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RESEARCH ARTICLE

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Evaluating a health system-wide opioid disposal intervention distributing home-disposal bags

Lyen C. Huang MD, MPH, FACS, FASCRS[1,2] | Josh Bleicher MD[1] | Michael Torre PhD, MS[3] | Jordan E. Johnson MPH, CHES, CPH[1] | Angela Presson PhD[3] | Morgan M. Millar PhD[3] | Adam J. Gordon MD, MPH, FACP, DFASAM[4,5] | Benjamin S. Brooke MD, PHD, FACS, DFSVS[1] | Kimberly A. Kaphingst ScD[2,6] | Alex H. S. Harris PhD, MS[7,8]

[1]Department of Surgery, University of Utah, Salt Lake City, Utah, USA

[2]Huntsman Cancer Institute, University of Utah, Salt Lake City, Utah, USA

[3]Department of Internal Medicine, University of Utah, Salt Lake City, Utah, USA

[4]Program for Addiction Research, Clinical Care, Knowledge and Advocacy (PARCKA), Division of Epidemiology, Department of Internal Medicine, University of Utah School of Medicine, Salt Lake City, Utah, USA

[5]Informatics, Decision-Enhancement, and Analytic Sciences (IDEAS) Center, VA Salt Lake City Health Care System, Salt Lake City, Utah, USA

[6]Department of Communication, University of Utah, Salt Lake City, Utah, USA

[7]Department of Surgery, Stanford University, Stanford, California, USA

[8]VA HSR&D Center for Innovation to Implementation, Palo Alto VA Health Care System, Palo Alto, California, USA

Correspondence
Lyen C. Huang, Division of General Surgery, Department of Surgery, 1950 Circle of Hope Drive, K7532, University of Utah and Huntsman Cancer Institute, Salt Lake City, UT 84112, USA.
Email: lyen.huang@hsc.utah.edu

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Abstract

Objective: To evaluate a health system-wide intervention distributing free home-disposal bags to surgery patients prescribed opioids.

Data Sources and Study Setting: We collected patient surveys and electronic medical record data at an academic health system.

Study Design: We conducted a prospective observational study. The bags were primarily distributed at pharmacies, though pharmacists delivered bags to some patients. The primary outcome was disposal of leftover opioids (effectiveness). Secondary outcomes were patient willingness to dispose and factors associated with disposal (effectiveness), recalling receipt of the bag (reach), and recalling receipt of bags and disposal over time (maintenance). We used a modified Poisson regression to evaluate the relative risk of disposal. Inverse probability of treatment weighting, based on propensity scores, was used to account for differences between survey responders and non-responders and reduce nonresponse bias.

Data Collection/Extraction Methods: From August 2020 to May 2021, we surveyed patients 2 weeks after discharge (allowing for home opioid use). Eligibility criteria were age ≥18, English being primary language, valid email address, hospitalization ≤30 days, discharge home, and an opioid prescription sent to a system pharmacy.

Principal Findings: We identified 5134 patients with 2174 completing the survey (response rate 42.3%). Among respondents, 1375 (63.8%) recalled receiving the disposal bag. Among 1075 respondents with leftover opioids, 284 (26.4%) disposed, 552 (51.3%) planned to dispose, 79 (7.4%) did not plan to dispose, 69 (6.4%) had undecided, and 91 (8.5%) had not considered disposal. Recalling receipt of the bag (incidence rate ratio [IRR] 1.25, 95% confidence interval [CI] 1.13–1.37) was positively associated with disposal. Patients who used opioids in the last year were less likely to dispose (IRR 0.82, 95% CI 0.73–0.93). Disposal rates remained stable over the study period while recalling receipt of bags trended up.

Conclusions: A pragmatic implementation of a disposal intervention resulted in lower disposal rates than prior trials.

KEYWORDS
health system intervention, implementation, opioids, prevention of opioid-related harms, surgery

What is known on this topic

- In the United States, most patients will have leftover prescription opioids after surgery.
- Opioid misuse continues to be a problem and risk assessment and mitigation interventions (e.g., disposal of unused opioids) are needed.
- In small-scale trials, distribution of a home-disposal bag to surgery patients increased the likelihood of disposal of leftover prescription opioids.

What this study adds

- A pragmatic implementation of a system-wide intervention distributing home-disposal bags resulted in 26.4% disposal rate, while 51.3% of surgery patients were planning to dispose but had not yet done so.
- Recalling receipt of the disposal bag is an important factor in promoting disposal.

1 | INTRODUCTION

More than 64 million operations are performed each year in the United States, and 56%–70% of these patients will be prescribed opioids.[1–4] Although opioid prescribing after surgery has decreased in recent years, between 50% and 92% of patients still have leftover opioids.[5–9] Eleven percent of individuals who died from prescription-opioid overdoses received their prescription from a surgeon.[10] In 2020, 24% of the 68,630 opioid-related overdose deaths involved prescription opioids.[11] Amidst a crisis in which 247,000 people died from prescription opioid overdoses between 1999 and 2019, the US government has advocated for the secure storage of opioids followed by immediate disposal when treatment is complete.[12–14] However, few patients store opioids securely, even in households with children.[15–17] Without interventions, only 4%–9% of patients will dispose of opioids after surgery.[7,8,18] In 2018, the Substance Use-Disorder Prevention that Promotes Opioid Recovery and Treatment for Patients and Communities Act (SUPPORT Act) provided the United States Food and Drug Administration (FDA) with the authority to require drug manufacturers to provide a safe drug disposal system. The FDA has not exercised its authority yet, but in 2022 requested public comments regarding a mandated Risk Evaluation and Mitigation Strategy.[19] The Stanford-Lancet Commission on the North American Opioid Crisis recently called for raising the quality of excess opioid disposal programs to foster healthier environments and reduce the incidence of addiction.[20]

To date, the most common medication disposal interventions are public health campaigns asking patients to return medications to take-back days or drop boxes. Although these campaigns tout impressive quantities of returned medications, most are not controlled substances like opioids.[18,21–24] One study from Kentucky estimated that only 0.3% of dispensed opioids were ultimately disposed of.[25] Interventions using only education to promote disposal (e.g., handouts and videos) have shown either null[26–28] or modest effects (i.e., absolute increases in disposal of 11%–22%).[29,30] The lone study using financial incentives to promote opioid disposal found that only 30% of veterans participated, despite being paid $5 per returned tablet (max $50).[31]

Prior studies by our group and others suggest that providing postoperative home-disposal bags resulted in 55%–95% of patients disposing of their leftover opioids.[32–36] However, a subsequent trial showed disappointing results, with only 14% of patients disposing of their opioids.[37] However, no study to date has reported on the feasibility of a pragmatic, low-effort opioid disposal quality improvement intervention implemented outside of a research trial or across an entire health system.

In this prospective observational study, we examined the reach, effectiveness, and maintenance of an ongoing health system intervention providing home-disposal bags to every patient filling an opioid prescription after surgery.[38] In addition, we sought to test whether a stage-based behavior change framework we previously adapted from the Precaution Adoption Process Model (PAPM) could help us further promote safe and appropriate disposal.[39,40] Our primary outcome was patient-reported disposal of leftover prescription opioids (effectiveness). Our secondary outcomes were patient willingness to dispose and factors associated with disposal (effectiveness based on PAPM stages), the percentage of eligible patients recalling receipt of the disposal bag (reach); factors associated with disposal (effectiveness); and recalling receipt of the bag and disposal rates over time (maintenance).

2 | METHODS

2.1 | Health system disposal intervention

After we established the effectiveness of disposal bags at a large, regional, tertiary care, academic health system in a pilot study,[32] our system used savings generated from the United States' federal 340B Drug Pricing Program to fund the distribution of free disposal bags to every patient filling an opioid prescription at our 16 pharmacies. The program was officially launched in August 2020. Each pharmacy unit was allowed to implement the intervention as they saw fit. Most units provided the bags at the point-of-care delivery window at the pharmacy. However, several motivated and engaged pharmacists, when available, provided bags and patient education at discharge to admitted inpatients.

2.2 | Study setting, participants, and design

We conducted a prospective observational study of patients undergoing surgery from August 2020 to May 2021 at a large, regional, tertiary care, academic health system. Patients underwent surgery in nine different operating room suites (seven located at the main campus and two located at outpatient surgery centers). Patient-level inclusion criteria were an operation with a provider in the University of Utah Department of Surgery, an opioid prescription sent at discharge to a health system pharmacy, age ≥18 years, primary language listed as English, an email address on file, and discharge to home or home health. Discharge-level exclusion criteria were length of stay greater than 30 days, death during admission, operation and discharge in the prior 30 days, and discharge to a nursing facility, rehab facility, hospice, another hospital, or correctional facility. Patients undergoing multiple operations in a single hospitalization were classified by their primary procedure.

Two weeks after discharge, we invited eligible patients via email to complete a web-based REDCap survey (Supplement S1). We selected this time point based on prior studies suggesting that up to 96.8% of patients cease using opioids by 2 weeks after discharge.[41–43] For outpatient surgery, the discharge date was the same as the surgery date. For inpatient surgery, we used the discharge date to ensure patients had an adequate amount of time to use their opioids at home. At the start of the survey, patients were presented with a consent letter describing the study, potential risks, and requesting authorization to link survey responses with electronic medical record data. The survey asked questions about patients' quantity of leftover opioids; recollection of receiving a disposal bag; receipt of, or intention to request, an opioid refill; pain management satisfaction; experiences with pain prior to surgery; current smoking, alcohol, or illicit drug use; prior use of opioids within the past year; completion and manner of disposal; and reasons for disposal (or not). To maximize response, patients received up to four emails requesting participation. We excluded survey responses that were incomplete. We merged survey responses with data on patient demographics, clinical characteristics, and discharge prescriptions from our electronic medical record system. We converted opioid dosing into morphine milligram equivalents (MME). For reference, one 5 mg tablet of oxycodone is equivalent to 7.5 MME.[44] We used the responses from the first survey completed for patients who completed more than one survey. The study was approved by the Institutional Review Board at the University of Utah and was conducted in compliance with Strengthening The Reporting of OBservational studies in Epidemiology (STROBE) guidelines.[45]

2.3 | Study outcomes

In this analysis, our primary effectiveness outcome was patient-reported disposal of leftover prescription opioids (versus non-disposal). We first asked patients to indicate their stage of readiness to dispose based on our prior work adapted from the Precaution Adoption Process Model (PAPM).[40] Understanding where patients are in their decision-making process can inform future interventions that promote disposal. Our prior studies suggest that the choice to dispose results not from a single discrete decision but a progression through stages of readiness (Figure 1). We asked patients to report their willingness to dispose and categorized them into one of five stages: "I have not thought about disposal" (PAPM Stage 2), "I am undecided about whether I will dispose of them" (Stage 3), "I do not plan to dispose of them" (Stage 4), "I plan to dispose of them but have not yet" (Stage 5), and "I have disposed of them" (Stage 6).[40] We did not include Stage 1 as the survey created awareness. We defined our primary outcome as disposal (Stage 6) versus non-disposal (Stages 2–5). Our secondary outcomes were patient willingness to dispose and factors associated with disposal (effectiveness), the percentage of eligible patients reporting receipt of the disposal bag (reach), and recalling receipt of the bag and disposal over time (maintenance). We also examined the patient-, surgery-, and patient-reported factors associated with disposal.

2.4 | Analysis

We summarized patient characteristics and survey responses using the mean and standard deviation or median and interquartile range for continuous variables; for categorical variables, we reported frequency and percentages. The prespecified race and ethnicity terms were extracted from the electronic medical record. We stratified descriptive tables by survey response status—patients who completed at least one survey ("survey respondents") are compared with patients who did not ("nonresponders"). We used responses from patients' first survey for those who underwent multiple discharges. We tested for differences using a nonparametric Wilcoxon rank sum test for continuous variables and chi-squared or Fisher's exact test for categorical variables. In cases where the normal conditions of a chi-squared test were not met, we calculated *p*-values via Monte-Carlo simulation.

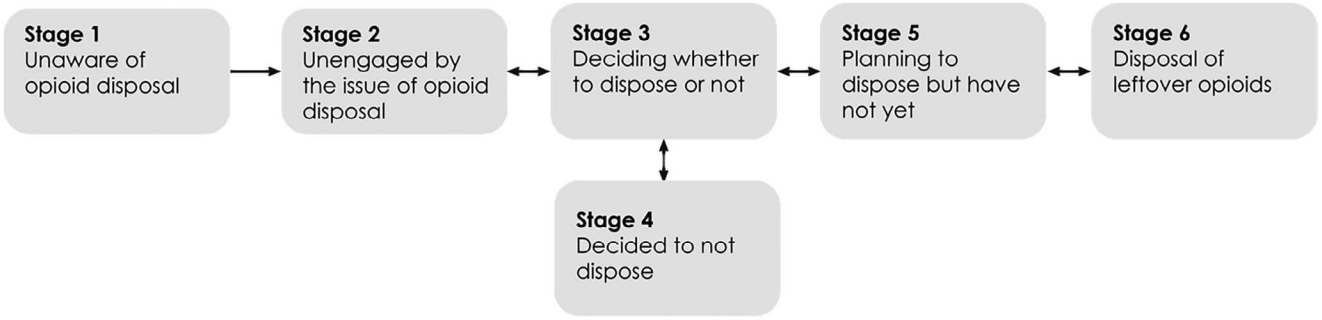

FIGURE 1 A theoretical framework of patient willingness to dispose based on the Precaution Adoption Process Model.[39]

We used modified Poisson regression to determine the relative risk of disposal following surgery according to patient demographics, surgery characteristics, patient experiences with pain, opioid prescription and usage, and recall of disposal bag being provided.[46] We chose a binary outcome of disposal versus non-disposal rather than trying to fit the PAPM model for two reasons. First, an ordered model would have required dropping PAPM Stage 4 as a response level. Second, intentionality consists of a combination of concepts, awareness of opioid handling safety and willingness to dispose, that were not equally represented among the possible response levels. We constructed this model using the subset of patients who had leftover opioids and were exposed to the intervention (i.e., filled their prescription at a health system pharmacy). We included all variables in the adjusted model (rather than using a selection process) as our goal was identifying the relevant factors rather than creating a predictive model.

To reduce survey nonresponse bias, we used inverse probability of treatment weighting or "nonresponse weights".[47,48] Incorporating nonresponse weights in our outcome model adjusted the respondent covariate distributions to be more similar to the original sample, thus reducing the potential for nonresponse bias.[49] The nonresponse weights were derived from a gradient-boosted logistic regression where the outcome was response status and the predictors included surgery type, surgical specialty, and all available patient characteristics at baseline (age, sex, rurality, race, ethnicity, smoking, alcohol and drug use).[50]

Our outcome model standard errors were adjusted via robust clustered sandwich estimators to account for clustering by surgeon.[51] We assessed multicollinearity using the variance inflation factor and all values were <2, indicating no collinearity issues.[52] We report relative risks or incident rate ratios (IRRs), where higher values indicate a greater probability of disposal, 95% confidence intervals (CIs), and *p*-values. This same modeling framework was repeated for our secondary outcome of disposed or planning to dispose.

We examined maintenance of the intervention by plotting patient recall of receiving the disposal bag and patient-reported disposal (aggregated by month) and fitting a simple regression line to visualize the trend. We assessed statistical significance at the 0.05 level using two-tailed tests and conducted all analyses in R-statistics v. 3.6.2 (R Core Team 2021).

3 | RESULTS

We identified 5134 surgery patients with an opioid prescription sent at discharge to a health system pharmacy. Overall, 2174 patients completed at least one survey while 2960 patients did not (response rate 42.3%). Twenty-nine patients opted out of the study. The characteristics of eligible patients and their operations are shown in Table 1. In comparison to nonresponders, survey respondents were more likely to be age ≥65 years (30.7% vs. 15.7%, $p < 0.001$) and identify as Caucasian/White (92.6% vs 87.5%, $p < 0.001$). Respondents were less likely than non-respondents to identify as Hispanic/Latino (5.7% vs. 8.8%, $p < 0.001$), be current smokers (4.7% vs. 8.8%, $p < 0.001$), or use illicit drugs (5.2% vs. 8.6%, $p < 0.001$). Most of the operations were outpatient procedures (survey respondents $n = 1563$, 71.9%; nonresponders $n = 2166$, 73.2%) and done electively (survey respondents $n = 1996$, 91.9%; nonresponders $n = 2628$, 88.9%). The most common specialties performing operations were general surgery, urology, and otolaryngology. The mean MME prescribed to nonresponders was higher than responders (114 vs. 102, $p < 0.001$).

Patient-reported outcomes are shown in Table 2. Most participants were very satisfied ($n = 1637$, 76.2%) or somewhat satisfied ($n = 325$, 15.1%) with their pain management after surgery. Two-thirds of participants recalled receiving a disposal bag ($n = 1375$, 63.8%).

Among the 1075 respondents with leftover opioids who reported their disposal plans, 284 (26.4%) had disposed 2 weeks after discharge (PAPM Stage 6). The remaining participants planned to dispose but had not yet (Stage 5, $n = 552$, 51.3%), did not plan to dispose (Stage 4, $n = 79$, 7.4%), were undecided about disposal (Stage 3, $n = 69$, 6.4%), or had not considered disposal (Stage 2, $n = 91$, 8.5%). We found an upward trend in monthly aggregated rates of patient recall of receiving the disposal bag but no significant change in disposal over the 10-month study period (Figure 2). There may be a seasonal trend for both recall and disposal.

On univariable analysis, disposal was positively associated with recalling receipt of a home-disposal bag (incidence rate ratio [IRR] 1.24, 95% confidence interval [CI] 1.13–1.36) (Table 3). Disposal was negatively associated with patient use of opioids in the last year (IRR 0.81, 95% CI 0.72–0.91). On multivariable analysis, disposal was

TABLE 1 Characteristics of the surgery patients with prescribed opioids sent to health system pharmacies and their operations.

	Overall		Survey respondents		Nonresponders		
	n	%	*n*	%	*n*	%	*p*-value[a]
	5134		2174	42.3%	2960	57.7%	
Age group							<0.001
18–64	4004	78.0%	1507	69.3%	2497	84.3%	
≥65	1130	22.0%	667	30.7%	463	15.7%	
Sex							0.17[b]
Female	2615	50.93%	1134	52.2%	1481	50.04%	
Male	2518	49.05%	1040	47.8%	1478	49.93%	
Nonbinary	1	0.02%	0	0.0%	1	0.03%	
Home location							0.10
Nonrural	3865	75.3%	1612	74.1%	2253	76.1	
Rural	1269	24.7%	562	25.9%	707	23.9%	
Race							<0.001
Asian	59	1.1%	22	1.0%	37	1.3%	
Black or African American	70	1.4%	22	1.0%	48	1.6%	
Caucasian/White	4534	88.3%	1986	91.4%	2548	86.1%	
Native Hawaiian/Pacific Islander	50	1.0%	11	0.5%	39	1.3%	
Other/Unknown	421	8.2%	133	6.1%	288	9.7%	
Ethnicity							<0.001
Hispanic/Latino	382	7.4%	124	5.7%	258	8.8%	
Non-Hispanic/Latino	4752	92.6%	2050	94.3%	2702	91.2%	
Current smoker							<0.001
No	4771	92.9%	2071	95.3%	2700	91.2%	
Yes	363	7.1%	103	4.7%	260	8.8%	
Current alcohol use							0.24
No	3325	64.8%	1388	63.8%	1937	65.4%	
Yes	1809	35.2%	786	36.2%	1023	34.6%	
Current illicit drug use							<0.001
No	4769	92.9%	2062	94.8%	2707	91.4%	
Yes	365	7.1%	112	5.2%	253	8.6%	
Surgery type							0.31
Outpatient surgery	3729	72.6%	1563	71.9%	2166	73.2%	
Inpatient surgery	1405	27.4%	611	28.1%	794	26.8%	
Urgency of surgery							0.001
Elective	4624	90.1%	1996	91.9%	2628	88.9%	
Urgent	478	9.3%	170	7.8%	308	10.4%	
Emergent	28	0.6%	7	0.3%	21	0.8%	
Surgical specialty							<0.001
Cardiothoracic	307	6.0%	144	6.6%	163	5.5%	
General surgery	2155	42.0%	927	42.6%	1228	41.5%	
Otolaryngology	745	14.5%	306	14.1%	439	14.8%	
Plastics	646	12.6%	259	11.9%	387	13.1%	
Transplant	126	2.5%	49	2.3%	77	2.6%	
Urology	1060	20.6%	468	21.5%	592	20.0%	
Vascular	95	1.8%	21	1.0%	74	2.5%	

TABLE 1 (Continued)

	Overall		Survey respondents		Nonresponders		
	n	%	*n*	%	*n*	%	*p*-value[a]
Mean MME prescribed at discharge (SD)	108.7	123.7	102	101	114	138	<0.001[c]
Mean MME consumed (SD)			69	109			

Abbreviations: MME, morphine milligram equivalent; SD, standard deviation.
[a]*p*-value for chi-square test.
[b]*p*-value for Fisher's exact test.
[c]*p*-value for Wilcoxon rank-sum test.

TABLE 2 Patient-reported outcomes of the patients with prescribed opioids sent to health system pharmacies.

	Survey respondents	
	n	%
Patient used opioids in the last year		
No	1712	78.5%
Yes	462	21.5%
Patient satisfaction with pain management		
Very satisfied	1637	76.2%
Somewhat satisfied	325	15.1%
Neither satisfied nor dissatisfied	74	3.5%
Somewhat dissatisfied	80	3.7%
Very dissatisfied	32	1.5%
Expectations of pain after surgery		
"I experienced less pain than I expected"	861	40.1%
"I experienced about as much pain as I expected"	863	40.1%
"I experienced more pain than I expected"	425	19.8%
Patient reported having pain issues with prior surgeries		
No prior surgeries	199	9.3%
No	1531	71.4%
Yes	414	19.3%
Patient recalled receiving disposal bag		
No (or unsure)	782	36.2%
Yes	1375	63.8%
Precaution adoption process model stage		
Stage 6-"I have disposed of them"	284	26.4%
Stage 5-"I plan to dispose of them but have not yet"	552	51.3%
Stage 3-"I am undecided about whether I will dispose of them"	69	6.4%
Stage 4-"I do not plan to dispose of them"	79	7.4%
Stage 2-"I have not thought about disposal"	91	8.5%

positively associated with recalling receipt of a home-disposal bag (IRR 1.25, 95% CI 1.13–1.37). Patients who used opioids in the last year were less likely to dispose (IRR 0.82, 95% CI 0.73–0.93).

4 | DISCUSSION

In this study, we evaluated the reach, effectiveness, and maintenance of a health system-wide intervention distributing home-disposal bags to all patients prescribed opioids after surgery. Based on patients' recall of receiving the bag, we reached 69.5% of the eligible patients who were prescribed opioids. Among patients to whom the bag was distributed, 26.4% disposed of their leftover opioids. On multivariable analysis, disposal was positively associated with recalling receipt of the bag and negatively associated with those who used opioids in the last year.

Our disposal rate of 26.4% was lower than most prior disposal bag studies which reported rates of 55%–95%.[32–36] Several factors likely contribute to this lower rate of disposal. First, the prior studies were conducted as time-limited trials which allowed for close follow-up and monitoring by research personnel. Second, we allowed each of the 16 pharmacy units to decide to how they wanted to distribute disposal bags and education. We selected this implementation approach based on feedback from pharmacy stakeholders suggesting it would reduce the complexity and labor costs of implementation and allow for tailoring to local resources and conditions (which were constrained during the COVID-19 pandemic). However, our findings suggest more active patient engagement and intensive implementation strategies are needed. Passive distribution was also cited by one trial as the likely explanation for their low disposal rate of 14%.[37] We are currently conducting a post-formative mixed methods evaluation to identify and address the barriers to implementations and to guide the design of future interventions and implementation efforts.

Nonetheless, our study has several important findings. First, recalling receipt of the disposal bag was strongly associated with disposal which suggests that the bags can positively influence patient behavior. Second, despite our pragmatic low-effort implementation approach, disposal rates were maintained over the study period. Third, the stages-based Precaution Adoption Process Model provides important insights into patient willingness to dispose. Two weeks after discharge, 51.3% of eligible patients planned to dispose but had not yet (Stage 5). Prior studies suggest that most surgery patients are no longer using opioids less than a week after surgery. Our prior study on the barriers and facilitators to disposal suggests that these patients have not disposed because there is a low perceived risk associated with non-disposal or are having difficulty converting their decision into action.[40] Interventions targeting this large population of well-

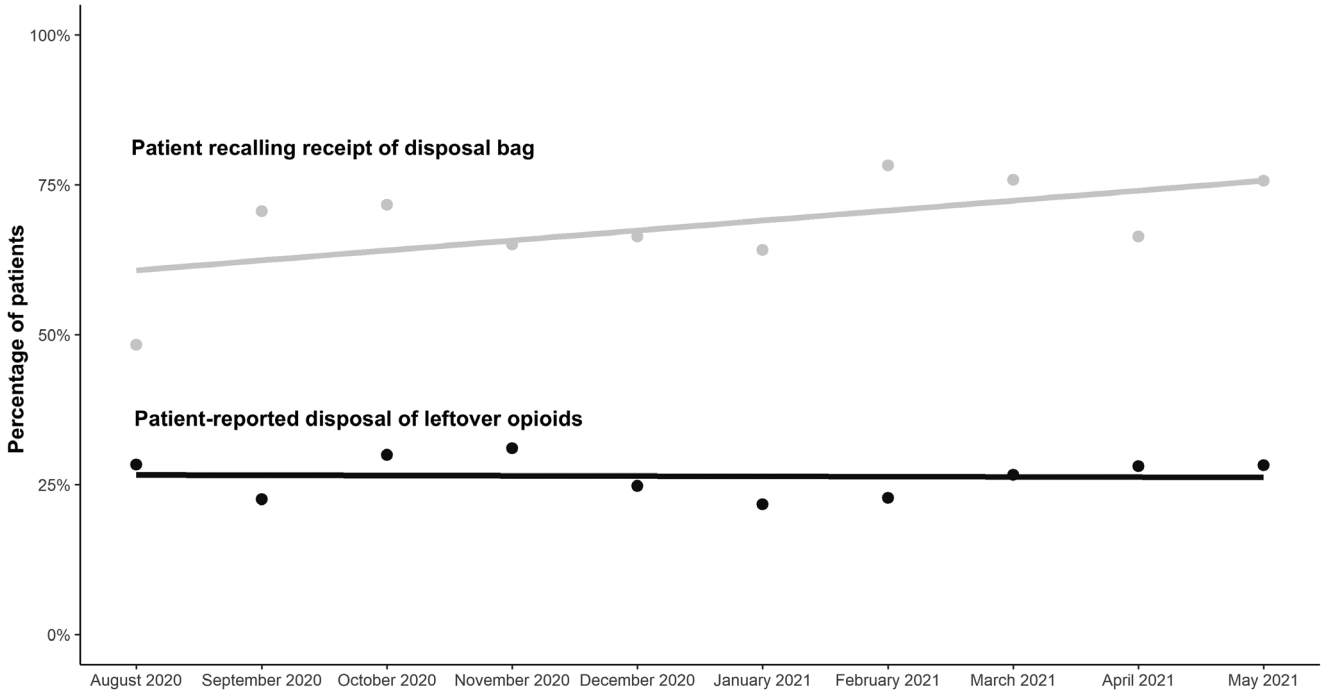

FIGURE 2 Disposal rates aggregated by month over the study period. The lower black dots and line indicate the monthly percentage of patient-reported disposal and linear regression line, respectively. The upper light gray dots and line indicate monthly percentage of patients recalling receipt of the disposal bag and linear regression line, respectively.

TABLE 3 Univariable and multivariable modified Poisson regression analyses examining prescription opioid disposal among survey respondents with leftover prescription opioids that were filled at a health system pharmacy.

	Univariable[a]			Multivariable[a]		
	Incidence rate ratio	95% CI	*p*-value	Incidence rate ratio	95% CI	*p*-value
Patient recalled receiving disposal bag						
No (or unsure)	Referent			Referent		
Yes	1.24	1.13, 1.36	<0.001	1.25	1.13, 1.37	<0.001
Patient used opioids in the last year						
No	Referent			Referent		
Yes	0.81	0.72, 0.91	<0.001	0.82	0.73, 0.93	0.003

Abbreviation: CI, confidence interval.

[a]The following variables were included in the multivariable model but are not shown due to non-significance: age, race, ethnicity, sex, rural home location, current smoker, current alcohol use, urgency of surgery, surgery type (outpatient vs. inpatient), current illicit drug use, median morphine milligram equivalents prescribed at discharge, percentage of morphine milligram equivalents consumed, patient satisfaction, pain issues with prior surgeries, and expectations of pain after surgery. Models account for clustering by surgeon and differences between survey responders and nonresponders through inverse probability weighting.

intentioned patients could increase the effectiveness of disposal interventions. Surprisingly, only 7.4% of patients did not plan to dispose (Stage 4). This suggests that most patients are amenable to disposing of their leftover opioids. A prospective cohort study patients undergoing inpatient surgery combined patient education, reminder phone calls 1–3 days prior to in-person clinic follow-ups, and a clinic drop box to achieve an 83% disposal rate.[9] While promising, the study was labor-intensive and reliant on study coordinators to provide education and the reminder calls and patients to attend in-person follow-up visits. Whether these results can be replicated on a larger scale and in an era in which follow-up appointments are increasingly virtual remains to be seen. Automated reminders tailored to patients' stage of readiness to dispose and reasons for (non-)disposal may provide many of the benefits while allowing for better sustainability and scalability. Finally, there may be a seasonal trend in disposal though more data is needed. Prior studies have found seasonal trends in opioid prescriptions and prescription opioid-related overdoses and suicides.[53–55]

Our study has several limitations. First, we relied on participants to report their disposal behaviors and accurately self-report their

stage of readiness to dispose. While we had a 42% response rate, our findings may still be subject to nonresponder error as our respondents were likely to be older adults, living in rural locations, and identify as Caucasian/White. We have mitigated the possibility of survey nonresponse bias by incorporating nonresponse weights in our outcome model. This approach adjusts for differences between responders and nonresponders using the covariates available among both groups, that is, the baseline characteristics. However, it is possible that there are additional covariates (outside of the covariates that we measured) that could be related to the tendency for a person to respond. Second, our response rate was above what would be expected for an email survey despite recent research showing a decrease in survey response rates over the past few decades.[56,57] Studies have also shown that response rates are not good proxies for validity, and response rates as low as 18% can still provide reliable estimates of exposure-outcome relationships.[58] Additional modes of survey distribution, such as text messaging or paper surveys, could not only increase the response rate but also reach nonresponders and otherwise ineligible participants. Third, social desirability bias may lead to over-reporting of disposal. However, in our prior qualitative study, participants openly shared why they did not dispose. Future studies may use indirect-questioning and non-randomized-response techniques to evaluate social desirability bias in opioid-disposal behaviors. Fourth, we were unable to establish a baseline disposal rate within this study or conduct a randomized trial comparing distribution of disposal bags with a minimal intervention arm of the follow-up survey alone. The lack of a comparison group means that external factors might affect our primary outcome. For example, a local health system announced a contemporaneous opioid-free surgery program.[59] National pharmacy chains have expanded the availability of drop boxes and one company had previously announced they would distribute a free home-disposal kit with every opioid prescription (though whether the program was active during our study period is not known).[60,61] However, almost all of our surgery patients fill their opioids at one of our pharmacies. Several states (not in our catchment area) have enacted laws requiring manufacturers to fund drug disposal. In 2020, the state of Washington launched their state-wide drug take-back program (which is funded by drug manufacturers) though no opioid-specific disposal outcomes have been reported.[62] Finally, news media and the federal government have increased awareness of the opioid crisis and its associated risks.[63,64]

5 | CONCLUSION

Prescription opioids are a critical tool for managing pain after surgery, but their over-supply likely contributes to the opioid crisis in the United States. Our pragmatic low-effort implementation of a system-wide disposal intervention resulted in a lower disposal rate than previous controlled trials though we were able to reach two-thirds of patients and maintain the intervention over time. Our study suggests that motivating patients who are planning to dispose but have not yet done so will be critical to increasing the effectiveness of health-system disposal interventions. Further studies translating the interventions used in small-scale research studies into health-system interventions and testing implementation strategies in a variety of health systems are also needed.

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ORCID

Lyen C. Huang https://orcid.org/0000-0002-8605-2631

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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