular surgery patients. Among the 37 patients with leftover opioids, those who received the intervention were more likely to report disposing opioids (72% vs. 44%, $p<0.05$). Lam (2020) randomized 84 women who had a cesarean section to receive a brochure and in-person education on opioid use vs. 91 who received usual care. Patients in the education group were more likely to dispose of their opioids properly (38% vs. 16.9%, relative risk 2.25, 95% CI 1.29 – 3.93). Khorfan (2020) developed an intervention that included pre- and post-operative patient education and studied it in 112 patients after general surgery. Of the 58 patients who had excess opioids, 14 (24%) disposed of the excess and another 20 (35%) intended to. The rate was higher in those who received pre-operative education compared to those who did not (30% vs. 0%, $p<0.05$). In contrast, Cabo (2019) compared 127 patients post urological surgery, 59 of whom received a handout on opioid disposal methods. Approximately 9% of patients in each group disposed of opioids.

Two studies included text message reminders in addition to education. McCarthy (2019) conducted a randomized clinical trial using individuals who visited an ED. Interventions

included patient and provider education (N=113), education plus text message reminders (N=207), and usual care (N=85). Participants who received education plus text messages were more likely to plan to dispose of their unused opioids compared to usual care patients (70.5% vs. 33.9%, $p<0.001$); no other disposal-related results were reported. Nahhas (2020) randomized individuals undergoing hip or knee arthroplasty to receive usual care (N=139), a pamphlet (N=217), or a pamphlet plus text messaging (N=183) related to proper opioid disposal. Of those with unused opioids at the time of follow-up, patients who received text messages and education were more likely to dispose of their medication properly compared to the other two groups (38% vs. 33% for education and 9% for usual care). Interestingly, similar proportions of patients disposed of their medications improperly in the text message and usual care groups (7% and 9%, respectively); 3% of the education group improperly disposed of their opioids.

Three studies examined the effect of standardized prescriptions and education on patient opioid disposal behavior. Woodward (2019) gathered baseline opioid medication information from a group of 38 patients after cornea surgery and implemented a standardized prescription as well as patient education including opioid disposal. Forty-four additional patients were surveyed after the implementation. Twenty-seven of those 44 patients had filled a prescription for an opioid after surgery, and 4 of those 27 (15%) had disposed of their opioid. Glaser (2020) assessed the effect of patient and provider education and a standardized prescription on disposal in a group of 620 women with ovarian cancer post-laparotomy compared to 599 historical controls; fewer than 25% of patients disposed of their excess medication. Finally, Mocon (2019) used information from 127 patients post-laparoscopic surgery to create a standardized prescription, which was then used for 109 additional patients. While there was a decrease in the number of opioid pills prescribed (20 vs. 10) and an increase in the number of patients receiving disposal education (10% vs. 44%), fewer than 5% of patients in the pre- or post-intervention groups disposed of their excess opioids.

The final study examined opioid prescribing practices in surgical residents before and after an educational program (Yorkgitis 2019). Twenty-three residents completed the study. The mean number of pills prescribed decreased after education; however, only two respondents provided information on unused opioids, so their answers were not analyzed further.

5 DISCUSSION

The intent of this literature scan and review was to determine a baseline for opioid disposal rates in the U.S., and to assess the feasibility of including an opioid disposal product with dispensed prescriptions. Of particular interest were any articles that did a comparative assessment of opioid disposal products intended for patient use.

Academic interest in opioid disposal has increased as the opioid crisis has continued in the U.S. For this reason and due to rapidly changing institutional policies and prescribing practices related to opioids, the abstraction was limited to 2019-2020; this time period also had the most articles related to patient opioid disposal practices.

There was a wide range of opioid disposal rates in the observational studies included, from a low of 5% to 80%. Most of the rates observed by these studies were under 50%; only three had

disposal rates higher than that. Although a wide variety of patients post-surgery were studied, there were two groups – parents of pediatric patients and patients who had joint or spine surgery – that were the focus of several investigations. The disposal rate range for patients after joint surgery was between 26% and 53%, but the range in pediatric caregiver populations was very wide, mirroring the overall range. In addition, interpretation was complicated because authors were not always clear if disposal rates were being calculated based on the entire study population or on those with leftover medication.

Two observational studies provided rates in community-based populations; both study samples were composed of either patients diagnosed with chronic pain or those who had an opioid prescription in the past year. The reported opioid disposal rates were similar (33% and 44%, respectively). Both surveys were conducted in pre-selected panels of individuals who had already agreed to participate in research studies for compensation; although the selection panels were national in scope, the population source makes it difficult to adequately characterize the population or generalize the results.

Interestingly, one observational study focused on cultural and other barriers to opioid disposal. The authors were able to identify several challenges to increasing opioid disposal, including language barriers, lack of knowledge of take-back days, lack of transportation to events, limited duration of events, and the police presence at such events.

Several of the surveys were in provider populations, and generally found that between one-quarter and one-third of providers discussed opioid disposal with patients at least some of the time. These surveys included several different types of providers – attending and resident doctors, nurse practitioners, nurses, pharmacists, but were all in inpatient specialties. There were no provider surveys in community-based practices or pharmacies.

A number of interventional studies focused on enhancing patient education as a way to increase disposal rates. Education was defined in several ways, from provision of a brochure to a combination of provider education and pre-and post-procedure discussion with patients. Six of the seven studies that compared enhanced education alone to usual care also found notable increases in opioid disposal rates associated with the intervention; in the last study, the disposal rates did not differ.

Two interventional studies included text message reminders in addition to education, which also increased the disposal rate over education alone. Finally, two studies also included standardized prescriptions as a part of the education intervention, but neither investigation reported that the intervention increased disposal rates.

Seven interventional studies included the provision of a take-home disposal kit; four of these reported the increase in disposal rate compared to a usual care or baseline group. Across all four studies, the provision of a bag increased the disposal rates by approximately 20%. Interestingly, two of the four studies combined the kit and enhanced education as the intervention, while two examined kit alone as an intervention arm. The meaning of this is not clear, since education alone also increased disposal rates. Additionally, authors did not consistently specify if disposal

rates were calculated based on all participants in the study or just those with leftover medication. None of the studies found in this literature review compared multiple disposal products.

The studies shared a number of strengths. First, by focusing mostly on hospital-based populations, it was easy to verify what patients were prescribed, and to follow-up after the procedure. Although the articles did not always specify, most patients were assumed to be opioid-naïve at the start of surgery. Where the authors specified, most studies followed up from days to weeks after surgery, which helped to minimize recall bias. Focusing on one or two closely related surgical procedures help to ensure that patients who received an educational or other intervention were similar to those that did not, and that the anticipated opioid use after the procedure would be similar between groups. Third, by generally selecting patients from one or few institutions, there were known prescribing guidelines for providers, and geographic variations in prescribing were also minimized.

There are also some notable limitations, which limited the ability to interpret results, but also point towards future directions for research. First, authors did not always specify the time between surgery or discharge and follow-up; from those who did include the information, it ranged from a few days to up to 2 years. Depending on the procedure and resources available to patients and the recovery time, disposal rates could vary widely. Although some investigations that focused on unused opioids contacted patients multiple times, most did not; it was unclear if patients were asked about disposal behaviors more than once. Second, there were very few studies in community-based populations, and no interventions were tested in that group. Due to the nature of the population source (i.e., pre-selected survey panels) in the two studies found, it was not possible to further characterize the patients. These patients may have different storage and disposal practices compared to individuals who received opioids in relation to a surgical procedure. Third, the studies were generally small; for example, the sample size for the six studies that provided take-home kits was between 119 and 571 patients. It is not clear how logistically feasible it would be to scale-up hospital dispensing of opioid disposal kits to the national level.

One of the interesting attributes of this group of studies is that there were no discernible trends in disposal rates – that is, there was no particular patient type (e.g. parents of pediatric patients, patients with cancer) or a specific surgical procedure or encounter where the opioid disposal rates were consistently high or low. While there may truly not be a pattern, there are some methodological issues that could be addressed that may affect this finding. Studies examined few of the patient attributes that could hypothetically influence baseline disposal behavior, or receptiveness to an intervention. For example, while most investigations collected baseline information relevant to the reason for surgery, and some collected data on prior opioid use and substance abuse, there were not enough data to clarify which, if any, of these variables was most relevant. Other, potentially important baseline attributes, such as knowledge about disposal options, access to disposal opportunities, pain levels, and expected need for analgesia, were not measured. Most of the prescribing information concentrated on opioids given for the procedure being studied, and although some studies asked about baseline opioid consumption or included only opioid-naïve patients, this was not uniform. The number of pills prescribed was not reported, and it also wasn't clear how long patients were expected to need opioid therapy after

their procedure. Not all studies reported the time between the surgery or medical encounter and follow-up regarding disposal, which further complicates interpretation.

When providers were surveyed, they were from surgical or inpatient specialties. None of the studies identified in this review included community-based prescribers. Opioid counseling best practices may be very different for general practitioners and family physicians compared to surgeons and other hospital-based prescribers. Finally, some of the studies measured opioid disposal of any kind, while some only included "proper" (i.e., FDA-approved) disposal practices – improper disposal behavior was not enumerated or could not be separated out. Being able to identify proper and improper disposal could point to a need for specific areas of patient education in addition to raising awareness of the need to dispose of excess medication.

6 CONCLUSION

There was wide variation in opioid disposal rates seen in the studies included in this literature review, with no apparent trends in opioid disposal rates within or across study type, patient population (e.g., adult, pediatric, gender), or surgical procedure. This could be due to many factors, for example, the inclusion of patients who may have had other opioid prescriptions indicated for other conditions (beyond the one being studied), the follow-up time(s) selected by the investigators, and/or patient access to opioid disposal options at the start of the study. These factors were not consistently reported across all studies, so their relative importance (or lack thereof) could not be ascertained in this literature review. Better characterization of patient history regarding prior opioid use and baseline disposal options, as well as more consistent reporting of characteristics such as opioid-naïve status, follow-up interval, and the number of pills dispensed would be helpful in discerning if there are trends in opioid disposal rates within certain subgroups.

Despite this variation, however, there were some insights that are relevant to the Agency's questions on consumer opioid disposal practices. Increased patient education is associated with increased disposal, but further study would be needed to determine the optimal method or combination of methods – pamphlet or brochure, verbal reinforcement, and/or text message reminders. It is also not clear if these methods will work on patients diagnosed with chronic pain, since all of the interventional studies were done in populations with either emergency department or surgical encounters, which tend to be associated with more acute pain.

With regard to patient opioid disposal practices, providing a method for home disposal increases the disposal rate above that associated with patient education; however, no studies compared consumer use or preference for different opioid home disposal options. In addition, while results of these studies were positive, they were all relatively small (500 participants or less) in size and within an institution. Several national chain pharmacies are providing drug disposal kiosks and/or disposal bags, depending on location; however, we are not aware of any published, peer-reviewed evaluation of these large-scale interventions.

In sum, while the literature review was able to address some important basic questions and provide valuable background information, the workgroup remains interested in assessing consumer preferences among opioid disposal products and determining optimal patient and/or provider educational approach to increase the current prescription opioid disposal rates. To help

achieve this goal, the work group solicited a series of proposed projects in the November 2020 Broad Agency Announcement, specifically to:

- Better understand the importance of various disposal product features (e.g., cost, ease of use, time to drug neutralization, etc.),
- Identify and evaluate appropriate endpoints for studies assessing opioid disposal options, and to
- Measure and compare the extent of patient opioid (and other medication) disposal across various disposal options and when providing or not providing patient education on opioid disposal.

In conjunction with the Duke-Margolis Center for Health Policy, the workgroup is planning a public meeting for summer 2021 to discuss opioid disposal issues. Depending on the outcome of these efforts, the workgroup will also consider other pathways to gather the data needed to make an informed decision on what disposal products and educational practices to recommend.

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8 APPENDIX A: OBSERVATIONAL STUDIES

Author	Study Design	Study Population	Data Source	Primary Outcome	Opioid Disposal Findings
Abraham 2020	Analysis of online survey response (Year not specified)	A total of 190 students (53% female, 53% White, 32% Hispanic) completed the survey	Data were obtained from students of grades 9-12 from three Wisconsin high schools	Attitudes and knowledge about misuse of prescription opioids, safe handling, storage, information seeking behaviors, and their preferences for education about medication safety practices	Overall, 65% of students had never learned how to dispose of prescription opioids and 70% of students had never learned how to safely store prescription opioids. Students identified their prefer method for receiving opioid safety education which included instructor led lectures (40%), educational websites (34%), online videos (32%), written information sheets (20%), and educational games (18%). (Conference poster: further detail unavailable.)
Ahn 2019	Cross sectional analysis of responses of prescribers (survey year not specified)	A sample of 102 prescribers with a response rate of 31% completed the survey	Data comes from survey of members of Societies for Pediatric Urology (SPU), American Urological Association or Royal College of Surgeons-Canada.	Description and correlates of reported opioid prescribing patterns and attitudes of pediatric urologists' practices in routine ambulatory procedures.	Only 35% of providers provide education to patients on proper disposal of unused opioids, and only 16% of providers believe patients take the majority of opioids prescribed. No further opioid disposal-related details were available in article.
Arora 2020	Cross-sectional analysis of prospective survey responses between July and August 2016)	A total of 91 (majority were female 56% and Latino 93.2%) completed the survey	Data were collected from patients aged 15- to 22-year old in in the Los Angeles County University of Southern California emergency department (ED). Critically ill, psychiatric, and non-English speaking patients were excluded. 29.7% had previously received an opioid prescription (prior prescription date not specified).	Attitudes toward opioid misuse, personal history of prescription opioid use and leftover pills, and willingness to commit to only using opioids as prescribed and disposing of leftover pills	Overall, 29.7% of adolescents had received a prescription for opioids and 40.7% had leftover pills. 87.9% were willing to commit to take opioids only as prescribed and 83.5% were willing to commit to securely disposing leftover opioids. In terms of predictors of willingness to commit to take opioids as prescribed and to secure disposal, there was no significant difference with Opioids naive and approval of opioids misuse status. No further opioid disposal-related details were available in the article.

Author	Study Design	Study Population	Data Source	Primary Outcome	Opioid Disposal Findings
Arwi 2020	Systematic review of articles between database inception and December 1, 2018.	A total of 28 articles included in the review	Data comes from articles searched on MEDLINE, EMBASE, and Cochrane databases. Six articles examined opioid-naïve patients; status unknown in remaining studies.	The potential of harm from discharge opioids after inpatient care including excessive prescribing of discharge opioids, improper handling of unused opioids, and unintentional chronic opioid use	On average, patients consumed only 38% of the prescribed discharge opioid pills. The proportion of opioid-naïve patients still consuming opioids 3 months after hospital discharge is 10.4%. At 6 months, the proportion is 4.4%. Adjusted mean (72%) of patients stored their leftover opioids in an unlocked location, and failure to dispose of unused opioids was reported in 94.5% of patients. Among reviewed articles, five cohort studies reported on the disposal of left-over opioids; the % of patients who failed to dispose their unused opioids 2 weeks post-discharge ranged from 94 to 96%, with an adjusted mean of 94.5%. One study reported that 19% of patients were told how to dispose of their leftover opioids.
Baker 2020	Cross sectional analysis of prospective Survey responses between January and May 2018.	A total of 75 patients completed the survey	Data were collected from patients who received Opioids after surgical procedure (vasectomy) using telephone interviews. Patients were excluded if they had used opioids in the past 30 days.	Determine the most appropriate quantity of medication and post-procedure Opioids disposal methods	A majority of subjects (75.3%) were prescribed excess medication. In total, 648 extra narcotic tablets were given to the study subjects. Regarding medication disposal, 20 (25.9%) of subjects disposed of extra medication, 14 (24.7%) used all medication, and 50.6% did not dispose of their excess opioid medication. In terms of correct disposal, 64.9% reported a correct method with 38.9% flushing in the toilet/sink and 26% returning them to a locked pharmacy collection container. No further opioid disposal-related details were available in the article.

Author	Study Design	Study Population	Data Source	Primary Outcome	Opioid Disposal Findings
Bicket 2019	Longitudinal analysis of prospective Survey responses between August and November 2016.	A total of 140 patients (mean age 56 years; 47 % women) included in the study	Data were collected at 2-day, 2-week, 1-month, and 6-month via telephone from individuals ≥18 years of age undergoing elective same-day or inpatient joint and spine surgery at a large, inner-city tertiary care hospital (JHU, Baltimore MD). 91 patients were opioid naïve at study entry.	(1) the prevalence of unused opioids opioid pills, (2) number of unused opioid tablets reported after stopping opioids, (3) use of nonopioid pain treatments, and (4) knowledge and practice regarding safe opioid storage and disposal	Among patients who stopped opioid therapy at 1 month, 73% of patients reported having unused opioid pills. Among these, 46% had ≥20 unused pills, 37% had ≥200 morphine milligram equivalents. Many patients also reported unsafe storage and failure to dispose of opioids at 1-month (89% and 92%, respectively). Regarding instruction on storage and disposal at 1 month, most patients reported receiving no instructions on how to store (83%) or dispose (75%) of opioids. Of patients who had stopped opioid therapy at the 6-month follow-up, 34% (95% CI, 24%–45%) reported having unused opioids, and 96% were storing pills in an unsecure location. At this time point, 15% of patients reported receiving no instructions on how to dispose of opioids, and 47% said they had not disposed of unused pills.
Bouzaher 2020	Cross sectional analysis of patient, provider, and medical students' responses between December 2017 and April 2018.	A total of 547 participants (255 patient, 212 physician, and 80 medical students with a response rate of approximately 34%, 29%, and 47%, respectively) completed the survey.	Data of new, ambulatory patients 18 years or older presenting for elective consultation at health system orthopedics department; all institutionally employed physicians with active system e-mail addresses; and all current students at a large, nonprofit health care organization and allopathic medical school in Southwestern Virginia. Patient opioid-naïve status was not reported.	To understand patient, provider, and medical students' perceptions and potential misconceptions regarding proper methods of prescription opioid disposal	The majority of physicians believed that their patients are most likely to use in-home methods of disposal or store prescription medications for future use, but 67% of patients indicated a preference for disposing their medications. Within this group, 20% intended to use a home disposal method (flush, throw in trash, mix with trash), 17% a designated disposal box or clinic, 16% a police station or take-back event, and 14% would return their medication to a pharmacy. Sixty-four percent of patient, 56% of physician, and 78% of medical student respondents reported never having received formal education regarding proper methods of opioid disposal. In terms of predictors, there was statistically significant difference in intention for disposal with receiving opioid disposal education and age of patients. Note that some calculations were presented using eligible individuals (750 patients, 732 physicians, 171 medical students) not those who completed the survey.

Author	Study Design	Study Population	Data Source	Primary Outcome	Opioid Disposal Findings
Buffington 2019	Cross sectional analysis of survey responses between September and October 2016.	A total of 152 patients included (majority were female (67%) and aged 35–64 (76%) years) completed the survey.	Patients were part of a previously established research panel. Eligible individuals had a history of acute or chronic pain, had been treated with prescription opioid medication within the preceding 2 years, and had unused (leftover) opioid medication. Opioid-naïve status was not available.	Drivers of disposal behavior and design of future disposal and take-back programs.	Thirty six percent of patients reported that they received information about appropriate methods for disposing of unused medication. Of these, 25 (45.5%) received the information from a pharmacist and 25 (45.5%) received from a prescriber. Fifty (33%) of patients reported that they disposed of their unused opioid medication. Reported methods for disposal included a drug disposal kiosk or other local take-back program (N=25, 50%), flushing in the toilet (N=13, 26%), trash (N=8, 16%), and other unspecified methods (N=4, 8%). In regard to incentives for safe opioid disposal, over 80% of patients indicated they were more likely to use a drug take-back service if they were offered compensation or if the kiosk was in a location that they visited frequently. As of factors for proper disposal behavior, patients that received information about the importance of and methods for appropriate medication disposal, and patients that were prescribed only an extended-release or long-acting opioid reported a greater frequency of unused opioid medication disposal compared to those that did not receive any information and those who were prescribed only an immediate release or short-acting opioid analgesic, respectively.
Choo 2019	Analysis of chart review data and prospective survey responses between January and August 2018.	A total of 64 patients surveyed	Data comes from a chart review of prescribed narcotic and patient-reported usage following tonsillectomy. Only opioid-naïve patients were eligible for the study.	Prescribed amounts of narcotic and patient-reported usage	Across the entire study cohort, patients were overprescribed 50.6% more than they consumed. Sixty-seven percent of patients reported excess narcotic medication (with 228.1 MMEs remaining per patient) following the recovery period: 53.5% of these were still accessible, with 91.30% kept in medicine cabinets and 8.7% in other locations. The remaining 46.5% was disposed via trashcan (20.0%); pouring the medications down the drain, toilet, or garbage disposal (45.0%); or taking the medication to a pharmacy or police department for disposal (35.0%).
Engster 2019	Cross-sectional of online survey	A convenience sample of 243	Data of adolescents who were 12-18 years with at least one controlled prescription medication in the home	Household management (storage, administration, and disposal) of	Of the total sample, 78.2% (n = 190) dyads store medication out of sight, 68.7% (n = 167) lock up medications, 78.2% (n = 190) do not store pills besides a school nurse's office or a

Author	Study Design	Study Population	Data Source	Primary Outcome	Opioid Disposal Findings
	responses between May and July 2017.	adolescent-parent dyads included	and parents via an adolescent medicine clinic associated with a large academic center. Opioid-naïve status was not available.	controlled prescription medications	parent's place of work, and 80.2% (n = 195) dispose of controlled medications in a prescription drug take-back program or by flushing. Families with an adolescent prescription for a controlled medication were more likely to use several core management strategies (periodic parental monitoring, frequent disposal, and appropriate disposal location). More than half of adolescents (50.6%, n=123) and parents (75.7%, n=184) had household leftover medication. Most parents disposed of controlled medications every 3–4 months (64.6%, n=157), yet some parents (20%, n=37) never disposed of them. Thirty-four percent of adolescents (n=84) said their family disposed of controlled medications in a prescription take-back or pill drop program compared to 77% of parents (n=187). A small number of parents disposed of controlled medications by flushing in a toilet (11.4%, n=21).
Garbutt 2019	Cross sectional analysis of self-administered survey responses between March and May 2017.	A total of 700 parents and other caregivers (who had a youth in their home aged 10 or older) attending community-based pediatric practices with 88.3% response rate completed the survey	Parents (77% of respondents) or caregivers in the waiting rooms of 12 pediatric practices in the Midwest. Opioid-naïve status was not reported in the article.	Knowledge, attitudes, and behaviors of adolescents' caregivers regarding prescribed opioids in the home	In total, 242/700 (34.6%) of survey respondents had opioids at home. Ninety-five (13.6%) had active prescriptions, 89 (12.7%) had leftover medications, and 58 (8.3%) had both. Of those with an active prescription, 66.0% intended to keep any leftover medications for future needs, while 26.1% reported they planned to get rid of any leftover medications immediately. Of those with leftover medications, 60.5% retained them for the future needs. Others kept medications unintentionally, either because they never got around to disposing of them (30.6%), they did not know how to dispose of them properly (15.7%), or it never occurred to them to dispose of the medications (7.5%). If leftover opioids were available to them, 7.1% of caregivers indicated that they would use them to provide pain relief for an adolescent and 5.9% indicated they may do so to control pain. No further opioid disposal-related details were available in the article.
Garren 2019	Retrospective analysis of pharmacy database and prospective survey	A total of 67 parents of pediatric patients undergoing inguinal hernia repair (n=39),	Data were obtained using telephone interviews of parents or guardians 2	Postoperative opioid-prescribing and consumption patterns, as well as storage and disposal trends	Sixty-six patients were prescribed opioids after surgery, and 41 (62%) had leftover opioid medication after two weeks of procedure. Thirty-two of 41 (78%) patients did not dispose of their leftover medication. Thirteen (19%) patients received

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	responses between August and December 2017.	circumcision (n=27), or cystoscopy (n=16).	- 3 weeks post discharge. Patient opioid-naïve status was not reported.		perioperative counseling on appropriate storage and disposal of opiates. Nine of the 41 patients with surplus medications were able to specify their disposal method by flushing down the toilet (N = 1), pouring down the sink (N = 5), throwing in the trash (N = 2), or emptying into a designated opiate drop box (N = 1).
Glogovac 2019	Cross sectional analysis of prospective survey responses between June and December 2018.	A total of 50 patients completed the survey	Data were collected from patients undergoing arthroscopic knee surgery prospectively at 1 week, 2 weeks, 4 weeks, and 90 days post-operatively as necessary until opioid cessation at a single academic medical center. Opioid-naïve status was not reported.	Patterns of postoperative narcotic use and determine the impact of psychosocial and perioperative factors on postoperative opioid consumption	Seventy-four percent (37/50) reported surplus pills and 18/37 (49%) of those patients had plans for pill disposal. The most common disposal plans included flushing the surplus pills down the toilet, returning pills to the pharmacy or health center, or depositing pills at a fire station. Forty-three percent (16/37) of patients planned on keeping the surplus pills, and the remainder were unsure what they would do with their extra pills. With regards to predictors of higher consumption, higher pain scores and reported average pain level at 1 week were predictive of higher opioid consumption ($p < 0.05$).
Gregorian 2020	Cross sectional analysis of online survey responses collected from September to October 2018.	A total of 500 patients completed the survey. Patients were recruited from a third-party market research consumer panel.	Data were collected from adults ≥18 years of age who had experienced either acute pain (resulting from surgery or injury) or chronic pain (lasting >90 days) within 90 days before the survey, and who had been prescribed an oral opioid product containing codeine, hydrocodone, hydromorphone, morphine, oxycodone, oxymorphone, or tapentadol. Opioid-naïve status was not reported.	Knowledge and practice of safe opioid storage and disposal	At the time of the survey, 28.0% of patients had either not taken their prescribed medication [n=27, 5.4%] or had leftover pills after reporting that they no longer take their medication [n=113, 22.6%]). One-third of all patients received safe opioid storage (n=176) and/or disposal counseling (n=157, 31.4%) from a healthcare provider, while 50.0% received neither storage nor disposal information. Among the 250 patients counseled, 65.6% reported receiving the information from a physician, 30.4% from a nurse, and/or 32.0% from a pharmacist. The most common form of counseling was verbal (81.2%), while 49.2% of patients received printed materials, and 7.6% received information from electronic sources. Of the 140 patients with unused medication, only 17.9% (n=25) disposed of their opioids and 79.3% still had them in their possession. Patients who received any opioid counseling were more likely to keep their medication in a locked location compared with those who did not (42.4% vs 12.4%, respectively; P<0.0001), as were those who perceived any risk of opioid diversion in the home compared with those who

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					perceived no risk or were unsure (53.7% vs 24.2%, respectively; P<0.0001). Disposal rates did not differ based on counseling received (20.8% counseled vs 16.1% not counseled; P=0.5011) or perceived diversion risk (27.8% perceived any risk vs 16.4% perceived no risk or unsure; P=0.3166).
Holst 2020	Cross sectional analysis of prospective survey responses between March 2017 and January 2018.	A total of 153 adults completed the survey	Data were obtained via a mixture of chart review and telephone responses of adults undergoing lung resection with either minimally invasive surgery (MIS) or thoracotomy from 3 academic centers. Twenty patients indicated they had pre-operative opioid use, but the metric was not defined further in the article.	The amount of opioid medication consumed, the disposition of unused opioids, and predictors of prescribing patterns	The majority of patients (73.7%; 101) had residual opioid medication at the time of the survey, and patients after MIS had a relative increase in amount of remaining opioid medication: 58.3% vs 33.3% (P = .05) of the original prescription. Five patients (of 85 with leftover opioids; 5.9%) had disposed of their remaining opioid medication at the time of survey, and 3 used appropriate disposal strategies. Note that calculations were based on patients with leftover opioids (n=85), not the number completing the survey (n=101).
Holub 2019	Cross sectional analysis of survey response from November to December 2018.	A convenience sample of 178 patients (majority were men (55%); white (74%), > high school degree (64%)) were surveyed	Data comes from adults (18–89 years old) who presented to the ED at University of Rochester Medical Center. Opioid-naïve status was not reported.	Proper disposal of unused opioids and antibiotics medications	More than 1 in 3 patients reported not finishing an opioid prescription as intended (n = 61), and 1 in 5 currently had excess opioids in the home (n = 34). Of those with excess opioids, 38% report retention for later use. Overall, sixty patients reported they do not dispose of excess medication. The most common disposal method was throwing away in garbage/trash (35%), with 26% of these individuals reporting they placed medications in ground coffee beans or kitty litter prior to throwing away (recommended for many medications by the FDA), leave at drop-off location (26%), and flash down the toilet (~11%). The majority of patients (115; 65%) did not know where the nearest drug drop-off location was, though most were willing to use one of these locations (99; 68%). Willingness was a function of distance though, as 57% would travel ≤5 miles and only 14% would travel >10 miles. As predictors, White and older patients were more likely to have excess opioids than non-White and younger individuals ($r = 0.26$, $p = 0.001$; $r = 0.26$, $p < 0.001$). Note that disposal

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					metrics were calculated from the total sample; numbers for each method were not reported in the article.
Huang 2019	Cross sectional analysis of survey responses. Study period was not reported.	A convenience sample of 16 patients.	Data come from Semi-structured telephone and in-person interviews of those who underwent general surgery operations at an academic tertiary hospital. Opioid-naïve status was not reported.	Factors contributing to opioid misuse and barriers to disposal in rural patients undergoing surgery	Patients reported a lack of education regarding postoperative pain control. Many felt they did not need an opioid prescription but took the medication home anyway because they did not know they had a choice, the doctor ordered it, or the prescription was already filled for them. Few patients disposed of leftover opioids after surgery. They cited a number of barriers to disposal including distance to disposal sites, mistrust, and lack of education or incentives to dispose vs saving for future use.
Hunsberger 2019	Longitudinal analysis of prospective survey responses between July 2015 and May 2016.	A total of 115 families of pediatric patients enrolled in the study.	Data comes from patients/families discharged from the post-anesthesia care unit (PACU) with an opioid prescription written by the primary surgical service at the Johns Hopkins Hospital's Children's Center. Opioid-naïve status was not reported.	The amount of opioid prescribed and consumed, duration of treatment, and disposition of unconsumed opioid	Median number of doses prescribed was 30 (interquartile range [IQR], 23-31; n = 138) for both respondents who reported doses remaining (IQR, 29-31; n = 83) and those who did not (IQR, 22-32; n = 55). An estimated 75% (95% CI, 69%-81%) of opioid dispensed was not consumed, and 86% (72/83) of patients took ≤18 doses. Forty-four of 65 (68%) families reported receiving no disposal instructions for leftover opioid, and only 7 families disposed of leftover medication. The most common disposal method reported was flushing down the toilet (n = 5). One family reported returning leftover medication to the pharmacy, and another family reported having thrown the medicine bottle containing leftover opioid into the trash.

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Iobst 2019	Analysis of phone calls received by pharmacies of every children's hospital in the United States, and police stations.	A total of 1477 phone calls were analyzed	Data of phone calls received by 858 pharmacies (436 chain, 422 nonchain), 431 police stations, and 188 children's hospitals in all 50 states.	The rate of unused opioid return acceptance by caregivers, pharmacies, and law enforcement authorities, and whether pharmacies provide patient education regarding the return of unused opioids	In total, 415 of the 1477 (28%) of the contacted locations offered to take the medication. Police stations offered to take the opioids at a significantly higher rate (60%, P<0.001) than pharmacies (15%) or children's hospitals (11%). There was also a significant difference in pharmacy types, with independent pharmacies having a higher take-back rate (24%, P<0.001) than retail chain pharmacies (7%). Finally, 78% of children's hospital pharmacies reported that they recommend proper disposal of any unused opioids at the time the medication is dispensed compared to only 29% of chain and nonchain pharmacies (P<0.0001). The overall opioids return rate was highest (p=0.012) in the Northeast (30%) and lowest in the West (23%). Among the pharmacies, non-metropolitan locations had a slightly higher take-back rate than metropolitan locations (33% vs. 27%, P=0.033). In regard to alternative disposal method, the most common response from the pharmacy and hospital was to mix the opioid with a deterrent (wet coffee grounds, kitty litter, etc.) and throw away in the trash (49.5%). The primary suggestion of police personnel was to dissolve or flush the opioids down the toilet or sink (44%), and others such as disposal bag and mail to DEA.
Kattail 2019	Cross sectional analysis of prescriber responses between April and June 2016.	A total of 127 (38 attending physician, 48 residents, 2 fellows, 19 PA, and 20 nurse practitioners) providers with 71% response rate completed the survey.	Data were obtained from Orthopedic physicians and mid-level providers practicing at Johns Hopkins Medical Institutions and University of Maryland Medical System.	Quantity of opioid prescribed, utilization of PDMPs, and provision of opioid disposal instructions.	Fewer than half (48%) of respondents reported knowing proper opioid disposal methods; 21% of respondents reported instructing patients to dispose of leftover medications. Trainees were least likely to counsel patients or report knowing proper opioids disposal techniques. Attending physicians were 4.5 time more likely (P=0.024) and mid-level providers were 4.4 times more likely (p=0.011) than trainees to report informing patients to dispose of leftover medication. Furthermore, mid-level providers were 4.2 times more likely than trainees to report knowing how to dispose leftover medications (p=0.008). With regard to prescriber's recommendations for disposal methods, 35 (57.4%) of respondents recommended their patients to return unused opioids to the pharmacy, 11 (18%) recommended flushing, 5

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					(8.2%) recommended mixing with ground coffee and throw in garbage, 5(8.2%) retuming to law enforcement agency, and other 4 (6.6%).
Kearney 2019	Mixed method design: Key informants, survey, and focus group discussion in 2017.	A total of 136 participants completed the survey	Data comes from key informant interviews of site coordinators (n = 4), intercept surveys (n = 71), and focus group discussions (n = 8; 61 participants) culturally and linguistically diverse adult participants from suburban subpopulations, four community locations in Bucks County, PA.	knowledge, understanding, and awareness of prescription drug misuse to inform culturally appropriate prevention services particularly prescription disposal interventions.	Approximately one in three survey respondents (30%) had heard of drug-take back events, and one in ten (10%) had participated. Non-English speakers were less likely to both perceive a community problem with prescription drugs (β = - 0.35; p <0 .001) and be aware of take-back opportunities (β = - .23; p = .038). Focus group participants expressed confusion about appropriate medication disposal methods, identifying potential sources of conflicting information. The majority of respondents had not heard of a drug take-back event (68%), while 22% had heard of the events but had not gone. Lack of transportation and low awareness as barriers, police presence and infrequencies of events as challenges, and multilingual marketing materials and integrating with existing prevention programs were mentioned as opportunities for unused opioids take back programs by both key informants, intercept survey respondents and focus group participants.
Klimczak 2020	Cross sectional analysis of an anonymous electronic survey responses from March to July of 2018.	A total of 50 Otolaryngology residents completed the survey (35 residents in NY and 15 program directors [PDs])	Data were obtained from Otolaryngology residents in the greater New York City area and Otolaryngology PDs across the US.	Opioid and non-opioid prescribing habits & influences, use/knowledge of pain management resources, and prior opioid prescribing education	Majority (65.71%) of residents never, and 11.43% rarely, educate their patients postoperatively on how to properly dispose of excess narcotic medication. No further disposal details were reported.

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Kneuss 2019	Cross sectional analysis of responses of hospice program directors from October to December 2017.	A total of 52 directors with 39.4% response rate completed the survey	Data were collected from hospice executive directors of Ohio hospice programs.	Percentage of programs with a written policy in place for disposal of opioids and to calculate a compliance score	All survey respondents report having a written policy in place for disposal of controlled substances containing opioids, and 98% of respondents report providing the policy in written format to patients/family at the time of admission. The overall average compliance score was 95.5%, with the largest disparity occurring in regard to timing of opioid disposal. Although the policy requires opioid disposal at the time opioids are deemed no longer needed, only 84% of hospice programs reported disposing opioids upon discontinuation. All respondents report having a standardized disposal method for unused controlled substances containing opioids implemented within their hospice program. The disposal methods reported by respondents includes home-made disposal kit (41), sewage system (20), commercial disposal kit (12), or take back event (3).
Knight 2019	Cross sectional analysis of prospective survey responses between March 2017 and January 2018.	A total of 195 patients with 74% response rate completed the survey	Data comes from opioid-naïve adults (≥18 years) undergoing open or minimally invasive surgery inguinal hernia repair from 3 centers (Mayo Clinic Arizona, Mayo Clinic Florida, and Mayo Clinic Rochester).	Opioid prescription and consumption	Overall, 91.6% of patients had opioids left over at the time of survey. The majority of patients kept their remaining opioids (77%), whereas a small number of others discarded the medication by throwing it in the trash (6%) or flushing it down the toilet (3%). Only one patient returned their medication to a pharmacy. The remaining 13% patients handled their remaining opioids by other various means (responses not described further in report).
Kunkel 2019	Cross sectional analysis of prospective survey responses between December 2016 and March 2017.	A total of 343 total hip arthroplasty (THA) =199 and total knee arthroplasty (TKA)=144) respondents completed the survey.	Data comes from retrospective electronic medical record review related to preoperative opioid use, and prospective responses of English-speaking patients ≥18 years old, who underwent THA or TKA. Sixty-five patients had taken opioids in the 30 days prior to surgery.	Opioid utilization, excess opioids, and pain control satisfaction	One-hundred thirty-six (39.9%) of patients disposed of unused opioids appropriately. The remaining patients reported that they still had their opioids (N=63, 18.5%), did not know where they were (N=28, 8.2%), or other (N=115, 33.4%). There was no significant association with the type of opioid prescribed and disposed between THA and TKA patients.

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Levy 2019	Cross sectional analysis of online survey responses in May 2018.	A total of 199 respondents surveyed	Data comes from survey of delegates at the 6th World Congress of the Enhanced Recovery After Surgery (ERAS) Society meeting.	Examine the international adoption of postoperative opioid stewardship standards and Education of medical and nursing staff; poor advice to patients on how to taper their opioids and how to dispose of excess opioids	Twenty-one per cent of the respondents' hospitals had a mandatory education program for drug prescribers on safe opioid prescribing. Thirty-six per cent of the respondents' hospitals had a protocol for prescribing discharge medication and 59% of the respondents' hospitals promoted deprescribing. Twenty-nine per cent of the respondents' hospitals promoted safe opioid disposal on discharge and 47% of the respondents felt that opioids were overprescribed in their country.
Lovecchio 2019	Cross sectional analysis of prospective survey responses between September 2017 and 2018.	A total of 85 respondents completed the survey.	Data of adult patients who underwent one-level lumbar decompression or microdiscectomy at two institutions. Non opioid-naïve patients were excluded by design.	Opioid use, the number of pills left over and the method of disposal.	Among 66 (77.6%) of patients who had leftover pain medications, the remaining amount was widely variable (average 13 +/- 21 pills). Only 18/66 patients (27.3%) reported appropriate methods of disposal (destroy or turn into pharmacy/authorities). Among properly disposed (destroy/throw away 14 (16.5%), turn into pharmacy/authorities 4 (4.7%), whereas Keep (21.2%), and unsure/no answer (57.7%)).
Madden 2020	Cross sectional analysis of prospective survey results between February and November 2018.	A total of 106 parents surveyed	Data come from parents of children who filled opioid prescription before their 19th birthday and within the past six months at the University of Texas MD Anderson Cancer Center.	Prescribed opioids safe storage, use, and disposal techniques	Fifty-five of 106 parents (52%) had leftover pain medication. Of the parents who had leftover opioids, 22 (40%) disposed of their child's opioids and 35 (64%) kept it. Among parents who disposed of their child's medication, nine (41%) returned it to the doctor/pharmacy for disposal, five (23%) flushed it down the toilet, 4 (18%) went to a take-back program, three (14%) threw them in the trash, and two (9%) mixed them with cat litter or coffee grounds. (Note that the number of responses may exceed the number of parents because multiple responses were allowed.) Very few parents (6 of 106; 6%) were instructed on how to dispose of their child's opioids.
McEntee 2019	Comparative analysis of pre- and post-operative survey responses between	A total of 99 women enrolled in the study	Data were collected from women undergoing hysterectomy for benign, non-obstetric indications via telephone interview at a university	Opioid prescribing, count of remaining opioid pills and predictors of number of pills taken equivalent to oxycodone	Eighty-one women completed the survey. On average, participants were prescribed 27.8 (std dev 11.3) pills and took 14.5 (std dev 13.2). Eighteen percent (n=15) of patients had an acceptable opioid disposal plan.

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	February 2018 and January 2019.		medical center. Opioid-naïve status was not reported.		
Mishra 2019	Comparative analysis of survey responses. Study time period not reported.	A total of 91 patients surveyed	Data comes from Patients undergoing routine outpatient urologic procedures that were randomized into being prescribed oxycodone or ketorolac for post-procedure pain. Opioid-naïve status was not reported.	Level of pain control, number of pills taken, and method of pill disposal	The oxycodone group used significantly more pills compared to ketorolac (7.4 vs 3.1; p [0.005). In addition, the oxycodone group was significantly more likely to hold onto their pills or dispose them inappropriately despite being provided written and oral instruction on appropriate disposal methods. A large percentage of patients in both groups did not fill or use their analgesics. Only 9% of patients disposed of their medications appropriately
Moustarah 2020	Cross sectional analysis of take-back event participant responses in May 2017.	A total of 104 participants of the event completed onsite survey	Data obtained from a community medication take-back event at the University of Michigan.	The study aimed to collect, count, and classify the types of turned-in medications	There were 1798 individual opioid dosing units (MME =16,689) collected and identified in the prescription drug category during medication take-back event. Of the 104 separate batches of dropped-off medications, opioid analgesics were reported in 77 (74%). Youth were reported living in the homes of 24 of the 104 surveyed participants, and people from 21 of the 24 homes with youth (87.5%) reported bringing unused opioids to the drop-off site.
Newberry 2019	Cross sectional analysis of electronic medical records and survey responses between March 2017 and August 2018.	A total of 364 patients surveyed	Data comes from electronic medical records and response of patients undergoing sino-nasal surgery within a single health-care system.	Predictors of opioid usage and prescription patterns	Three-hundred and nine patients (84.9%) had excess narcotics. Of these patients, 217 patients (70.3%) kept the remaining tablets, whereas 74 patients properly discarded excess medications by either disposing of medications in a medical drop box (n = 64, 86.5%) or flushing the designated narcotics (n = 10, 13.5%) or threw away in trash (n=15, 20.3%). Overall, 23.9% of patients properly disposed of remaining narcotics, whereas 76.1% of patients incorrectly discarded/kept excess opioids. Note that disposal metrics were calculated using only the 74 patients who discarded their excess medication.

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Patel 2019	Secondary analysis of Opioid Reduction Intervention for Open, Laparoscopic, and Endoscopic Surgery (ORIOLES) Initiative data collected between August 2017 and January 2018.	A total of 205 patients completed the follow up evaluation	Patient data is form ORIOLES, a study that was initiated to improve prescribing practice for Radical Prostatectomy (RP) across nine surgeons at Johns Hopkins Medical Institutions. The opioid-naïve status of participating patients was not reported.	To quantify the amount of Opioid prescribed, used, and predictors of Opioid use	Overall, 77% of post-discharge opioid medication was unused, with 84% of patients requiring ≤112.5mg OMEQ. Only 9% of patients appropriately disposed of leftover medication by 30 d (drop off or flushed) while 87% had medication at home. There was significant difference in the amount of opioid at home or not disposed between open RP 31 (74%) and robotic RP 120 (92%), p= 0.02). The study also reported disposal methods by surgical methods as Open and Robotic RP: medication drop off 9.6 % and 4.6%, flushed down the toilet 9.5% and 1.5%, thrown out 4.8% and 2.3%, and other methods 2.4% and 0%, respectively.
Premkumar 2019	Cross sectional analysis of survey responses collected between September 2017 and October 2018.	A total of 112 patients completed the survey	Data were collected from patients undergoing primary unilateral total knee arthroplasty (TKA) surgery with one of eight arthroplasty surgeons at a single specialty hospital. Patients with daily opioid use for the prior six months were excluded, but individuals with "intermittent" use (not further defined; n=10, 9.7%) were included in the analysis.	Postoperative opioid consumption and rate of appropriate disposal of excess opioid prescriptions	Sixty-six patients (64.1%) had leftover opioid medications at six weeks post-surgery. Thirty-seven patients (56.1%) saved their medication, while 17 (25.7%) were unsure of what do with it. Nine patients (13.6%) threw away or destroyed their medication, 8 individuals (12.1%) returned it to the pharmacy or authorities, and one person (1.5%) never filled the prescription.
Prentice 2019	Cross sectional analysis of chart review and Survey responses	A total of 30 patients (20 with vaginal deliveries and 10 with CS) included in the analysis	Data comes from chart review and telephone interview of patients who were recruited at the time of admission to the Labor and Delivery Unit at a community hospital in Oklahoma City, Oklahoma. Opioid-naïve status was not reported.	Determine the number of opiates prescribed and used during postpartum period	Patients prescribed opiates after a vaginal delivery were prescribed significantly more opiates than used (P<0.001). An average of 10 opiates per person were unused. Patients prescribed opiates after cesarean section were also often prescribed more opiates than used (P<0.05). Of 30 patients, only two disposed of remaining opioid pills

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Pruitt 2019	Cross sectional analysis of electronic medical records and postoperative survey responses between January 2017 and August 2018.	A total of 862 patients completed the survey	Used data from electronic medical records and responses of adult patients (18 years of age or older) undergoing OHNS surgical procedures within the Intermountain Hospital System. Seven hundred ten (82.4%) patients were opioid-naïve, while the remaining participants had recent opioid exposure.	Surgeon opioid prescribing patterns, opioid consumption by patients, and method of disposal	Overall, 693 patients (80%) had leftover opioid at the time of e-survey, a total of 56% of the total amount of opioids prescribed. Instructions for proper opioid disposal were provided to 432 patients (50%). Of the patients with excess opioids, most kept the excess opioid (n = 498; 72%). Of those who did not keep the excess, 123 patients (18%) disposed of the excess in a medication disposal box; 32 (5%) flushed excess; 27 (4%) threw away excess in the trash; two (0.3%) lost excess; one (0.1%) gave excess to a friend or family member; and seven (1%) did not report what was done with the excess opioid.
Schwartz 2019	Cross sectional analysis of methadone clinic directors in July 2018.	A total of 35 clinic directors completed the responses	Data were collected from directors of methadone clinics serving the Poison Control Centers (PCC) catchment area.	Content and frequency of medication safety education given to methadone clinic patients, the use and distribution of medication lock boxes/bags for storage in the home, and medication disposal information provided to patients	Medication safety education is provided through individual instruction (100%), printed information (52%), and group instruction (18%). In regard to who provides the education, counselors (93%), nurses (89%), and physicians (79%). Educational sessions are delivered at intake (89%), immediately prior to take home methadone prescription (78%), and during counseling sessions (78%). Regarding medication safety messages included: a small amount is potentially fatal (89%), safe storage in a locked location can prevent injury (96%), and unused medicine should be disposed of safely (81%). The most common recommendation for disposal of methadone was returning it to the clinic for disposal (69%). The majority of clinics reported that they do not distribute medication lock boxes (89%) or bags (96%). Of the three sites that do distribute lock boxes/bags, all include safe storage information with these boxes/bags in the form of verbal instruction and written information. None of the sites charge patients for the medication lock boxes/bags.

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Sada 2020	Cross sectional analysis of chart review and survey responses between March 2017 and January 2018.	A total of 91 patients completed the survey	Data comes from chart review and responses of patients undergoing parathyroidectomy at academic centers in 3 states (Arizona, Florida, and Minnesota). Eighty-two patients (90.1%) were opioid-naïve, and nine patients (9.9%) had pre-operative opioid use.	The amount and duration of opioid consumption, opioid refills, the use for nonprescribed alternative pain control, disposition of remaining opioid, and patients' overall experience with pain management.	At the time of our survey, 64.2% of patients reported they were prescribed the right amount of opioid, while 35.8% reported being prescribed too much and none reported they were not prescribed enough. Approximately 94.5% of prescribed opioids were unused, and 95% of patients kept their unused medication. No further opioid disposal information was reported.
Selekman 2020	Cross sectional survey of pharmacies in California in April 2018.	898 pharmacies responded to the survey	Data were collected from pharmacies using telephone-based, secret-shopper survey in California.	Accuracy of information pharmacies have given about the proper disposal of unused antibiotics and opioids.	Two hundred four pharmacies (19% [CI, 16% to 23%]) provided correct opioid disposal information. Correct opioids disposal information was given 20% of the time on a weekday call and 7% of the time on a weekend call. When directly queried about a take-back program at their location, 82 of 898 pharmacies (11% [CI, 8% to 14%]) reported a program for opioids disposal.
Shahi 2020	Cross sectional analysis of prospectively collected survey responses between April and December 2019.	A total of 142 parents of burn injury children surveyed	Data were collected from Parents of burn-injured children 8 months to 18 years old, who were seen in an outpatient setting within 2 weeks of their burn injury from.	The current use of opioids, storage, and disposal of opioids	Of the 23 patients whose parents filled the opioid prescription, only 3 used the entirety of the prescription and no patient used their entire prescription. In regard to storage and disposal of opioids, the most common storage responses were the kitchen counter (38%, 10/26) and the bathroom cabinet (31%, 8/26). Fewer than a quarter of patients stored opioid pain medications in a locked box (23%, 6/26) or in a locked bathroom cabinet (15%, 4/26). Only 27% (7/26) of the parents were educated on the safe disposal of opioids.

Author	Study Design	Study Population	Data Source	Primary Outcome	Opioid Disposal Findings
Sheally 2019	Cross sectional analysis of returned medications between 2013 and 2016.	A total of 242 returned medications analyzed.	Data collected during medication take-back days in a rural South Carolina town.	Rates of returns and trends in returns of potentially abused medications during medication take-back events	In 2013, 742 different medications were returned, and 64 (8.63%) were potential drugs of abuse. In the years 2014-2016, 117 (11.43%) returned medications were potential drugs of abuse. In 2017, 40 (13.27%) returned medications were potentially abused drugs. Opioid analgesics were the most common potentially abused medication returned, accounting for 51.6%, 62.4%, and 65% of potentially abused medications returned in 2013, 2014-2016, and 2017, respectively. In 2013, the most commonly returned medications were opioids analgesics (51.56%) and dextromethorphan (12.5%). During 2014-2016, the most frequently returned medications included opioid analgesics (62.39%), benzodiazepines (12.82%), and dextromethorphan (9.40%). In 2017, the opioid analgesics (65%) and hypnotics (12.5%).
Sheth 2020	A systematic review of articles in selected electronic databases from inception to 2018.	Eight studies) 816 patients) were included in the review. Five of these (348 patients total) asked about opioid disposal knowledge.	Articles reporting on postoperative opioid prescribing practices and consumption after arthroscopic shoulder, knee, or hip surgery were obtained from EMBASE, MEDLINE, and PubMed databases.	Opioid prescribing practices and rates of opioid consumption among patients undergoing common sports medicine procedures.	A mean of 610, 197, and 613 MMEs were prescribed to patients after arthroscopic procedures of the shoulder, knee, and hip, respectively. At final follow-up, 31%, 34%, and 64% of the prescribed opioids provided after shoulder, knee, and hip arthroscopy, respectively, remained. Of the 348 patients evaluated in the five studies that asked about opioid disposal behavior, 36% of patients had received preoperative instruction or were aware of the proper means by which to dispose of leftover opioids.
Shi 2019	Cross sectional analysis of prospective, single-centered record review and survey responses between December 2017 and February 2018.	A total of 98 patients completed the survey	Data comes from electronic health record, chart review and responses of patients discharged home who received an oral opioid prescription at the Intermountain Medical Center ED. Patient opioid-naïve status was not reported.	The percentage of patients with unused opioids and the quantity of opioids remaining 14 to 21 days post ED discharge	The median number of pills prescribed was 8 (IQR:8–12). Nearly half (49%) of patients had unused opioids 14 to 21 days post ED discharge, excluding 9.2% of patients who never filled their prescriptions. 21.4% of patients reported receiving counseling on storage and disposal. Of the 48 patients with unused opioid pills, 40 patients (83.3%) reported not expecting to finish the prescription, and 28 of 40 (70%) patients expressed plans to keep the remaining opioids for future use. Among the 12 patients with plans to dispose of medication, 7 patients had plans to dispose of opioids at the

Author	Study Design	Study Population	Data Source	Primary Outcome	Opioid Disposal Findings
					police or sheriff's department while 5 patients reported plans to dispose of opioids in toilet or sink.
Sloss 2019	Cross sectional analysis of survey responses between April and December 2018.	A total of 804 (63.9% of parents were male with median age of their children 5 years) parents with 59% response rate completed the survey. Opioid-naïve status was not reported.	Data come from parents of children aged younger than 18 years who were contacted by telephone 7 to 21 days after operation at an academic children's hospital.	Opioid use, storage, disposal, and education	Education on storage was reported by 29.2% of parents and disposal by 24.5%. Among 417 parents who filled an opioid prescription, 81 (18.9%) reported locked storage. Locked storage and storage education were significantly associated (education: 23.3%; no education: 14.7%; adjusted odds ratio 1.85; 95% CI 1.09 to 3.15; p = 0.02). Among 309 parents with leftover medication, 72 (21.4%) disposed of excess. There was no association between disposal and disposal education (education: 21.4%; no education: 26.3%; adjusted odds ratio 0.78; 95% CI 0.46 to 1.34; p = 0.37). Common reasons for not disposing were: "I plan to but haven't" (65%), "My child may need it again" (43.9%), "I don't know how to" (7.2%), and "I wasn't told to" (5.5%).

Author	Study Design	Study Population	Data Source	Primary Outcome	Opioid Disposal Findings
Sloss 2020	Analysis prospective phone or in-person survey responses between April 2018 and March 2019.	A total of 606 caregivers responded to the survey	Data were collected from caregivers or 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 an affiliated outpatient surgical center. Patient opioid-naïve status was not reported.	The proportions of unsafe storage, unsafe use, and unsafe disposal of opioids	Among study sample, 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, 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%). 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. 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%).
Theisen 2019	Cross sectional analysis of prospectively (after 3-4 weeks post-operation) collected survey data between January and May of 2017.	A total of 155 patients included in the analysis	Data were collected from opioid naïve patients who underwent a major prostate or kidney operation.	Prescribed, used, and disposal of opioids	Overall, a total of 4065 oxycodone-equivalents were prescribed during the study period, and 60% of pills prescribed went unused. This resulted in 2622 excess pills in the community. Of cohorts of this study, no patients reported receiving counseling on proper disposal of unused opioids. With regard to storage, 104 of 155 (67%) patients reported having excess opioids stored in their home, with a median of 23 oxycodone-equivalents per patient (IQR 7-33).

Author	Study Design	Study Population	Data Source	Primary Outcome	Opioid Disposal Findings
Tse 2019	Comparative analysis of prescribers (attending vs residents) responses. Study period was not reported.	A total of 22 surgical attendings and residents surveyed	Data comes from prescribers in the VCU Health System who were surveyed about personal opioid prescription education and behavior.	Personal opioid prescription education and behavior.	Surgical attendings were more likely to report knowledge of opioid prescription guidelines (85% vs 56%, p<0.02) and disposal regulations than residents (54% vs 31%, p<0.02). Attendings were also more likely than residents (69 vs 28%, p<0.003) to have received formal education on opioid prescriptions. For many common general surgery procedures, an average of 59% less OME was prescribed by residents when compared to attendings (p<0.03)
Varisco 2019	Cross sectional analysis of internet-based survey responses. Study time period was not reported.	A total of 400 patients surveyed	Participants were recruited from a nationally representative panel of adults (aged 18 years and older) opioid users with chronic pain. Opioid-naïve status was not reported.	Effect of health care practitioner counseling on medication disposal and disposal of unused opioid medications	In total, 44.5% of respondents (n = 178) had disposed of an opioid medication (note: total respondents with leftover opioids was not reported), 38.5% (154) had disposed of another controlled substance, and 181 (45.25%) had disposed of another prescription drug. The most commonly selected method was flushing unused medications down the toilet (33%), household garbage (29%), hazardous waste facility (30.9%), mix with another substance (15.7%), returned to the pharmacy for disposal (17.4%), and returned medications at a DEA takeback event (10.1%). More than two-thirds (70.2%) of participants responded that they had less than 25% of their opioid prescription remaining at the time of disposal. More than half of participants (n = 243; 60.75%) had received counseling on medication disposal from a health professional in the previous year. Of these, 62.6% were counseled by a general practitioner, 21.4% were counseled by a pharmacist, and 32.1% received counseling from a pain management specialist. After adjustment for covariates, those who received health care practitioner counseling were more likely to have disposed of opioid medications in the past year (adjusted odds ratio 1.66, 95% CI 1.03-2.69).

9 APPENDIX B: INTERVENTIONAL STUDIES

Author	Study Design	Study Population	Data Source	Intervention	Primary Outcome	Opioid Disposal Findings
Adler 2020	Feasibility study of patients who returned with those who didn't return opioids between November 2017 and October 2018.	A total of 331 participants included in the analysis	Data were obtained from children and adolescents prescribed opioids after outpatient surgery at Texas Children's Hospital's main campus. Patient opioid-naïve status was not reported.	Participants were provided a return envelope as well as instruction on the dangers of opioids in the home by an anesthesiologist	Rate of opioid return by using a mail-back envelope	In total, 64 (19.3%) of patients returned opioids using the provided envelopes. The total of 2000 mL of liquid opioids and 250 tablets (nearly 3000 mg of oral morphine equivalents) were removed from the homes of the 64 participants returning unused medications. Of these patients, the median rate of return was 58% of the written prescription. Hydrocodone and acetaminophen in liquid and tablet forms constitute 46.8% and 48.4% of the total return, respectively. Note that values for the control group (i.e., disposal rates for those who did not receive either education or a mail-back envelope) were not reported.
Brummett 2019	Randomized clinical trial conducted between June 2016 and July 2017.	A total of 208 participants included in the analysis	Used data of opioid-naive patients 18 years or older undergoing an outpatient surgical procedure at Michigan Medicine.	(1) usual care, (2) educational pamphlet with detailed instructions for locating DEA–registered disposal locations (3) activated charcoal bag for opioid deactivation (DEA System; Verde Technologies).	The effect of an activated charcoal bag that allows for in-home opioid disposal on the probability of disposal after a surgical procedure, compared to usual care or educational materials detailing disposal resources	The study reported that 28.6% patients who received usual care reported disposing opioids, compared with 33.3% patients who received education regarding disposal locations and 57.1% patients who received a charcoal activated bag. After adjusting for preoperative characteristics (age, gender, ethnicity, type of surgery, insurance type), the odds of opioid disposal were 3.8 (95% CI, 1.7-8.5) times higher among participants who received a charcoal bag compared with those who received usual care. Participants who received a charcoal bag reported significantly less medication flushing (5.0%), compared with those who received pamphlet (20%), usual care (16.7%) or participants who received a charcoal bag reported inappropriate garbage disposal (5.0%), compared with those who received pamphlet (20%), usual care (11.1%) and were statistically significantly less likely to leave the home for disposal (2.5%), when compared with participants in the other 2 groups.

Author	Study Design	Study Population	Data Source	Intervention	Primary Outcome	Opioid Disposal Findings
Cabo 2019	Pre/post intervention analysis. Pre-intervention data collected between October 2017 and January 2018; timeframe for post-intervention data collection not reported.	A total of 127 patients (retrospective or pre-education =68 and prospective/post-education =59) included in the analysis	Data comes from patients who underwent urological surgery during the pre- and post-intervention time frames. Patients with previous chronic pain diagnoses and those with previous opioid prescriptions were eligible for participation.	Patient education handout detailing FDA approved disposal methods	Trends in postoperative opiate use, predictors of opiate keeping and the effectiveness of a patient education handout for improving the rate of proper opiate disposal	In the pre-education cohort, 57 (84%) had a preexisting opiate prescription or had received a postoperative prescription from a urologist. Of these patients, 41 (72%) exhibited opiate keeping behavior. Of the nonkeepers, 11/16 used all of prescription while 5 (31%) disposed of leftover medication in a FDA compliant manner (3 flushed excess down the toilet and 2 returned to a pharmacy with a take-back box). Of the keepers, 68% kept the opiates unsecured while 27% stored the medication in a locked container. In the post education cohort, no significant difference in opiate keeping (72% vs 68%, p = 0.66) or disposal practices (9% vs 8%, p= 1.0) between pre-education and post-education groups. Across entire patient population opiate keepers were less knowledgeable about safe disposal practices than nonkeepers (72% vs 85%, p= 0.005). Opiate keepers scored significantly higher (11%) on the knowledge score assessment in the post-education group compared to the pre-education group (77% vs 66%, p=0.03). Of the 25 patients who kept the opiates in the post-education cohort, 20 (80%) left the medication unsecured, 3 (12%) stored it securely and 2 (8%) gave the leftover medication away.
Egan 2020	Pre/post intervention analysis conducted in Fall 2019.	A total of 491 residents completed the survey	Data comes from residents of Five rural, Appalachian counties (three in Kentucky and two in North Carolina).	Exposure to messages that incorporated perceived benefits of proper disposal, self-efficacy surrounding disposal, and cues to action for proper disposal of prescription medications. The four messages focused	To develop and test community-based campaign message to encourage disposal of unused opioid medications.	Following exposure to message sets with Message 1, participants agreed more strongly with the statement that they worry about having unused opioids in the home ($\beta = 0.25$ (SE = 0.11); 95% CI = 0.03, 0.46). Exposure to message sets with Message 3 was associated with increased confidence in knowledge of disposing unused prescription opioids from baseline to post-exposure ($\beta = 0.20$ (SE = 0.09); 95% CI = 0.02, 0.28). Conversely, participants exposed to message sets with Message 4 had decreased agreement with the statements on being worried about having unused prescription opioids in the home ($\beta = -0.34$ (SE =

Author	Study Design	Study Population	Data Source	Intervention	Primary Outcome	Opioid Disposal Findings
				around worry (message 1), risks (message 2), and encouragement (message 3 &4).		0.11); 95% CI = −0.55, −0.13), perceived risks associated with having unused prescription opioids in the home (β = −0.30 (SE = 0.11); 95% CI = −0.51, −0.09), and confidence in knowing how to dispose of unused prescription opioids (β = −0.24 (SE = 0.09); 95% CI = −0.41, −0.06).
Glaser 2020	Pre/post intervention analysis; pre-intervention period was March 2017 to October 2017; post-intervention was October 2017 to May 2018.	A total sample of 1219 patients (620 women in the tiered guideline cohort and 599 in the historical controls) included in the analysis	Data comes from a survey response of patients prescribed opioids during discharge using tiered guidelines after undergoing ovarian cancer laparotomy compared to consecutive historical control data from electronic medical records at three affiliated sites (Minnesota, Arizona, and Florida). Opioid-naïve status was not reported.	Standardized opioid prescription guidelines and targeted patient education at the pre-surgical visit, Obstetrics and Gynecology grand rounds, nursing education sessions, individual sessions with pharmacists, and group education of office staff.	The impact of implementing standardized guidelines for opioid prescriptions after gynecologic surgery and describe patient perspectives before and after its implementation	Both pre- and post-intervention, greater than 75% of patients with remaining opioid medication at the end of their treatment kept excess medications rather than dispose of them. No additional disposal information was reported.
Hite 2020	Pre/post intervention analysis conducted between 2018 and 2019.	A total of 53 patients in pre-intervention; 66 patients completed the post-intervention assessment	Data comes from quality improvement project that was implemented in the comprehensive breast surgery clinic and included female patients undergoing breast surgery for high risk breast lesions or breast cancer. Five patients in the pre-intervention group and four patients in the post-intervention group indicated they used	A standardized postoperative prescribing practice for prescribers; patients received preoperative educational handouts in clinic regarding the risks of opioid addiction; a charcoal disposal bag with disposal instructions was given to patients.	Opioid use, disposal practices, and pain satisfaction scores	Pre-intervention, most patients (n = 39, 83%) responded that they had unused pills. The majority (58%) of patients responded that the excess pills were in an unlocked cabinet at home, and 74% of patients had received narcotic safety education before surgery. Post-intervention, 89% of patients had pills left over. Receipt of preoperative educational handout was confirmed by 74% (n = 43) patients, of which 41 patients reported to have read the handout, and 89% (n = 39) of those who read the handout found to it be useful. In addition, 70% (n = 42) of patients reported receipt of the charcoal disposal bag. Of patients who received a charcoal bag, 37% (n = 17) used the bag.

Author	Study Design	Study Population	Data Source	Intervention	Primary Outcome	Opioid Disposal Findings
			pain medications daily prior to their operation.			
Jacobs 2019	Pre/post intervention analysis conducted between May 2018 and January 2019.	A total of 95 patients enrolled in the study with 41 (43%) receiving the educational intervention	Data comes from patients who received a survey at their first follow-up visit to determine opioid use, satisfaction with pain control, and disposal practice at a single tertiary academic medical center. Participants were allowed prior opioid use (further detail not reported).	The Safe Pain Control educational brochure for patients preparing for surgical procedures recently published by the American College of Surgeons	Opioid use and safe disposal practices	Intervention patients reported similar levels of satisfaction with pain control as controls but had a significantly higher number of unused opioid pills remaining (9.4 ± 4.7 intervention vs 4.7 ± 2.4 control; $p < 0.01$) at follow-up. Among the 37 patients with pills remaining, those receiving the intervention were more likely to report disposing unused opioids (72% intervention vs 44% control; $p < 0.05$) compared with saving for future use.
Khorfan 2020	Pre/post intervention analysis between April and December 2018.	A total of 112 patients with 28.8% response rate completed the survey.	Data of patients who had an elective operation at large, academic, general surgery clinic. Opioid-naïve status was not reported.	A multi-component intervention, including patient and providers education, and an in-clinic disposal box	Effectiveness of patient exposure to an intervention, and predictors of postoperative use and disposal of opioids.	Of the 58 patients who reported they had excess unused opioid pills, 14 (24%) disposed of the excess, and another 20 (35%) stated they intended to dispose of them. Only three patients used the in-clinic disposal box, while the remaining 11 patients disposed of their excess at home. While the overall disposal rate was relatively low, it was greater among those who received preoperative education compared to those who had not (29.8% vs 0%; $P < .05$).
Lam 2020	Randomized clinical trial conducted between January and August 2019.	A total of 175 (91 usual care, 84 women undergoing cesarean section (CS).	Data were collected from women ≥18 years starting 14 days post CS. Those with opioid use disorders or opioid use in pregnancy were excluded.	Standard care or discharge education with handouts and in-person instruction about optimal analgesic use	Number of analgesic tablets used and leftover, location of leftover opioids, and knowledge of optimal analgesic use (score 1-10)	Discharge education was associated with lower opioid use among participants who completed a college (OR 0.15, 95% CI 0.05-0.45) or graduate (OR 0.15, 95% CI 0.04-0.60) degree. Participants with discharge education were significantly more likely to properly dispose of leftover opioid tablets (38%) compared to women in the usual care group (16.9%). Note that the denominator for disposal metrics were calculated out of those who had leftover opioids.

Author	Study Design	Study Population	Data Source	Intervention	Primary Outcome	Opioid Disposal Findings
Lawrence 2019	Randomized clinical trial conducted from June to December 2018.	A total of 181 parents or guardians (92 in the intervention arm and 82 in the standard care arm) completed follow up.	Parents or guardians of children 1 to 17 years of age who underwent otolaryngologic or urologic surgery and prescribed an opioid prescription prior to discharge at the outpatient surgery centers of a tertiary children's hospital in Columbus, Ohio. Patient opioid-naïve status was not reported.	A drug disposal bag containing activated charcoal and instructions for use plus standard postoperative discharge instructions on opioid use, storage, and disposal	Effectiveness of a drug disposal bag on proper opioid disposal	At initial randomization, 92 families received a disposal bag and 89 families did not. Among all participants, 66 of the families (71.7%) randomized to receive a disposal bag reported properly disposing of their child's opioids, whereas 50 parents (56.2%) who did not receive a disposal bag reported proper opioid disposal (difference in proportions, 15.5%; 95% CI, 1.7%-29.3%; P = 0.03). Among only those families who filled an opioid prescription and had leftover opioids after resolution of their child's pain, 66 of 77 parents or guardians (85.7%) who had received a disposal bag and 50 of 77 parents or guardians (64.9%) who had received standard care reported properly disposing of their child's opioids (difference in proportions, 20.8%; 95% CI, 7.6%-34.0%). Among parents reporting disposal, the majority not receiving a disposal bag disposed of their child’s opioids by pouring them in the toilet or sink (34 of 54[63.0%]) whereas the majority of those receiving a disposal bag used it for opioid disposal (60 of 67 [89.6%]).
Liu 2020	Prospective cohort study conducted between April 2017 and August 2018.	A total of 578 eligible patients for buyback program was contacted	Data were obtained from the state PDMP, a computerized Patient Record System, and directly from patients aged 18 years or older who had ambulatory surgery and routinely prescribed opioids after ambulatory surgery at a single rural VA institution. Patients on chronic opioid therapy pre-operatively were excluded.	Discharge instruction and informational letter printed on pink paper in the bag and a pink reminder sticker on the bottle stating, “Return unused pills for $$." ($5 per pill with a limit of $50 if patients returned their unused opioid pain medication within 60 days). The findings of the buyback program were presented to	To motivate and educate patients about proper drug disposal while measuring actual opioid use by using a small monetary reimbursement in a rural environment.	Overall, 171 (29.6%) eligible patients returned unused opioid pills after ambulatory surgery as part of this program. Patients who returned unused opioids were older (P < 0.001) and more likely to be opioid naive (P <0 .001). After the findings were presented to surgeons as an education intervention, surgeons prescribed opioids to fewer patients after the same procedures (62.3% in 2017 vs 50.5% in 2018; P < .001).

Author	Study Design	Study Population	Data Source	Intervention	Primary Outcome	Opioid Disposal Findings
				prescribers as an education intervention.		
McCarthy 2019	Randomized clinical trial (study time period not reported).	652 patients enrolled, 57% were female, with a mean age of 42 years.	Used data of discharged patients at an urban academic ED with new hydrocodone-acetaminophen prescriptions received 1 of 3 care pathways based on randomization allocation of their physician: (1) usual care (UC), (2) EMC2intervention, or (3) EMC2+ SMS text messaging. Opioid-naïve status was not reported.	EMC2 intervention group exposed to educational tools (MedSheet, patient-centered prescription wording) and 3 provider-facing reminders to counsel (directed to ED physician, dispensing pharmacist, and follow-up physician), whereas those in EMC2+ SMS arm additionally received 1 text/day for 7 days post-visit	Assessed safe use of opioid analgesics and medication knowledge, patient knowledge, and self-report of activities associated with safety of use (e.g., storage, disposal).	There was no difference between arms in the primary outcome of demonstrated safe use (UC 68.4%, vs EMC282% [p=0.04], UC vs EMC2+ SMS 76% [p=0.31]). Those in the EMC2+ SMS were more likely to plan to dispose of their unused pills (70.5%) versus UC (33.9%, p<0.001). No further disposal information was reported.
Mocon 2019	Pre/post intervention analysis; pre-intervention period was April to June 2017; post-intervention was November 2017 to January 2018.	127 pre-intervention patients and 109 post-intervention patients were included.	Data comes from Patients undergoing laparoscopic appendectomy (LA) and laparoscopic cholecystectomy (LC) that were recruited prospectively during two separate time periods. Opioid-naïve status was not reported.	Pre-intervention patient data was used to create a baseline and create the intervention, a standardized prescription, that was given to post-intervention participants.	The outcomes were quantity of opioid medication prescribed and consumed; patient satisfaction with analgesia and disposal methods for unused opioids.	Pre-intervention, less than 10% of patients received education regarding proper disposal of unused opioids and fewer than 5% had disposed of the unused opioids. Post-intervention, there was a significant decrease in the median number of opioid pills prescribed (20 vs. 10) and consumed (2 vs. 0). The number of patients receiving opioid education increased (10% vs. 44%). Both pre-and post-intervention, fewer than 5% had disposed of the unused opioids.

Author	Study Design	Study Population	Data Source	Intervention	Primary Outcome	Opioid Disposal Findings
Nahhas 2020	Randomized clinical trial conducted between August 2018 and May 2019.	A total of 539 patients completed the survey	Data comes from electronic medical records and responses of patients scheduled to undergo inpatient or outpatient unilateral primary total hip arthroplasty, primary total knee arthroplasty, or unicompartmental knee arthroplasty. 79 patients reported pre-operative opioid use.	Educational pamphlets (N=229), educational pamphlets plus text messages (N=187), or usual care (N=147).	Baseline rate of proper disposal of unused opioids, and impacts of educational intervention on disposal rates	Overall, 342 patients (63.5%) had unused opioid pills at 6 weeks postoperatively: 89 patients in the usual care group, 128 patients in the pamphlet group, and 125 patients in the pamphlet and text message group. Of these 342 patients, 8/89 (9.0%) of patients in the usual care group, 42/128 (32.8%) of patients in the pamphlet group, and 48/125 (38.4%) of patients in the pamphlet and text message group properly disposed of their unused opioids ($p = 0.001$). There was a significant difference in the proportion of patients who kept their unused opioid pills in the household after six weeks, 82.0% of patients in the usual care group, 64.1% of patients in the pamphlet group, and 54.4% of patients in the pamphlet and text message group ($p < 0.001$). The most commonly used proper method of disposal was flushing (2.3% in the usual care group, 12.8% in the pamphlet group, and 16.4% in the pamphlet and text message group), followed by return to the pharmacy (3.1% in the usual care group, 2.1% in the pamphlet group, and 3.5% in the pamphlet and text message group). Improper disposal methods (garbage, give away, others) includes: 9% in the usual care group, 3.1% in the pamphlet group, and 7.2% in the pamphlet and text message group.
Ramel 2020	Analysis of chart review and survey responses between August and November 2018.	A total of 149 patients completed the survey vs. a historical comparison group	Data were collected from patients who were at least 18 years old, English-speaking US residents who underwent gynecologic, urologic, general, breast, plastic, or colorectal surgery during their admission and picked up an oxycodone or hydromorphone prescription at a single	Patients were provided a Drug Deactivation system (DDS) and an education sheet by dispensing pharmacist explaining how to use the DDS along with their opioid prescription. The	The impact of providing a DDS to post-surgical patients on the rate of opioid prescription disposal.	One hundred six patients reported having leftover opioids. Of these patients, 29 (27.4%) of had disposed of the remaining medication; 23 of those patients used the DDS as their method of disposal. Of these, 22 (95.6%) reported that they were very satisfied with the disposal process. Seventy-three respondents reported that they were keeping the medication for future use. Thirty-three respondents (of the 149 surveyed) planned to use the disposal bag on a future date.

Author	Study Design	Study Population	Data Source	Intervention	Primary Outcome	Opioid Disposal Findings
			outpatient pharmacy upon dismissal from an inpatient surgical unit. Patients who used opioids prior to admission were excluded.	DDS used was a 12-oz Deterra bag		
Stokes 2020	Comparative analysis of survey responses collected between March and December 2018.	A sample of 571 patients with a response of 92% completed the survey	Collected data were linked with medical records of adult patients (≥18 years) undergoing elective procedures in general, vascular, thoracic, and plastic surgery at the University of Utah. Sixty-five patients had a history of opioid use (not further defined) prior to surgery.	Patient in the intervention group received opioid disposal kit and educational handout before discharge from hospital	Effectiveness of postoperative opioid disposal kit	Of the 286 (60.0%) patients who still had opioid pills remaining at follow-up, 52 (18.3%) reported ongoing need, 100 (35.2%) reported keeping the medications for future use, and 109 (38.4%) reported planning to dispose of the medication. Among patients who had disposed of their medication, 44 (26.5%) had used the home disposal kit, 55 (33.1%) used an official disposal location, 31 (18.7%) used a take-back program, 21 (12.7%) disposed of the medication in the garbage/toilet, and 15 (9.0%) disposed of them through other means. Among those with tablets remaining, 52 received a home disposal kit, whereas 234 patients with tablets remaining did not. Patients who received the kit were more likely to dispose of opioid medications (54.9% versus 34.8%, relative risk = 1.8, 95% CI 1.3-2.5). Of the patients who received the bag and reported disposing medications, 82% utilized the bag over other disposal methods. In those who did not receive the bag, the disposal method was split between an opioid disposal location (47.5%), local take-back programs (21.3%), toilet/garbage (12.5%), home disposal bag after obtaining in clinic (11.3%), and other methods (7.5%).
Voepel-Lewis 2020	Randomized clinical trial conducted between October 2017	A total of 517 parents participated in the study	Data were collected at baseline, 7, and 14 days post discharge from parents whose children (aged 5–17 years) were	Behavioral disposal method (Nudge) with or without a Scenario-Tailored Opioid Messaging	Effect of risk enhancement education on patients' opioids disposal	Most parents (93%) reported leftover opioids; 99 (19%) estimated that >50% to 100% of doses remained, 146 (28%) had one quarter to half of the doses left, and 101 (20%) had only a few doses leftover. Prompt disposal behavior was higher for

Author	Study Design	Study Population	Data Source	Intervention	Primary Outcome	Opioid Disposal Findings
	and January 2019.		prescribed a short course of opioids. Opioid-naïve status was not reported.	Program (STOMP), which is risk-enhancement education	behavior as measured by prompt disposal (ie, immediate disposal of leftovers after use) and planned retention (intention to keep leftovers).	parents who received both the STOMP and Nudge interventions (38.5%), Nudge alone (33.3%), or STOMP alone (31%) compared with controls (19.2%; P ≤ .02). Furthermore, the STOMP intervention independently decreased planned retention rates (5.6% vs 12.5% no STOMP; adjusted odds ratio [aOR] 0.40 [95% confidence interval (CI) 0.19-0.85]). Higher risk perception lowered the odds of planned retention (aOR 0.87 [95% CI 0.79-0.96]), whereas parental past opioid misuse increased those odds (aOR 4.44 [95% CI 1.67-11.79]).
Woodward 2019	Pre/post intervention analysis; Pre-intervention was December 2017-January 2018, post-intervention was from June to September 2018.	A total of 82 participants (38 patients with 90% response rate in the first cohort and 44 with 63% response rate in the second cohort) included in the study.	Data were collected from adult patients who underwent corneal surgery at the cornea division of the University of Michigan's medical center by any physician. Opioid-naïve status was not reported for the first cohort, but one person in the second cohort used opioids daily prior to surgery.	Updated opioid prescribing guideline as part of Opioids monitoring program	Prevalence and predictors of opioid use	Participants in the first cohort had significantly more unused tablets compared with the second cohort (mean [SD], 10.3 [6.9] vs 2.9 [2.7]; difference, 7.5 [95% CI, 4.7-10.2]; P < .001). In the survey of the second cohort, twenty of 28 participants (71% [95% CI, 55%-88%]) had leftover tablets; 17 of 20 (85% [95% CI, 62%-97%]) did not dispose of leftovers, and 3 (15% [95% CI, 3%-38%]) threw away or flushed leftovers. Although state provided opioid education, 2 patients (7% [95% CI, 1%-21%]) reported not remembering receiving opioid information.
Yorkgitis 2019	Pre/post intervention analysis. Study time period was not reported.	A total of 23 residents completed the pre- and post-intervention training.	Data were collected from general surgery residents at an urban safety-net hospital	One hour in-person didactic Opioid Prescribing Education (OPE) session	Effectiveness of the OPE session	After the OPE, the mean opioid pills prescribed for laparoscopic cholecystectomy, open inguinal hernia repair, laparoscopic ventral hernia repair, and laparoscopic appendectomy were reduced by 2.6 (14.2%, P = 0.23), 3.7 (18.9%, P = 0.07), 2.6 (13.1%, P = 0.23), and 1.1 (7.3%, P = 0.60) pills, respectively. Information on unused opioid disposal was provided by only two (8.7%) participants. No further opioid disposal information was provided.

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/s/

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