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Use of biobehavioral interventions in children undergoing surgery and associated patient-reported outcomes

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Abstract

Background: Biobehavioral interventions including relaxation, distraction, and mindfulness meditation exercises have been shown to decrease perioperative stress, anxiety, and pain. Our aims were to 1) quantify pediatric surgical patient-reported pre-operative exposure to and post-operative

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use of biobehavioral interventions; 2) understand barriers and facilitators to incorporation of biobehavioral interventions into clinical practice; and 3) evaluate associated patient-reported outcomes.

Methods: We conducted an embedded mixed-methods study with a quantitative focus. Data were collected as part of the 18-hospital ENhanced Recovery In CHildren Undergoing Surgery (ENRICH-US) clinical trial for children, ages 10–18 years, undergoing elective gastrointestinal surgery. Patients/caregivers were surveyed about preoperative exposure to and postoperative use of biobehavioral interventions. Four semi-structured group interviews with 20 pediatric surgery providers were conducted. Outcomes included pain-related functional disability, health-related quality of life (HRQoL), and perioperative nervousness.

Results: 41 % ($n = 67$) of 164 enrolled patients/caregivers reported preoperative exposure to and 71 % ($n = 117$) reported postoperative use of a biobehavioral intervention(s). Barriers to incorporation of biobehavioral interventions included lack of standardized workflows, clinician knowledge, and resources. Potential facilitators included media and peer-counseling. After adjusting for individual and hospital characteristics, those who reported using a biobehavioral intervention(s) were 70 % less likely to report worsened postoperative nervousness (95 % CI 0.10–0.91; $p = 0.03$). Reported use of a biobehavioral intervention(s) was not found to be associated with pain-related functional disability or HRQoL.

Conclusions: Use of a biobehavioral intervention(s) may stabilize postoperative nervousness of children undergoing surgery. There is a need for redesign of clinical workflows and clinician training to facilitate integration of biobehavioral interventions.

Keywords

biobehavioral interventions; patient-reported outcomes; gastrointestinal surgery; children; pediatric; mixed-methods

Introduction

Use of multimodal pain management strategies in pediatric populations are recommended to improve pain control and reduce child, as well as, parental, anxiety [1,2]. Management of perioperative pain using non-opioid strategies has gained interest among surgical providers to reduce risk of persistent opioid use and future misuse associated with early opioid exposure [3,4]. Alternative pharmacological measures such as non-opioid analgesics and regional or neuraxial anesthesia are increasingly incorporated into perioperative protocols [5,6].

Biobehavioral interventions are psychological and behavioral practices that reduce perioperative anxiety and postoperative pain by addressing cognitive, affective, and stress responses that maintain pain. These interventions, including relaxation, distraction, and mindfulness meditation exercises, have been successfully implemented post-operatively in adults with preliminary reported success in opioid reduction [7–12]. Patients, caregivers, and providers express a need for perioperative psychosocial interventions that better prepare families for surgery [13]. Biobehavioral interventions such as distraction, hypnosis, multi-component cognitive-behavioral approaches and breathing interventions have been shown

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to reduce pain and distress in children undergoing needle-related procedures and surgery [14–16]. However, rigor of these trials has generally been low and further research is needed to elucidate the mechanisms of clinical effect, the ideal timing and dose of interventions, developmental considerations, and other implementation factors to optimally leverage these interventions in clinical settings.

While inclusion of biobehavioral interventions in perioperative pain and anxiety management in children appears to be increasing, the overall exposure to and use of these interventions in specific pediatric surgical populations have not been well described. The objectives of this study are to 1) quantify patient-reported preoperative exposure to and use of biobehavioral interventions for a cohort of children undergoing gastrointestinal surgery; 2) understand barriers and facilitators to incorporation of biobehavioral interventions into clinical practice; and 3) evaluate associated patient-reported outcomes including pain-related functional disability, health-related quality of life (HRQoL), and perioperative nervousness. We hypothesized that (a) patients had little prior exposure to biobehavioral interventions and (b) those who used the interventions would have improved postoperative anxiety and pain-related functional disability compared to patients who did not.

Methods

We conducted an embedded mixed-methods study with a quantitative emphasis. Quantitative data was collected to determine the reported use of biobehavioral interventions in pediatric surgery and evaluate associated patient-reported outcomes. Qualitative data was collected to augment quantitative findings with information on barriers and facilitators to the use of biobehavioral interventions.

Quantitative data collection and analyses

Study setting and data sources—Quantitative data were collected from patients and caregiver proxies (caregivers) participating in the ENhanced Recovery In CHildren Undergoing Surgery (ENRICH-US) study [19]. For more information about the ENRICH-US study, see Fig. 1. Pediatric patients, ages 10–18, undergoing elective abdominal surgery at 18 US pediatric surgical centers, and their caregivers, were included. The trial protocol (Protocol #0,003, 920) was approved by Advarra, Inc. (Columbia, MD) which serves as the single, central institutional review board for all study sites.

Surveys were sent electronically to caregivers and patients prior to surgery and 2–4 days postoperatively. Clinical data were abstracted from each patient's electronic health record (EHR) by trained data collectors at each site into a Research Electronic Data Capture (REDCap) database [17,18].

Study cohort—Data were collected from all patients and caregivers enrolled in the ENRICH-US Study between July 2020 and January 2022. Patients were only included from sites prior to implementation of the enhanced recovery protocol to capture baseline reported exposure to and use of biobehavioral interventions. The ENRICH-US protocol included education regarding biobehavioral interventions to be performed preoperatively. Specifically, a video demonstrating deep breathing exercises that was developed by the study team was

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provided to all participating sites to share with patients. Records that were missing data on biobehavioral intervention use were excluded.

Exposure to and use of biobehavioral interventions—Three forms of biobehavioral interventions were examined: relaxation practices, distraction techniques, and mindfulness meditation exercises. Exposure was defined as patient or caregiver report of the patient having received preoperative information about, or practice of these forms of biobehavioral intervention specifically for that surgical intervention. Additional questions were asked about the type of exposure and the specific intervention. In addition to reported exposure, the data collectors abstracted any documentation about preoperative exposure to a biobehavioral intervention(s) from the electronic health record (EHR). Use was defined as reported use of a biobehavioral intervention(s) by the patient postoperatively. Patient collected responses were used when available, and caregiver responses were used as a proxy when necessary [19,20].

Patient-reported outcomes—The patient-reported outcomes included pain-related functional disability, HRQoL, and perioperative nervousness. Patient-reported outcomes were used when available, and caregiver reported outcomes were used as a proxy when necessary [19,20].

Pain-related functional disability and HRQoL were assessed using validated questionnaires from the Patient-Reported Outcomes Measurement Information System (PROMIS) [21–23]. The PROMIS Pain Interference measure was used to assess self-reported consequences of pain on relevant aspects of the patient's life (pain-related functional disability). The PROMIS Pediatric Short Form version 2.0 – Pain Interference 8a and PROMIS Parent Proxy Short Form version 2.0 – Pain Interference 8a consists of eight questions with Likert scaled responses ranging from never to almost always. PROMIS scores are standardized with a mean of 50 and standard deviation of 10, based upon a U.S. general population reference. Scores higher than the standardized mean of 50 represent increased pain interference. Preoperative and post-operative pain interference were compared. "Improved" was defined as a 1 point or greater decrease in pain interference, "worsened" was defined as a 1 point or greater increase in pain interference, and "stable" was defined as unchanged pain interference.

The PROMIS Pediatric Scale version 1.0 – Global Health 7 and PROMIS Parent Proxy Scale version 1.0 – Global Health were used to assess a child's overall physical, mental, and social health (HRQoL). The questionnaire includes seven questions with Likert scaled responses, ranging from poor to excellent. PROMIS scores are standardized with a mean of 50 and standard deviation of 10, based upon a U.S. general population reference. Scores higher than the standardized mean of 50 represent increased overall global health. Preoperative and post-operative global health were compared. "Improved" was defined as a 1 point or greater increase in global health, "worsened" was defined as a 1 point or greater decrease in global health, and "stable" was defined as unchanged global health.

Patients and caregivers were asked to rate their level of preoperative and postoperative "nervousness" about the surgery, using a five-point Likert scale ranging from "no

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nervousness at all" to "very nervous" [24]. Higher scores represented an increased level of nervousness. Pre-operative and postoperative nervousness were compared and categorized based upon change in Likert response: "Improved" was defined as a 1 point or greater decrease in nervousness, "worsened" was defined as a 1 point or greater increase in nervousness, and "stable" was defined as unchanged nervousness.

Patient demographics and clinical characteristics—Age was treated as a continuous variable. Sex was treated as a binary variable (male vs female). Hospital volume was incorporated as a binary variable of low volume (< 20 cases) vs high volume (≥ 20 cases). Twenty was selected as the median number of cases. A categorical variable was created for surgical indication which included inflammatory bowel disease (IBD; Crohn's disease, ulcerative colitis, and mixed colitis) or other (history of trauma with prior bowel involvement, history of prior medical condition requiring bowel surgery, history of cancer, familial adenomatous polyposis, and other). Use of a perioperative block was treated as a binary variable (yes vs no). Operative approach was treated as a binary variable (minimally invasive, including robotic, vs open).

Statistical analysis—Patient demographic and clinical characteristics were compared by use of a biobehavioral intervention(s). Chi-squared tests were used to compare categorical demographic and clinical characteristics by use of a biobehavioral intervention(s). Student's *t*-test were used to compare age by use of a biobehavioral intervention(s). Univariate analysis was performed using Wilcoxon signed rank tests for post-operative compared to pre-operative patient-reported outcomes by use of a biobehavioral intervention(s).

A multinomial logistic regression model was fit to evaluate the association between patient-reported outcomes and use of a biobehavioral intervention(s) after adjusting for demographic and clinical characteristics. The baseline comparison group was stable for each patient-reported outcome.

The final analysis cohort had complete demographic and clinical characteristics. However, the patient-reported outcome of nervousness was missing for 16 patients (9.8 %). All tests were two-sided. Statistical analyses were done using Stata v17.0 (StataCorp LLC, College Station, TX, USA).

Qualitative data collection and analyses

Study population and recruitment—Qualitative data were collected through online group interviews with pediatric surgery providers. We recruited the providers from the 18 ENRICH-US hospitals. The invitations were disseminated via email to implementation team members of the 18 ENRICH-US hospitals. To ensure a broad perspective covering the entire perioperative pathway, the invitation targeted various providers including child-life specialists, pediatric psychologists, recreational and creative arts therapists, clinical social workers, nurses, surgeons, and anesthesiologists.

Semi-structured group interviews—Our multidisciplinary research team, including experts in qualitative research methods (WS, JJ), a pediatric psychologist (BE), and a pediatric surgeon (MR), developed semi-structured interview guides. The interview guide

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focused on current use of biobehavioral interventions and barriers and facilitators to their use. Between March and June 2021, four researchers (WS, BE, JJ, and MR) conducted four semi-structured group interviews with providers at six hospitals across the United States

Coding and data analyses—Recordings were transcribed verbatim and an inductive coding process was used. Coding was conducted by three study team members (WS, KG, and MW) across multiple rounds to identify emerging codes and themes related to barriers and facilitators to the use of biobehavioral interventions. Discrepancies were reconciled through consensus. Group interview data were analyzed concurrently to triangulate data. We used the MaxQDA software package (Version 2020; VERBI Software GmbH, Germany) to support data storage, coding, and analyses.

Results

Demographics and surgical information

The cohort consisted of 164 patients for whom either patient or caregiver surveys were complete (Fig. 2). Of these, 106 (65 %) included patient-reported outcomes and 58 (35 %) included caregiver-reported outcomes (Supplemental Table 1). The median age of the cohort was 15.6 years (interquartile range [IQR], 13.7–17.4) (Table 1). The median age of patients who self-reported outcomes was 16.3 years (IQR, 15.2–17.6) compared a median of 14.4 years (IQR: 12.7–16.2) for those with caregiver-reported outcomes. The cohort was 59 % male ($n = 97$). Perioperative regional anesthetic blocks were used in 41 % of patients ($n = 65$). Most patients ($n = 101$, 62 %) underwent minimally invasive surgery (MIS). The surgical indication was primarily IBD ($n = 119$, 73 %). The distribution of patients among ENRICH-US hospitals is included as Supplemental Table 2.

The qualitative interviews were conducted with 20 participants from six hospitals. Participants included six (30 %) child life specialists, one (5 %) clinical effectiveness consultant, one (5 %) nurse manager, two (10 %) nurse practitioners, one (5 %) pediatric hospitalist, three (15 %) pediatric nurses, two (10 %) pediatric psychologists, one (5 %) program manager, one (5 %) researcher, and two (10 %) social workers. Three (15 %) of the respondents were male and 17 (85 %) were female.

Preoperative exposure to and postoperative use of biobehavioral interventions

Forty-one percent of patients ($n = 67$) reported having been exposed preoperatively to a biobehavioral intervention(s), although more patients ($n = 117$, 71 %) reported actual use of a biobehavioral intervention(s) post-operatively (Fig. 3). However, only 7 (4 %) patients had documentation of exposure to a biobehavioral intervention(s) in the EHR. The most common reported modality of preoperative exposure was introduction or facilitation by a clinician ($n = 44$, 27 %), followed by self-education ($n = 17$, 10 %). Diaphragmatic breathing ($n = 36$, 22 %) and distraction ($n = 30$, 18 %) were the interventions with the highest rate of reported preoperative exposure. Distraction was the most frequently used intervention ($n = 72$, 44 %) postoperatively followed by diaphragmatic breathing ($n = 70$, 43 %). There were no differences in demographics, hospital volume, surgical indication, use of

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perioperative non-opioid pain control modalities, or operative approach between those who used biobehavioral interventions postoperatively and those who did not.

Barriers and facilitators to the incorporation of biobehavioral interventions into clinical practice

We identified three themes of barriers and facilitators to the incorporation of biobehavioral interventions into clinical practice: 1) lack of standardized workflows, 2) need for improved clinician knowledge and resources, and 3) advice for improvement in patient education modes. Regarding the first theme 'lack of standardized workflows', the respondents indicated that none of the hospitals had a specific workflow to ensure that every patient was routinely offered a biobehavioral intervention(s). A nurse practitioner stated:

> "I don't believe there [are] dedicated social workers [and] psychologists. I know there's some in the departments that will cross cover. So, there's kind of a lot of little silos, and I'm not sure how they all interact. And I think it just depends on someone identifying that this kid needs a little more TLC [tender, loving care]."

Respondents noted that pre-operative patients were not always seen by child-life specialists prior to their surgery. For example, when they were admitted from an inpatient area rather than outpatient. The respondents recognized the need to make all patients aware of the resources that are available, e.g., through a flyer combining options within and outside the hospital.

Further, the second theme revealed a 'need for improved clinician knowledge and resources'. Respondents indicated that not all groups of clinicians had knowledge on the availability or use of resources within their setting. A child-life specialist said:

> "I think we would need to somehow also specify….when should they refer a patient to child life versus social work versus psychology? And I think that piece would need to be made clear, not like, "Oh, these roles exist, these people exist," but when should they contact or refer to which of us?"

Respondents recognized that other providers, such as surgeons, could have a role in underlining the importance of the use of biobehavioral interventions. However, there was also a concern that some may culturally be less inclined to do so.

Resources were also limited. For example, various respondents indicated that there was a lack of space to practice these interventions in hospitals. When trying to educate patients on the day of hospital admission, they were impeded by noise and lack of privacy in the rooms. Furthermore, child-life specialists generally did not see the patients until their hospital admission. This created a barrier to the education process, which may be less effective when the child was nervous for their procedure. Respondents indicated that a solution would be to better introduce the interventions pre-operatively and pre-admission. This would give children time to practice and allow for reinforcement by other staff throughout the perioperative pathway.

Finally, the respondents offered some advice for 'improvement in the modes of education'. Children and adolescents may be more receptive to alternative modes of communication

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such as social media platforms (e. g., YouTube), apps, and peer-counselling, rather than in person by a provider. A social worker suggested:

> "I think it's helpful for teenagers to have an app on their phone…and different areas of mindfulness that they can click on, and then they can explore various activities in that realm."

Association between postoperative use of biobehavioral interventions and patient-reported outcomes—Pain-related functional disability was similar in the post-operative compared to pre-operative setting for those that used a biobehavioral intervention(s) compared to those who did not (median, 53.5 [IQR, 48.0–59.0] vs 54.9 [45.7–61.0], $p = 0.39$) (Table 2). HRQoL was improved in the post-operative setting compared to the pre-operative setting for those that used a biobehavioral intervention(s) (median, 44.5 [IQR, 39.1–48.1] vs 41.6 [35.8–47.2], $p < 0.01$). Nervousness was improved in the post-operative compared to the pre-operative setting for those that used a biobehavioral intervention(s) (median, 2 [IQR, 2–4] vs 3 [IQR 2–4], $p < 0.01$).

Multinomial logistic regressions were performed to determine the relationship between reported postoperative use of any biobehavioral intervention and patient-reported outcomes (Table 3). After adjusting for age, sex, hospital volume, surgical indication, perioperative block, and operative approach, those who reported using a biobehavioral intervention(s) were 70 % less likely to report worsened postoperative nervousness compared to stable nervousness (95 % CI 0.10–0.91; $p = 0.03$). There was no association between use of a biobehavioral intervention(s) and improved nervousness compared to stable. There was no association between use of biobehavioral intervention and post-operative as compared to pre-operative changes in pain-related functional disability or HRQoL.

Discussion

Exposure to and use of biobehavioral interventions such as relaxation, distraction, and mindfulness exercises in the perioperative setting have not been well-characterized in children. To our knowledge, this study is the first to report on the prevalence of biobehavioral interventions being used perioperatively in a pediatric surgical population. As expected, formal exposure to biobehavioral interventions was limited; less than twenty-six percent of patients and their caregivers reported receiving clinician provided preoperative education. Yet, and surprisingly, these interventions are frequently being used by children after gastrointestinal surgery. These findings suggest that patients and caregivers may be seeking information about and using these interventions. Further, patients and caregivers are potentially highly receptive to the introduction of these interventions as perioperative strategies to reduce pain and anxiety. Barriers for better integration in routine care include lack of a standardized workflow, clinician knowledge, and resources. The study suggests that use of a biobehavioral intervention(s) perioperatively can stabilize postoperative nervousness. Thus, biobehavioral interventions may serve as important adjuncts to current pediatric perioperative pain and distress management protocols.

Implementation of programs that expose, inform, or teach biobehavioral interventions perioperatively may improve outcomes, particularly anxiety/nervousness. Many pediatric

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patients experience anxiety prior to surgery with intensity in emotion increasing from preoperative holding to anesthesia induction [25]. Preoperative anxiety has been linked to negative behavioral changes both immediately and at long-term follow-up after surgery, demonstrating the need to develop targeted strategies that address perioperative anxiety [26]. Formal training in biobehavioral interventions has demonstrated reduced postoperative anxiety in patients with high levels of preoperative anxiety [27]. This study similarly showed stable postoperative nervousness in children who reported using a biobehavioral intervention(s), despite not necessarily having received any formal training. However, no associations with other outcomes were found. Because effectiveness of a biobehavioral intervention(s) increases with practice, formal introduction and teaching of these interventions in the perioperative setting could potentially increase improvements in the associated patient-reported outcomes. As part of the ENRICH-US study, we developed a training video and educational materials about diaphragmatic breathing that are being implemented and should provide data to assess effects on outcomes. Diaphragmatic breathing, in particular, has shown promise in adults [7] and children [15,28]. Further studies to assess implementation of biobehavioral interventions, independently and possibly in combination, are needed to understand their potential effects on pain-related functional disability, HRQoL, and perioperative nervousness in children.

Multimodal strategies to manage perioperative pain that include biobehavioral interventions have been recommended by an expert panel [1]. Additionally, both clinicians and families have identified a need for further strategies beyond pharmacologic pain control to address post-operative pain and recovery in children [29]. As we continue to focus on patient/caregiver-centered care, identifying and addressing patient and caregiver needs and desires for biobehavioral interventions should be heeded. Certain interventions such as distraction or use of imagery have been effective in reducing postoperative pain in children [15]. Additionally, severe post-surgical pain is associated with worse HRQoL in children, which suggests that improvements in postoperative pain could also impact overall HRQoL [13]. This study primarily included patients with IBD, a patient population that already experiences high levels of stress and pain that impact HRQoL [30]. As preoperative HRQoL in this population may already be lower than other children, interventions targeted at reducing postoperative pain could have even greater implications for improved recovery.

Incorporation of biobehavioral interventions into clinical practice would require center specific plans for implementation with buy-in from key stakeholders. At each center, there are likely several specialists including child life, social work, and psychology who could serve as leaders regarding developing and implementing biobehavioral intervention protocols. Other key stakeholders including nurses, advanced practice providers, surgeons, and anesthesiologists may be particularly helpful at determining ideal timing of intervention within the confines of current clinical workflows. While one specific group may ultimately be responsible for the initial counseling and teaching of biobehavioral interventions, all clinicians would ideally help to reinforce the techniques.

There are several limitations to this study. Patient-reported outcomes were only available for 65 % of patients, with the remainder being replaced by caregiver-reported. However, other studies have validated the use of caregiver-reported data for child pain intensity

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and HRQoL following surgery [19,20]. Nevertheless, missing patient-reported data are a limitation. Further, 94 (36 %) of patients/caregivers did not complete the postoperative surveys, which introduces bias through only including those who self-selected to participate. For the group interviews, participation was elective, which introduces selection bias in those implementation team members who chose to participate as well. No pediatric surgeons or anesthesiologists chose to participate, though their perspectives would have been valuable given their roles in post-operative pain management. Generalizability of the findings is limited since most patients in this study had IBD, a condition that typically is associated with high healthcare utilization, which may have resulted in greater exposure to biobehavioral interventions from child-life specialists or other healthcare providers. Twenty-six percent of patients in this cohort indicated prior exposure from a healthcare provider and use of these interventions in a more general pediatric surgical population with lower healthcare utilization may differ. Finally, as a preliminary study, our focus was on reported use of a biobehavioral intervention(s); competency or correct use was not assessed. Further qualitative or mixed methods studies examining training in and use of biobehavioral interventions would be beneficial for evaluating competency.

Conclusions

Reported use of biobehavioral interventions in pediatric patients after surgery was higher than expected despite low reported rates of formal preoperative exposure. This suggests that many pediatric patients and caregivers likely sought information from sources other than their surgical care team and are willing to use these interventions. Postoperative nervousness may be stabilized or positively impacted by use of biobehavioral interventions. Implementation of standardized workflows and education of all providers regarding use of biobehavioral interventions among children could enhance their effectiveness on pain-related functional disability, HRQoL, and perioperative nervousness.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Declaration of competing interest

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Abbreviations

EHR	electronic health record

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ENRICH-US	ENhanced Recovery In CHildren Undergoing Surgery
HRQoL	Health-related quality of life
LOS	length of stay
PROMIS	Patient-Reported Outcomes Measurement Information System

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TEXT BOX:

Overall design: ENRICH-US is a prospective, multi-site study that uses a stepped-wedge, cluster-randomized study design to evaluate the implementation of the enhanced recovery protocol for pediatric patients undergoing elective gastrointestinal surgery. The 18 US pediatric hospitals enrolled each will be evaluated during a control phase, a 1-year implementation phase, and sustainability phase. The first group entered into implementation in April, 2021, which was three months prior to data collection.

Site selection: Sites were all participants in the Pediatric Surgery Research Collaborative (PedSRC) which is a cooperative group of surgeons and researchers committed to performing clinical research in pediatric surgery. All sites have comprehensive, inpatient, pediatric services, including surgical services.

Implementation: The Enhanced Recovery Protocol (ERP) included 21 elements: patient and family education, patient advocate liaisons, provider education, optimization of medical comorbidities, avoidance of prolonged fasting, non-opioid analgesia, venous thromboembolism prophylaxis, pre-incision prophylaxis, standard anesthetic protocols, use of minimally invasive techniques, nausea/vomiting prevention, nasogastric tube avoidance, hypothermia prevention, no intraperitoneal/perianastomotic drains placed, minimalization of fluid therapy, avoidance of urinary drains, prevention of ileus, opioid sparing pain regimen, early nutrition, early mobilization, audit of protocol compliance/outcomes. Local teams including a surgical champion, quality improvement expert, coordinator, and patient advocate liaisons are implementing the protocols at their sites with support through learning collaboratives, coaching, and data-driven feedback.

Biobehavioral practices: A diaphragmatic breathing video has been developed and distributed to all participating sites for inclusion in their ERP. Additional education around biobehavioral practices are encouraged and often led by child-life specialists.

Main outcome measures: The primary outcome measure of the study is length of stay (LOS) with secondary outcomes including intraoperative fluid use, surgical complications, hospital readmission, intraoperative opioid use, postoperative opioid use, post-discharge opioid prescriptions, time to regular diet, and health-related quality of life (HRQoL) assessments including pre-operative, immediately post-operative, and long-term.

Fig. 1.
Overview of the ENhanced Recovery In CHildren Undergoing Surgery (ENRICH-US) study.

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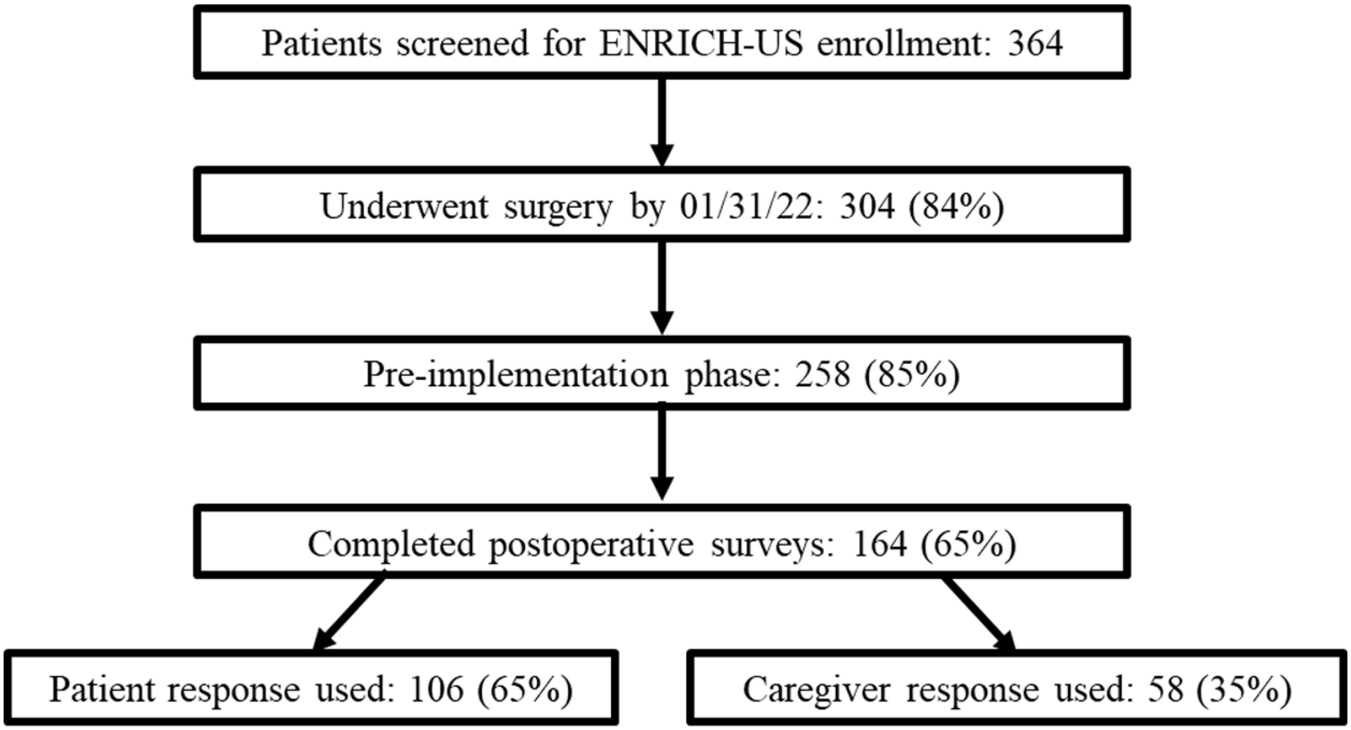

Fig. 2.

Study Cohort from Enhanced Recovery in Children Undergoing Surgery (ENRICH-US).

HRQoL = health related quality of life.

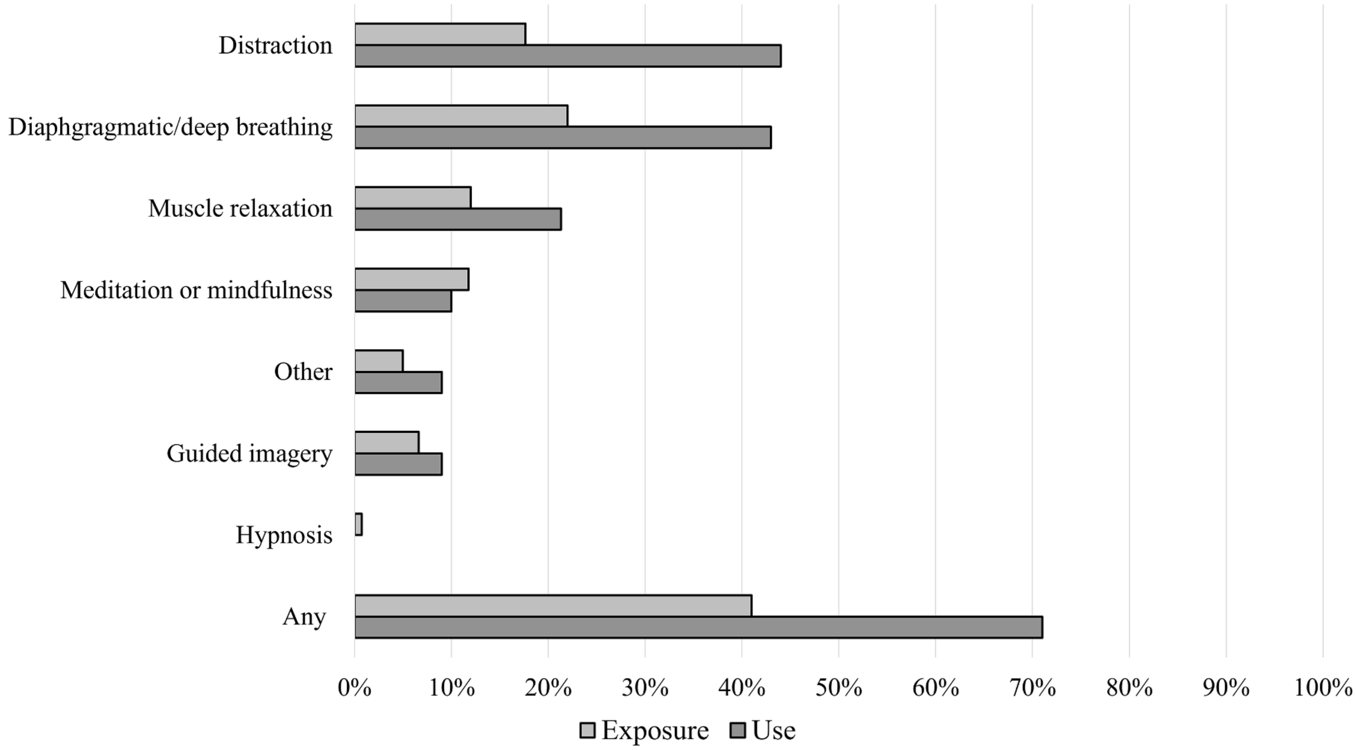

Fig. 3.
Comparison of exposure to and use of various biobehavioral interventions.

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Table 1

Comparison of patient characteristics based on use or no use of a biobehavioral intervention(s).

Variables	Total	Use of a biobehavioral intervention(s)	No use of a biobehavioral intervention(s)	P value
Total	164	117 (71.3)	47 (28.7)	
Age (median, IQR)	15.6 (13.7–17.4)	15.61 (14.0–17.4)	15.62 (13.2–17.3)	0.68
Sex				
Male	97 (59.2)	69 (59.0)	28 (59.6)	0.94
Female	67 (40.9)	48 (41.0)	19 (40.4)	
Hospital volume				0.64
Low (< 20 cases)	86 (52.4)	60 (51.3)	26 (55.3)	
High (≥ 20 cases)	78 (47.6)	57 (48.7)	21 (44.7)	
Surgical indication				
IBD	119 (72.6)	89 (76.1)	30 (63.8)	0.11
Other	45 (27.4)	28 (23.9)	17 (36.2)	
Perioperative block *				
Yes	65 (40.9)	49 (42.2)	16 (37.2)	0.57
No	94 (59.1)	67 (57.8)	27 (62.8)	
Operative approach				0.57
Open	63 (38.4)	47 (40.2)	16 (34.0)	
MIS	101 (61.6)	70 (59.8)	31 (70.0)	0.57

All variables are reported as number, percentage unless otherwise indicated.

* Missing value of 6. P values obtained from univariate analysis including Wilcoxon rank sum or Chi square. MIS = minimally invasive surgery; IBD = inflammatory bowel disease.

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Table 2

Comparison of patient-reported outcomes preoperatively and postoperatively by use of biobehavioral interventions.

	N	Pre-operative	Post-operative	P value
Pain-related functional disability	164			
Use of a biobehavioral intervention(s)	117 (71.3)	54.9 (45.7–61.0)	53.5 (48.0–59.0)	0.39
No use of a biobehavioral intervention(s)	47 (28.7)	50.9 (43.6–58.5)	51.6 (48.0–59.0)	0.62
Health-related quality of life	164			
Use of a biobehavioral intervention(s)	117 (71.3)	41.6 (35.8–47.2)	44.5 (39.1–48.1)	<0.01
No use of a biobehavioral intervention(s)	47 (28.7)	44.6 (38.5–51.5)	46.1 (38.5–48.9)	0.15
Nervousness	148			
Use of a biobehavioral intervention(s)	101 (68.2)	3 (2–4)	2 (2–4)	<0.01
No use of a biobehavioral ntervention(s)	47 (31.8)	3 (2–4)	3 (2–4)	0.56

Values are either number (percentage) or median (interquartile range). Scores can be interpreted as follows: increased scores represent increased pain-related functional disability, increased scored represent increased HRQoL, increased score represents higher nervousness. P values represent Wilcoxon signed rank comparing patients who used versus did not use biobehavioral intervention.

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Table 3

Multinomial logistic regression models for change in patient-reported outcomes based upon use of a biobehavioral intervention(s).

	Pain-related functional disability				Health-related quality of life				Nervousness			
	Worsened		Improved		Worsened		Improved		Worsened		Improved	
Variable	**RRR (95 % CI)**	**P value**	**RRR (95 % CI)**	**P value**	**RRR (95 % CI)**	**P value**	**RRR (95 % CI)**	**P value**	**RRR (95 % CI)**	**P value**	**RRR (95 % CI)**	**P value**
Biobehavioral Intervention												
Use No	Ref		Ref		Ref		Ref		Ref		Ref	
Yes	2.70 (0.47–15.64)	0.27	4.67 (0.78–28.1)	0.09	0.86 (0.16–4.73)	0.86	0.74 (0.14–3.86)	0.72	0.30 (0.10–0.91)	0.03	0.72 (0.30–1.72)	0.46
Age	2.03 (1.32–3.13)	<0.01	2.01 (1.30–3.12)	<0.01	1.09 (0.81–1.47)	0.55	1.14 (0.86–1.52)	0.37	1.22 (0.94–1.58)	0.14	0.85 (0.73–1.03)	0.10
Sex												
Male	Ref		Ref		Ref		Ref		Ref		Ref	
Female	271 (0.39–18.93)	0.32	2.17 (0.30–15.48)	0.44	1.23 (0.27–5.68)	0.79	2.02 (0.46–8.81)	0.35	1.32 (0.45–3.84)	0.62	1.28 (0.58–2.85)	0.54
Hospital volume												
Low (<20 cases)	Ref		Ref		Ref		Ref		Ref		Ref	
High (≥ 20 cases)	1.22 (0.20–7.35)	0.83	0.70 (0.12–4.30)	0.70	0.82 (0.18–3.78)	0.80	0.78 (0.18–3.38)	0.74	0.32 (0.11–0.96)	0.04	0.94 (0.43–2.07)	0.88
Surgical indication												
Other	Ref		Ref		Ref		Ref		Ref		Ref	
IBD	0.82 (0.14–4.74)	0.82	0.90 (0.15–5.34)		0.19 (0.02–1.71)	0.14	1.07 (0.26–4.36)	0.20	3.38 (0.87–13.17)	0.08	3.05 (1.25–7.45)	0.01
Perioperative block												
No	Ref		Ref		Ref		Ref		Ref		Ref	
Yes	0.42 (0.07–2.69)	0.36	0.34 (0.05–2.21)	0.26	0.82 (0.19–3.55)	0.79	1.07 (0.26–436)	0.93	0.26 (0.08–0.86)	0.03	1.37 (0.61–3.06)	0.44
Operative approach												
Open	Ref		Ref		Ref		Ref		Ref		Ref	
MIS	2.33 (0.37–14.82)	0.37	4.14 (0.63–27.13)	0.14	3.14 (0.75–13.18)	0.12	3.04 (0.76–12.11)	0.12	3.78 (1.09–13.11)	0.04	1.04 (0.47–2.28)	0.92