Surgery Open Science 13 (2023) 27–34

Contents lists available at ScienceDirect

Surgery Open Science

journal homepage: https://www.journals.elsevier.com/surgery-open-science

Research Paper

Improving pain management and safe opioid use after surgery: A DMAIC-based quality intervention

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ARTICLE INFO

Article history:
Received 7 December 2022
Received in revised form 16 March 2023
Accepted 10 April 2023
Available online 15 April 2023

Keywords:
Opioids
Education
Post-operative recovery
Pain

ABSTRACT

Background: Multimodal perioperative patient education and expectation-setting can reduce post-operative opioid use while maintaining pain control and satisfaction. As part of a quality-improvement project, we developed a standardized model for perioperative education built upon the American College of Surgeons (ACS) Safe and Effective Pain Control After Surgery (SEPCAS) brochure to improve perioperative education regarding opioid use and pain control.

Material and methods: Our study was designed within the Define, Measure, Analyze, Improve, Control (DMAIC) quality-improvement framework. Patients were surveyed about the adequacy of their perioperative education regarding pain control and use of prescription opioid medication. After gathering baseline data, a multimodal educational intervention based on the SEPCAS brochure was implemented. Survey responses were then compared between groups.

Results: Twenty-seven subjects were included from the pre-intervention period, and thirty-nine were included from the post-intervention period ($n = 66$). Those in the post-intervention period were more likely to report receiving the appropriate amount of education regarding recognizing the signs of opioid overdose and how to safely store and dispose of opioid medications. The majority of patients who received the SEPCAS brochure reported that it was useful in their post-operative recovery and that it should be given to every patient undergoing surgery.

Conclusions: The ACS SEPCAS brochure is an effective tool for improving patient preparation to safely store and dispose of their opioid medication and recognize the signs of opioid overdose. The brochure was also well received by patients and perceived as an effective educational material.

Introduction

Preparing patients to safely manage their pain and prescription opioids after surgery is critical amidst a worsening opioid crisis. While most opioid overdose deaths are due to synthetic opioids like fentanyl, about a third of deaths involve prescription opioids [1]. of the deaths involving prescription opioids, up to 11 % involve an opioid prescribed by a surgeon [2]. After surgery, up to 15 % of opioid naïve surgical patients transition to chronic opioid use [3–9], Surgeons and their colleagues thus have an important role to play in addressing the worsening opioid crisis by providing their patients with evidence-based resources and education designed to help them manage their post-operative pain in a safe and effective manner.

Prior studies have shown patient education and expectation-setting empowers patients to reduce opioid use after surgery while maintaining patient pain control [10–13]. and satisfaction [14]. Patients consistently report that pre-operative pain management education is useful [13,15], and ask that it should be standard practice [16]. However,

Abbreviations: ACS, American College of Surgeons; SEPCAS, Safe and Effective Pain Control After Surgery; DMAIC, Define, Measure, Analyze, Improve, Control; APS-POQ-R, American Pain Society Patient Outcome Questionnaire - Revised.

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https://doi.org/10.1016/j.sopen.2023.04.007

prior studies have used institution-specific educational materials and varied widely in their delivery of patient education.

In 2018, the American College of Surgeons (ACS) integrated the best practices and evidence from the literature and developed the Safe and Effective Pain Control After Surgery (SEPCAS) patient education brochure as part of their Strong for Surgery initiative [17]. The Strong for Surgery initiative is a bundle of checklists and patient education materials to improve surgical outcomes. The SEPCAS brochure provides patients with recommendations for pain management strategies, the use of non-opioid and opioid medications, and important information on the safe storage and disposal of opioids.

At our institution, a prior study identified three gaps in our existing patient education process: pre-operative expectation setting around post-operative pain, strategies for managing post-operative pain (including the use of opioid medications), and the importance of appropriate opioid disposal [18]. The object of the current study was to implement a quality improvement intervention using the Define, Measure, Analyze, Improve, and Control (DMAIC) methodology to target these gaps. We aimed to 1) improve our process of patient education and expectation-setting regarding perioperative pain management and the appropriate use and disposal of prescription opioids and 2) to evaluate the ACS SEPCAS brochure as an educational material and identify opportunities for further refinement.

Methods

We designed and evaluated our quality improvement intervention using the DMAIC framework. DMAIC is a data-driven quality strategy derived from industry quality improvement methodology that has been used in healthcare to address important quality metrics such as patient satisfaction [19], reduction in hospital acquired infections [20], and optimization of post-operative opioid prescription practices [21]. The five phases of DMAIC are defining the problem and improvement activity ('Define'), measuring baseline process performance ('Measure'), analyzing the existing process to determine the root causes of variation ('Analyze'), improving the process by addressing the root causes ('Improve'), and controlling the improved process and future process outcomes ('Control') [22].

Define phase

Current literature and establishing feasibility

After we defined our gaps in the existing patient education process in our prior study [18], we conducted a literature search on educational practices utilized in perioperative opioid education. We analyzed each article and identified the content used and how the education was delivered based on evidence-based practices (Table 1). We also met with surgeons, clinic and hospital nurses, pharmacists, and staff to identify feasibility and preference of integrating a QI intervention into their workflow.

Quality improvement intervention

Based on our literature search and initial discussions, we designed an intervention that leveraged the consensus and evidence-based ACS SEPCAS brochure and used evidence-based best practices for patient education including multimodal education, reinforcement through multiple sessions, and personalized education tailored to individual patients [23,24]. Our intervention consisted of the following components: 1) preoperative verbal education delivered by nurses in clinic and structured around the SEPCAS brochure in addition to providing patients with the physical brochure, 2) postoperative, pre-discharge verbal counseling by discharge pharmacists using the SEPCAS brochure to reinforce key concepts. Verbal educational materials (Appendices 1 and 2) were based on the ACS Strong for Surgery Safe and Effective Pain Control Screening Checklist. [25]

Setting and participants

We evaluated our intervention at two general surgery clinics in an academic health system. All English-speaking, adult patients (age ≥ 18) undergoing major abdominal surgery (defined as an operation involving the surgical entrance of the abdominal cavity with a hospital stay of at least 24 h) were eligible for inclusion. Patients who required interpreter services or who were admitted directly to the hospital without a pre-operative clinic visit (e.g., through the emergency department) were excluded from this study. The study was approved by the University of Utah Institutional Review Board (IRB_00133785). Informed consent was obtained from all participants.

Implementation personnel

A total of nine surgeons (four colorectal, two surgical oncologists, and three general surgeons) performed the operations on the patients involved in this study. At each of the two clinic locations, there was one nurse lead who performed the majority of the nurse-directed preoperative education and survey distribution who was assisted by 1–2 other nurses at each location. The pharmacist-led education at hospital discharge was performed by the two clinical pharmacists listed as authors in this manuscript.

Table 1
Existing literature on studies delivering patient education on post-operative pain management and safe opioid use. "x" indicates "yes".

	Standardized and widely available material	Verbal instruction	Written instruction	Video instruction	Pre- and Post-op instruction	Control and intervention	Results
Chen et al. [27]		x	x	x	x	No education vs. education	Experimental group reported less post-op pain and had superior functional ability
Hartford et al. [15]		x	x		x	No education vs. education	No difference in average post-op pain scores, post-intervention group used significantly less opioids
Syed et al. [11]			x	x		No education vs. education	Those in experimental group consumed less narcotics and stopped narcotic use sooner
Angioli et al. [31]		x	x			Written education vs. verbal education	Those in written education group had better satisfaction with information and fewer hospitalized days and daily pain medications
Sabesan et al. [32]		x	x		x	No education vs. education	Patients in education group used less opioid medications, had slightly higher post-op pain scores, but better functional ability scores
O'Donnell [35]		x	x			No education vs. education	Those in education group had better understanding of potential opioid side effects
Van Dijk et al. [34]				x		No education vs. education	Those in education group used similar amount of opioids, but reported better pain control
Current study	x	x	x		x	No education vs. education	See results

Evaluation tools

To evaluate our intervention, we developed a paper-based survey to be administered to patients in the pre-intervention and post-intervention periods. The survey asked all patients about their expectations about surgery and their post-operative recovery, satisfaction with pain management, pain scores, and clinical history of comorbidities associated with opioids and pain (Appendix 3). The survey was based on questions asked in the ACS SEPCAS brochure "Safe Pain Control Patient Evaluation" and patients provided answers on a 7-point Likert scale, ranging from 1 ("A lot less") to 7 ("A lot more") with the neutral option number 4 in the middle being "No more or less" [17]. We further refined the questions using iterative pilot-testing with surgeons, nurses, staff, and patients. Pain scores were measured using the Revised American Pain Society Patient Outcome Questionnaire (APS-POQ-R) which asks, "How often were you in severe pain during the first week after surgery?" on a scale of 0 % to 100 %, with 0 % being never, and 100 % being always [26]. We combined survey data with electronic medical record data such as patient demographics, type of pre-operative visit (in-person vs. telehealth), surgeon, characteristics of their surgery (e.g., open versus laparoscopic versus robotic), indications for surgery, and comorbidities. Opioid consumption was evaluated by calculating morphine milligram equivalents (MME's) from their discharge opioid prescription amount and their self-reported post-operative opioid use. For post-intervention patients ("Improve" phase), we asked patients an additional set of questions that asked them to evaluate the brochure as part of their surgical experience.

Patients presenting in-person to their 2–4-week follow-up appointment were given a paper-based survey. Patients who were scheduled for telehealth-based post-operative visits were mailed a survey in the week preceding their appointment and then completed their survey during their telehealth visit. Patients who completed their post-operative visit over telehealth also received telephone reminders to complete and return the survey. Patients did not receive any compensation for participation in the study.

Outcomes, power calculations, and statistical analysis

Our primary outcome was whether patients received sufficient information to prepare them to manage their post-operative pain. We defined this as not giving patients too little or too much information. To evaluate our primary outcome, we a priori dichotomized survey responses into two groups: those responding "no more or less" information needed and those responding that they would have liked either more or less information regarding each topic. Using a Mann-Whitney U power test we calculated the need to enroll 27 participants in the "Measure" phase (pre-intervention) and "Improve" phase (post-intervention) (total $n = 54$) to achieve 80 % power using a two-sided alpha 0.05 comparison, under the assumption that the pre-intervention group would report 50 % "no more or less" information desired compared to 85 % "no more or less" information desired in the post-intervention group regarding pain control options, alternatives to opioids, or using the lowest dose of opioids possible. The assumption of 50 % of the pre-intervention group reporting "no more or less" information desired came largely from our estimation of patient satisfaction with peri-operative education from prior and ongoing qualitative studies and focus groups that our research team has conducted with patients. The use of a 35 % effect size came from discussions within the research team about what would constitute a clinically relevant increase in sufficiency of perioperative education. Accounting for an estimated 75 % survey response rate, we planned to recruit 36 patients to each arm of the study.

Our secondary outcomes of interest were 1) acceptability of our intervention as measured by whether patients reported that they thought the ACS SEPCAS brochure was useful in their post-operative recovery and that it should be given to every patient undergoing surgery, 2) patient reported post-operative pain, 3) opioid consumption, and 4) satisfaction with pain control. We also collected process outcomes to evaluate the real-world feasibility and potential gaps in implementation: the percentage of eligible participants who received the education, participant recall about receiving the education, and integration of education into clinic and floor workflow.

Not all patients received all components of the educational intervention. However, we used an intention to treat analysis for those in the interventional arm regardless of whether they received both components of the educational intervention or not. Missing survey responses were not imputed and are noted in the tables. For patients in the post-intervention period who were asked questions regarding attitudes toward the SEPCAS brochure, responses were categorized by whether they agreed, disagreed, or were neutral regarding the series of questions asked about the brochure. Pain scores were analyzed as continuous variables [26]. To evaluate the relationship between adequacy of perioperative education and perioperative pain, we separated all patients by whether they thought their perioperative education was adequate versus if they wanted more education and compared their mean pain scores in the first week after surgery.

Categorical variables were analyzed using either Chi-square or Fisher's exact test, as appropriate. Two-tailed *t*-tests were used to analyze numerical variables. *P*-values <0.05 were considered statistically significant. All analyses were performed using Stata 17 (College Station, Texas, USA).

Measure, analyze, and improve phases. The "Measure" pre-intervention phase was conducted from 9/1/2020 to 2/1/2021. During a planned washout period from 2/1/21 to 2/28/21, we conducted an initial analysis of our baseline data. We also trained staff on delivering the intervention and surveys, established anticipated flow for implementation of the intervention in surgical clinics and on the hospital floor, and collected data on discharges. While we distributed the intervention surveys in this period, we did not include them in our analysis. We collected post-intervention data during the "Improve" phase from 3/1/2021 to 8/31/2021. A flowchart of data comparing data collection and intervention delivery in the pre- and post-intervention phases is shown in Fig. 1.

Control phase. For the purposes of our study, we monitored the implementation of our intervention for real-world feasibility application and expansion. Integration of the educational intervention into clinic and discharge workflow was continuously monitored throughout the study via periodic check-ins with the nursing staff and pharmacists responsible for providing the verbal education.

Results

A total of 93 surveys were completed in the baseline period. Of these, 27 (29.0 %) met inclusion criteria. During the post-intervention period, a total of 126 surveys were returned with 39 (30.9 %) meeting inclusion criteria. To reduce the burden on clinic staff, surveys were distributed prior to applying any exclusion criteria. Thus, we do not have a precise survey response rate. However, when we queried nurses during the implementation of the study, they reported that the large majority of post-op patients returned the completed survey at the end of their visit. Approximately half of participants were female with a mean age of 53 years (Table 2). The pre-intervention cohort was, on average, older than those in the post-intervention group. There were no differences between the two groups in terms of current tobacco, alcohol, chronic prescription opioid use (defined as use of a prescription opioid within the last year prior to their operation), chronic pain conditions, socio-environmental factors, psychiatric conditions, or history of substance abuse. There were no significant differences between the two groups in terms of gender, race, clinic site, or virtual vs. in-person post-op visits. The number of days between surgery and post-op appointment was on average, longer for those in the post-interventional

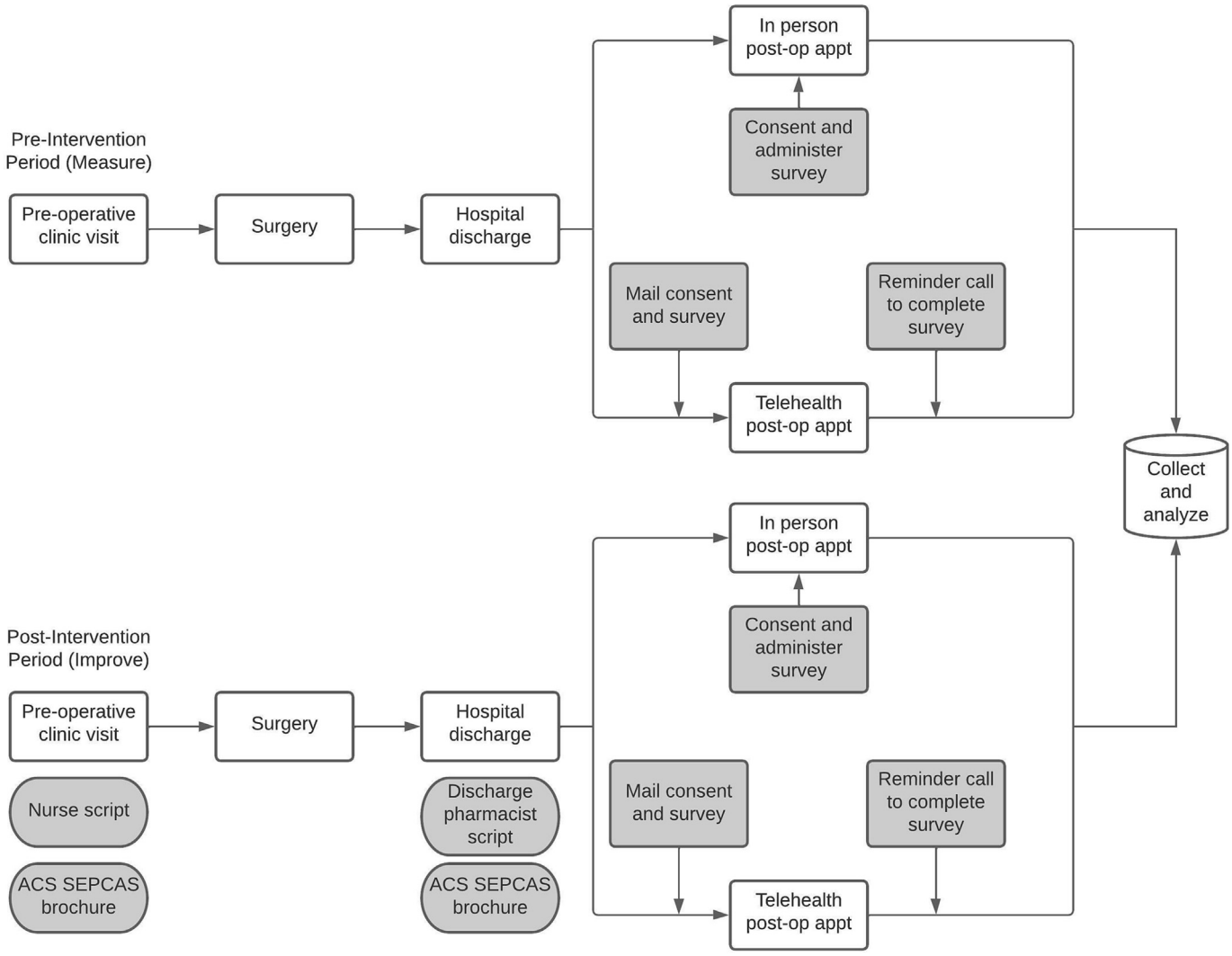

Fig. 1. Flowchart demonstrating implementation of the American College of Surgeons Safe and Effective Pain Control Brochure-based intervention through pre- and post-interventional periods.

period. There were no differences between the groups in terms of surgical indication (cancer vs. non-cancer related) or surgical approach (open, laparoscopic, or robotic).

Process outcomes. No participants in the pre-intervention group were given the SEPCAS brochure. However, 3 (11.1 %) of the pre-intervention participants reported receiving the brochure. All 39 (100.0 %) post-intervention participants received the pre-operative education and brochure. Due to limitations in pharmacist availability at the time of patient discharge, 18 (46.1 %) of the post-interventional group received both the pre-op and post-op educational materials. Nearly half of the post-intervention participants who received only the pre-op education remembered receiving the brochure. Of the participants who received both the pre- and post-op education, nearly two-thirds remembered receiving the brochure.

The ACS SEPCAS brochure as patient preparation for appropriate pain management. Those in the post-intervention period trended toward a larger percentage indicating adequacy of pre-operative education compared to the pre-intervention period in every topic we asked about (Fig. 2). However, the differences were only statistically significant for the "recognizing the signs of opioid overdose" and "opioid storage and disposal options" categories. Out of the 73 aggregate responses in a category other than "No more or less" for those in the pre-intervention group, 53 (72.6 %) were for wanting more information, and 20 (27.4 %) were for wanting less information.

Patient perception of the ACS SEPCAS brochure. The majority of participants who received the educational intervention answered the survey questions about their perception of the SEPCAS brochure ($n = 31$, 80 %) Participants who did not respond to these questions indicated that they did not remember receiving the brochure. Out of those who answered the questions regarding the brochure (n = 31), 20 (64.5 %) agreed that the brochure was useful for their post-operative recovery (Fig. 3a). Twenty-two participants (71.0 %) agreed that the brochure explained well the proper way to store and dispose of opioid medication (Fig. 3b). Fourteen participants (45.2 %) agreed that the brochure improved their surgical experience compared to 14 (45.2 %) who were neutral (Fig. 3c). Finally, 20 participants (64.5 %) agreed that the brochure should be offered to every patient undergoing surgery (Fig. 3d).

Pain and its relationship to perioperative experience. Patients in the pre-intervention period reported being in severe pain 40.2 % of the time during their first week after surgery. Those in the post-interventional period reported being in severe pain 44.9 % of the time in their first week after surgery ($p = 0.57$).

When respondents were stratified by whether they thought they received an adequate amount of information or not (regardless of

Table 2
Patient demographics and clinical characteristics.

		Pre-intervention ($n = 27$)	Post-intervention ($n = 39$)	p-Value
Age (years) Mean, 95 % CI		60.6 (54.2–67.1)	51.4 (46.1–56.8)	0.03
Sex n, (%)	Female	13 (48.2)	22 (56.4)	0.51
Race n, (%)	White/Caucasian	26 (96.3)	38 (97.4)	>0.99
	Other	1 (3.7)	1 (2.6)	
Active Smoker n, (%)		0 (0.0)	3 (7.9)	0.26
Current alcohol drinker n, (%)	Yes	9 (33.3)	7 (18.4)	0.17
Prescription opioid use in the last year n, (%)	Yes	8 (29.6)	13 (33.3)	0.75
Virtual Post Op Appt n, (%)	Yes	7 (25.9)	10 (25.6)	0.98
Days between surgery and post-op visit mean, 95 % CI		21.7 (17.9–25.6)	29.9 (25.0–34.9)	0.02
Indication for operation n, (%)	Non-cancer	11 (40.7)	25 (64.1)	0.06
Surgical approach n, (%)	Cancer-related	16 (59.3)	14 (35.9)	
	Open	6 (22.2)	3 (7.7)	0.14
	Laparoscopic	14 (51.9)	19 (48.7)	
	Robotic	7 (25.9)	17 (43.6)	
Personal history of… n, (%)				
Fibromyalgia		0 (0.0)	3 (8)	0.26
Chronic back pain		3 (11.5)	7 (18.4)	0.51
Headaches/migraines		9 (33.3)	6 (15.8)	0.10
Sexual abuse		2 (8.0)	3 (7.9)	1.00
Depression		12 (44.4)	12 (31.6)	0.29
Anxiety		9 (33.3)	13 (35.1)	0.88
Attention deficit disorder		1 (3.8)	5 (13.2)	0.39
Obsessive compulsive disorder		2 (8.0)	3 (7.9)	1.00
Schizophrenia		0 (0.0)	1 (2.6)	1.00
Alcohol abuse		1 (4.0)	1 (2.6)	1.00
Opioid abuse		0 (0.0)	0 (0.0)	
Illicit drug use		0 (0.0)	2 (5.3)	0.51

treatment group) We found that those who thought they had received an appropriate amount of information had significantly lower pain scores than those who felt they did not receive an appropriate amount of information in the categories of "What pain to expect after surgery", "Pain control options", "Alternatives to opioids", "Using the lowest dose of opioids for the shortest amount of time possible", and "How to reduce your chances of becoming addicted to opioids" (Fig. 4). Differences were not significant for those who had wanted more information regarding recovery at home, recognizing the signs of opioid overdose, and opioid storage and disposal options (Fig. 4).

Prescription opioid use. There was no difference in the amount of opioids prescribed at discharge in the pre- (101.2 MME, 95 % Confidence Interval (CI) 69.7–132.7) vs. post-intervention (103.2 MME, 95 % CI 74.0–132.5), ($p = 0.92$) periods and there was no difference in whether or not participants filled their opioid prescription (pre-intervention $n = 18$ [66.7 %], post-intervention $n = 30$ (76.9 %), $p = 0.61$). There were also no differences between the pre- and post-intervention groups in terms of whether those who filled their prescription consumed all their medication or received a refill.

Satisfaction. When queried about satisfaction with pain control at home after surgery, pre-intervention participants did not differ significantly from post-intervention patients (Table 3). Out of all respondents, 57 (86.4 %) reported they were satisfied with their pain control after surgery. Of note, the mean pain scores for those that were dissatisfied with their pain control after surgery were significantly higher than those who were satisfied with their pain control after surgery

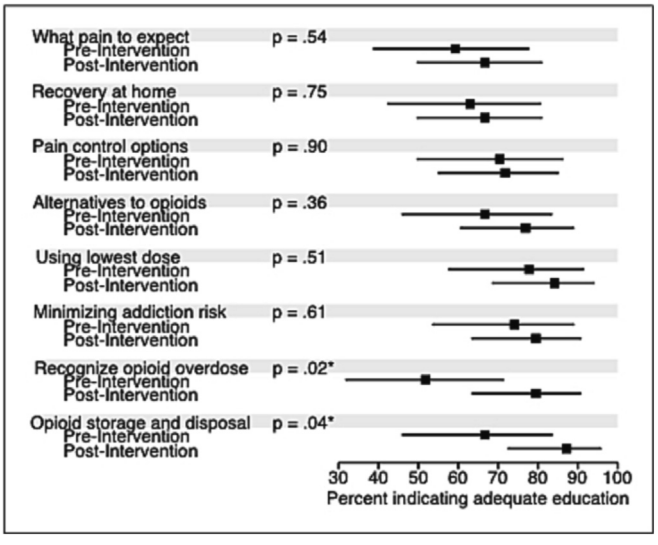

Fig. 2. Percentages of patients reporting appropriate amount of perioperative education for each topic in pre- vs. post-intervention groups.

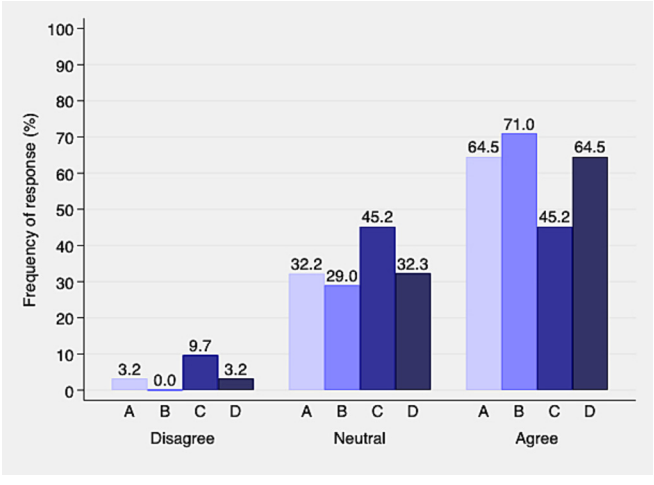

Fig. 3. Patient perceptions of ACS SEPCAS Brochure
3A. "The brochure was useful for your post-operative recovery"
3B. "The brochure explained well the proper way to store and dispose of opioid medication"
3C. "This brochure improved your surgical experience"
3D. "This brochure should be offered to every patient undergoing surgery".

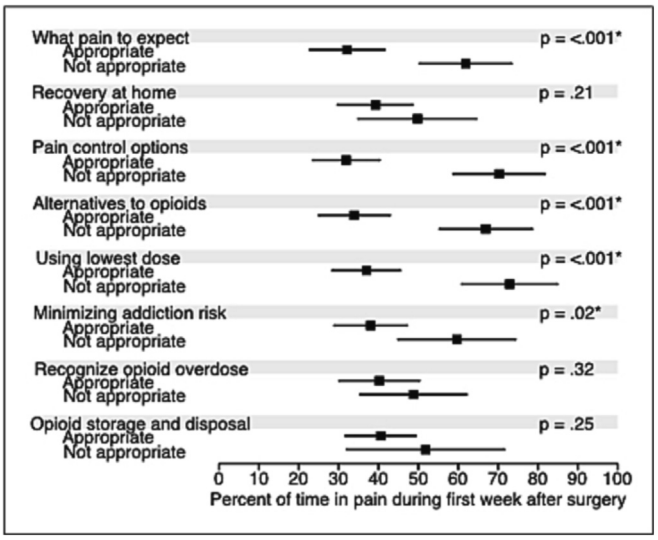

Fig. 4. Relationship of pain scores to whether participants thought they received an appropriate vs. not appropriate amount of information for each topic.

(Table 3). Out of the 8 patients who indicated dissatisfaction with their pain control after surgery, roughly half of them indicated the reason for their dissatisfaction was due to their receiving an insufficient prescription for pain medication (Table 3).

Discussion

While many studies have demonstrated the efficacy of patient education in the management of post-operative pain, there has remained a lack of consensus regarding the best educational materials [10,27,28]. This fact has resulted in the widespread call for standardized patient education practices in pain management [8,10,15,29,30]. After defining that gap using the DMAIC framework and our literature review, we identified the ACS SEPCAS brochure as an optimal educational material given that it is evidenced based, consensus-driven, and widely available. Utilizing the brochure as the foundational material, we then created an educational model that integrates multiple educational modalities such as written and verbal components, repetition, and shared decision making which have proved effective in prior studies [11,15,27,31–33].

In terms of measuring the effectiveness of our educational framework, patients who received the educational bundle were more likely to report receiving an appropriate amount of information regarding how to recognize the signs of opioid overdose and how to safely store and dispose of opioid medications compared to those who did not receive the education. Our findings regarding improvement of patient understanding regarding warning signs of opioid overdose and appropriate opioid storage and disposal are consistent with prior studies demonstrating that educational interventions are effective in improving patient prescription opioid safety [15].

Patients also reported that the ACS SEPCAS brochure itself was an important component of preparing them for their recovery. The large majority of patients indicated that the brochure was useful in their post-operative recovery, was effective in explaining how to appropriately use and dispose of their opioid prescription, and should be offered to every patient undergoing surgery. This suggests that in addition to the brochure being effective from a clinical standpoint, the ACS brochure is an appropriate and usable tool from the patient's perspective. While other studies have demonstrated similar findings in terms of patient perception of educational material [13,15], our study is the first to point to a standardized material such as the ACS SEPCAS brochure that is both authoritative and widely available.

Lastly, our data is consistent with prior findings that pain is an important modulator of the patient's perioperative experience [34]. Unsurprisingly, those in our study who reported higher levels of post-operative pain were less satisfied with their pain control at home after surgery. We also found that patients in our study who indicated greater pain during their first week after surgery were less likely to indicate they received an appropriate amount of information regarding what pain to expect after surgery and their pain control options. Thus, addressing patient concerns about, and preparing them to adequately manage their post-operative pain is an important component of effective surgical care.

Our study has a number of limitations. First, we conducted our study at a single institution. Future studies are needed to study the feasibility of the SEPCAS handout in other institutions and populations to improve generalizability. In addition, our real-world trial application of an educational model identified potential barriers to implementation as described in our process outcomes. Such issues included gaps in patient education due to limited staff or periods or coverage gaps on weekends or holidays. These barriers represent areas of ongoing work in the "Improve" component of the DMAIC framework. Our study may also be affected by social desirability or recall bias. However, there were patients who indicated their perception of inadequacy of the perioperative education and there was a low rate of missing data, suggesting that patients were comfortable expressing their true opinions in our survey. Given that the overall differences between the responses of those in the pre- vs. post- interventional groups were very modest (statistically significant in only 2 of the 8 categories we examined) we estimate that the effect from social desirability was likely not a major influence to their survey responses. Similarly, we did not see a significant difference in reported pain scores between the pre- and post-intervention group suggesting recall bias did not play a significant role in participants' responses. Lastly, as is common in survey-based research, we faced challenges with survey response rates, particularly for those who received the survey via mail rather than during an in-person clinic visit. Despite follow up via phone calls, those who received mailed surveys had survey response rates of an average of 16 %, while nurses reported that the majority of clinic-based patient visits resulted in completed surveys.

Future directions for these findings would be to implement the ACS SEPCAS brochure education bundle at a multi-institutional level with further streamlining of processes. For example, incorporating the brochure into pharmacists workflow (and providing additional resources) might allow them more opportunities for pre-discharge counseling. In terms of the brochure itself, patients largely agreed that it was thorough in explaining the options for perioperative pain control. However, the brochure might be improved by including a summary of key points for those patients that do not wish to utilize the brochure in its entirety.

Table 3
Patient satisfaction with pain control at home after surgery and distribution of pain scores stratified by satisfaction rating.

		Pre-intervention n = 27	Post-intervention n = 39	Total n = 66	*p* Value
Patient satisfaction with pain control at home after surgery n, (%)	Satisfied	26 (96.3)	31 (79.5)	57 (86.4)	0.13
	Dissatisfied	1 (3.7)	7 (18.0)	8 (12.1)	
	Neutral	0 (0.0)	1 (2.6)	1 (1.5)	
Pain scores for those who were satisfied vs. not satisfied with their pain control after surgery, mean, (95 % CI)	Satisfied	–	–	38.7 (30.5–46.9), *n* = 57	0.02
	Dissatisfied	–	–	66.2 (41.4–91.1), *n* = 8	

Conclusion

This study utilized the DMAIC framework for quality improvement to identify and address the current gap in perioperative education regarding lack of a standardized educational material and process for delivering perioperative education. We found that using the ACS SEPCAS brochure improved patient preparation to safely store and dispose of their opioid medication and recognize the signs of opioid overdose. We also found that patients were receptive to, and appreciated the brochure being part of their recovery and preparation for pain control. Lastly, we found that post-operative pain is an important component of how patients perceive their surgical experience. Due to its position as an evidence-based, authoritative, and widely available document, the ACS SEPCAS brochure is squarely positioned to become the unifying standard tool for perioperative pain management education. Future research should be targeted toward developing scalable patient interventions based on the brochure and better understanding of the interplay between post-operative pain and patient's surgical experience.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.sopen.2023.04.007.

Declaration of competing interest

None of the authors have any financial or non-financial conflicts of interest to report.

Acknowledgements

The authors would like to thank Belma Devedzic, RN and Marcy Neeley, RN for their assistance in developing the education script and delivering the educational intervention to patients.

CRediT authorship contribution statement

ZF: design, implementation, analysis, drafting and submitting final manuscript. JB: design, analysis, drafting and editing final manuscript. JJ: design, implementation, drafting and editing of final manuscript. KP and DP: implementation, editing and approval of final manuscript. GS: design, analysis, editing and approval of final manuscript. BB: design, analysis, drafting and approval of final manuscript. LH: design, analysis, editing and approval of final manuscript, supervision of all other activities.

Funding sources

The research reported in this publication was supported in part by the National Center for Advancing Translational Sciences of the National Institutes of Health under Award Number UL1TR002538 and KL2TR002539. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Ethics approval

The study was approved by the University of Utah Institutional Review Board (IRB_00133785). Informed consent was obtained from all participants.

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