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Holly Cordray March 24, 2021

Preparing Children for Surgery with Educational Pop-Up Books: From Theory to Clinical Trial

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An abstract of
a thesis submitted to the Faculty of Emory College of Arts and Sciences
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Abstract

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Background and Objectives
Preoperative education empowers children to approach surgery with positive expectations. There is a need for effective, child-focused education resources that pediatric clinics, surgery centers, and hospitals can easily supply. The objectives of this study were to evaluate an interactive pop-up book as a tool for explaining surgery, managing preoperative anxiety, and strengthening coping strategies.

Methods
Children ages 5-12 undergoing outpatient surgery participated in a prospective, randomized controlled trial. Patients read a pop-up book about general anesthesia (intervention) or received standard care (control). Patients self-reported their preoperative fear, pain expectations, views of the procedure and preoperative explanations, and coping strategies. Outcomes also included observer-rated behavioral anxiety and caregiver satisfaction.

Results
Of 169 patients screened for eligibility, 148 completed the study. The pop-up book had a significant, large effect in reducing patients' fear of anesthesia induction ($d = 0.95$; $P < .001$). Pop-up book patients also expected less pain than standard-care patients from the anesthesia mask and during surgery, with medium-to-large effect sizes ($d = 0.61$-0.79; $P < .001$). The book encouraged more positive views of the procedure and preoperative explanations, with medium-to-large effect sizes ($d = 0.58$-1.20; $P < .005$). Further, the book prepared patients to cope adaptively: pop-up book patients were significantly more likely to generate positive active coping strategies, distraction strategies, and support-seeking strategies ($P < .001$). Observer-rated behavioral anxiety at anesthesia induction did not differ between groups ($P = .81$). Caregivers in the pop-up book group were significantly more satisfied with each aspect of the surgical experience ($P \leq .02$).

Conclusion
The educational pop-up book offers a child-focused resource that effectively alleviates children's preoperative fears, encourages positive coping, and improves caregivers' perceptions of the experience.

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Table of Contents

List of Tables and Figures

Abbreviations

ANCOVA: analysis of covariance

CFS: Children's Fear Scale

CHOA: Children's Healthcare of Atlanta

FPS-R: Faces Pain Scale-Revised

mYPAS-SF: modified Yale Preoperative Anxiety Scale-Short Form

Introduction

Children are prone to intense preoperative anxiety, which may lead to adverse postoperative outcomes, including greater pain perceptions and maladaptive behaviors.[1-3] Preoperative education alleviates fears by comforting and empowering patients. It can also supply effective, adaptive coping strategies. For invasive medical procedures, equipping children with understanding and familiarity lowers threat appraisals, in turn decreasing anxiety.[4] Most children facing outpatient surgery, particularly children with higher anxiety, feel a strong need for comprehensive information, primarily about pain, anesthesia, and timing.[5] While hospital-based preparation programs and child life services are valuable sources of interactive education in advance of surgery,[6-10] they demand time flexibility and personnel resources that families and care centers may be unable to provide, especially for outpatient surgery.[11] Health care providers have limited time to counsel families on the day of surgery, and medical talk is predominantly directed to caregivers.[11,12] Therefore, standard care (typically a brief consultation with the provider) may not adequately prepare children to cope with medical stressors such as anesthesia induction, which is the greatest stressor for children during the perioperative period.[13,14] Indeed, providers have identified a need for more age-appropriate, child-focused education materials.[12] Child-directed approaches that offer more practical, flexible alternatives to hospital-based preparation include interactive websites,[15] audiovisual resources,[16-18] storybooks,[19,20] and comic books.[21]

This study evaluated a new resource for pediatric preoperative education: an interactive pop-up book. The book was developed as a comprehensive educational tool for patients undergoing tonsillectomy; the study piloted a shorter version that applied more broadly to outpatient surgery, focusing on general anesthesia induction. The book was designed to teach

children about anesthesia induction, answer common questions, and lay a framework for adaptive coping. It engaged patients in active learning through hands-on manipulatives and question-and-answer text. Through targeted, appealing, age-appropriate education, we hoped to help children approach the procedure with less fear, more appropriate expectations, and stronger coping skills. The study's objectives were to evaluate the book as an educational tool and to understand its effects on patient and caregiver perceptions of the surgical experience. We hypothesized that preoperative education from the pop-up book, compared to standard care, would more effectively reduce children's fear and expected pain, facilitate more positive views of the procedure and preoperative explanations, encourage adaptive coping strategies, reduce behavioral anxiety at anesthesia induction, and increase caregiver satisfaction with the surgical experience.

Theory and Structure of the Resource

The pop-up book, titled *Ready for Anesthesia!*, addresses children's preoperative information needs with child-focused strategies that support learning and positive coping. Giving pediatric patients specific procedural and sensory information better enables them to frame their upcoming procedure appropriately in terms of related knowledge and experiences, which in turn shapes the way they appraise the event and their ability to cope.[4,22] The pop-up book describes what the patient will experience and feel at each step, addressing many of the pressing concerns that children have before surgery.[5] The book provides sensory expectations for anesthesia induction and surgery, explaining how anesthesia prevents pain, what the mask is like, and how the doctor will monitor the patient throughout the surgical procedure. The book also discusses timing, caregiver presence, and potential coping strategies. *Ready for Anesthesia!* was adapted

from the author's more comprehensive pop-up book about tonsillectomy. Beyond anesthesia, the larger tonsillectomy-specific book illustrates the reasons for tonsillectomy, the preoperative and postoperative periods at the hospital or surgery center, the operating room, and recovery at home. The larger book supports treatment adherence by including standard instructions for preoperative fasting, appropriate expectations for and ways to relieve discomfort during recovery, and the long-term benefits of treatment.

Delivering this education in an engaging, child-focused manner is paramount. To help patients process and retain preparatory information under emotionally stressful circumstances, preoperative education should use child-appropriate language along with illustrations and analogies.[22] The pop-up book communicates through "my/your" language that emphasizes the patient's perspective and role in the treatment process. The text is distributed into manageable segments, which are integrated with elements that reinforce learning. The book incorporates 3 key strategies to enhance learning and familiarize the patient with the upcoming experience: interactive participation, illustrations, and analogies.

Interactive Participation. Pop-up books are a prime format for engaging patients' hands-on participation. Like hospital-based programs that involve patients in medical play, demonstrations, coping strategy coaching, and operating room tours,[6-10] the pop-up book promotes active learning. To achieve active learning in an accessible format, the book presents a variety of tactile manipulatives along with question-based text that encourages interactive responses. When the reader moves a flap, a pop-up anesthesiologist places the anesthesia mask onto the illustrated child's face; turning a wheel reveals child-friendly ways of reimagining the mask; and scratch-and-sniff stickers demonstrate possible flavored scents for the mask (Figure

1B). The book also features illustrated lift-the-flap answers to common questions and lift-the-flap vital signs (Figure 1C). These flaps engage the patient physically in uncovering answers, and they encourage the patient to seek information, which is an active and adaptive form of coping.[14,23,24]

According to the indexical hypothesis in learning theory, pairing verbal information with physical manipulation enhances learning.[25,26] Multimodal engagement (both verbal and tactile) helps learners more effectively map new concepts within memory. Physically manipulating objects to represent concepts within a story has shown significant, large effects in improving children's recall, even compared to illustrated stories.[25,26] Patients can actively manipulate the hands-on components of the pop-up book, facilitating richer and more lasting mental representations of the preoperative education content. By creating opportunities for tactile participation and a dialogue with the reader, the book provides an interactive structure for learning in a ready-made format.

Illustrations. The pop-up book also uses illustrations to support understanding. The illustrations help patients visualize important but unfamiliar aspects of the experience, such as the anesthesia mask and the anesthesiologist placing the mask onto the patient's face. Combining verbal information with illustrations further strengthens learning. According to dual coding theory, visual imagery interacts with verbal memory as learners encode new information, enriching the networks that associate new information with existing memory (including relevant experiences and semantic knowledge).[27] In turn, these associative connections shape the way learners contextualize or schematize new information.[27] They also improve reading comprehension and learning consolidation.[27]

Illustrated education materials demonstrably increase the effectiveness of patient education. For pediatric outpatient surgery, illustrated pre-anesthesia instructions have significantly increased caregivers' understanding of the reasons for preoperative fasting, potentially improving adherence and minimizing surgical cancelations due to nil per os (NPO) violations.[28] Similarly, illustrated discharge instructions (compared to plain-text instructions) have significantly increased patients' and caregivers' understanding of proper wound care, and significantly improved treatment adherence during recovery.[29,30] Patients who received illustrated discharge instructions were also significantly more likely to read the instructions.[29]

The pop-up book's illustrations rely on color theory to influence the emotional tone of the material. Emotional responses to the principal components of color have been evaluated[31] according to the Pleasure-Arousal-Dominance Emotion Model, an extensively validated emotional state model.[32] Color has 3 principal components: hue (pure color based on wavelength), saturation (chromatic vividness), and brightness (value). Brightness and pleasure were strongly positively correlated, and saturation and pleasure were weakly positively correlated: brighter and, to a lesser extent, more saturated colors promoted a more positive emotional valence.[31] Brighter and, to an even greater extent, less saturated colors were associated with lower arousal (i.e., a greater sense of calm).[31] Brighter and less saturated colors were also associated with lower dominance.[31] In terms of hue, short-wavelength colors such as purple, blue, and green induced the most positive emotional valences.[31]

The pop-up book uses a pastel and predominantly short-wavelength color palette to promote a soothing, positive emotional valence (Figure 1). Pastels have high brightness and low-to-medium saturation, optimizing low arousal. The palette's brightness and hues also align with high pleasure ratings. On the Pleasure-Arousal-Dominance scale, the combination of high

pleasure and low arousal reflects a relaxed and consoled emotional state.[31,32] The targeted color palette thus reinforces the book's goals of comforting patients and presenting preoperative education in a positive, non-threatening light.

Analogies. Lastly, the book aids understanding through analogies. For example, the book's turn-the-wheel feature provides possible ways of reimagining the anesthesia mask, successively revealing an astronaut helmet, an elephant trunk, and a snorkel (Figure 1B). Relating the mask to child-friendly and familiar analogs helps patients conceptualize the experience of breathing through the mask. Furthermore, the analogies facilitate positive cognitive restructuring, which is a highly adaptive coping strategy: patients can engage actively with anesthesia induction through positive imagination.[23] The book's age-appropriate explanation of how anesthesia works in the nervous system also uses analogies, and flaps explain how anesthesia induction is similar to and different from going to sleep (Figure 1C).

As learners map unfamiliar concepts within memory, analogies guide the associative connections that link new information with existing knowledge stores.[33] By structuring these connections, analogies influence how learners appraise and reason about new information.[33] Several studies have shown that, when school-aged children read educational science- and health-related information that uses analogies, they are better able to understand and reason inferentially about target concepts.[34-37] In addition, caregivers often use analogies to support their children's learning of science concepts, which improves children's understanding.[38] Therefore, by providing analogies, the pop-up book scaffolds patients' learning and helps structure caregiver-child discussion of the upcoming procedure.

(A)

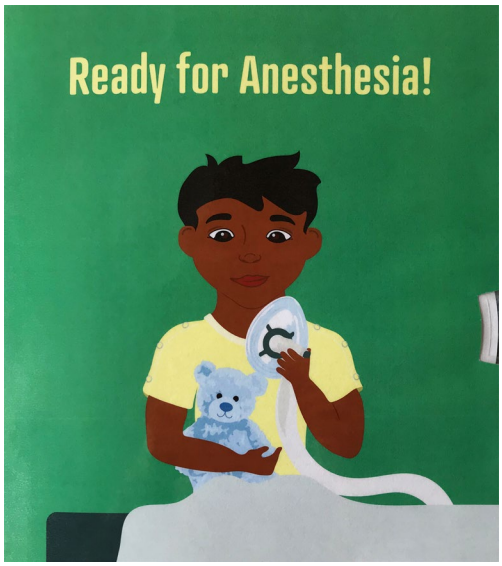
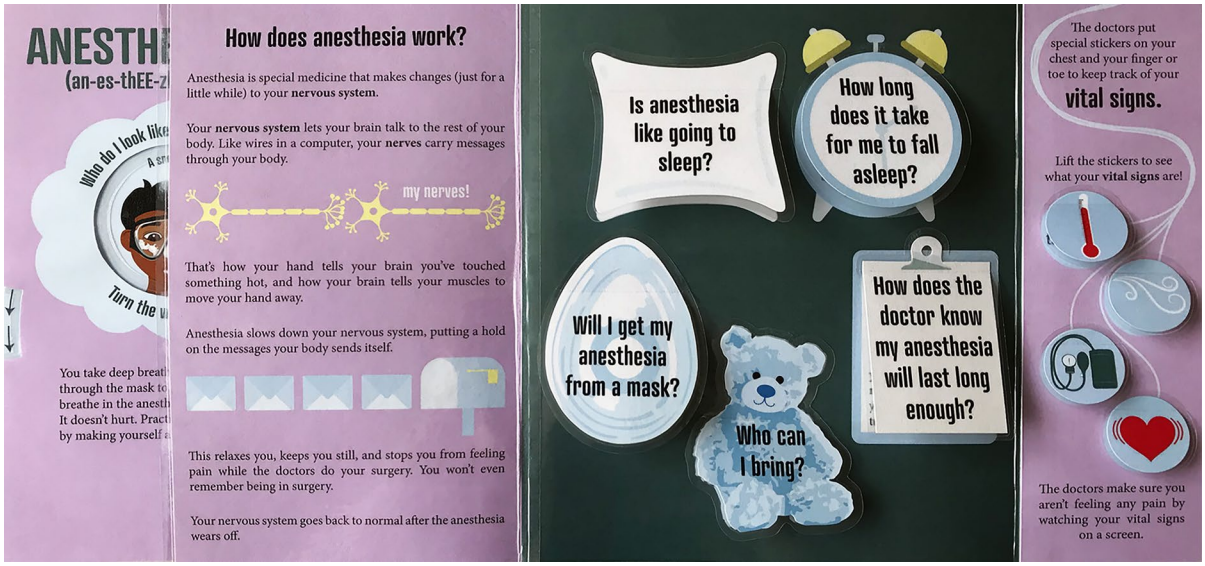


Figure 1

The pop-up book, *Ready for Anesthesia!* (cover, **A**). The first spread (**B**) includes a turn-the-wheel feature that reimagines the anesthesia mask as an astronaut helmet, an elephant trunk, and a snorkel; a pop-up anesthesiologist who places the mask onto the illustrated child's face when the reader moves a flap; and scratch-and-sniff stickers that demonstrate possible flavored scents for the mask. The second spread (**C**) includes an explanation of how anesthesia works, illustrated lift-the-flap answers to common questions, and lift-the-flap vital signs.

(B)

(C)



Methods

Study Design and Participants

A prospective, randomized controlled trial was conducted at a Children's Healthcare of Atlanta (CHOA) outpatient surgery center from August 26, 2020 to December 18, 2020. The trial was approved by the CHOA Institutional Review Board (STUDY00000660) and registered at www.clinicaltrials.gov (identifier NCT04796077). Study data were collected and managed using REDCap (Research Electronic Data Capture) tools hosted at CHOA.[39,40]

English-speaking patients ages 5-12 undergoing outpatient medical procedures under general anesthesia with inhalation induction were eligible to participate. Patients with severe developmental disabilities were excluded. Patients' legal guardians provided electronic consent/assent.

Patients either read an educational pop-up book about anesthesia induction (intervention) in addition to standard consultation with an anesthesia provider, or they received provider consultation alone (control). To minimize group imbalance, patients were allocated following a block-randomized list that a clinical research coordinator generated using an online randomization tool (Sealed Envelope™); the list was concealed by a head nurse. Investigators were blinded to the assignment list and recruited patients on a rolling basis upon admission. Within 90 minutes before surgery and prior to premedication, patients in the intervention group spent 5-10 minutes reading and exploring the pop-up book with the author. All patients received provider consultation. After self-report assessments, patients received acetaminophen, hydrocodone/acetaminophen, midazolam, or no premedication based on anesthesia provider evaluation.

Outcome Measures

Self-Reported Fear and Expected Pain. After education, patients self-reported their fear and expected pain using pictorial faces scales. An image of the anesthesia mask was presented with introductory prompts adapted from a previous study.[8] Using the Children's Fear Scale (CFS; Appendix A), a 5-face series ranging from no fear to extreme fear (scored 0-4),[41] patients rated their fear of anesthesia induction. Using the Faces Pain Scale-Revised (FPS-R; Appendix B), a 6-face series ranging from no pain to extreme pain (scored 0-5),[42] patients also rated how much pain they anticipated (1) from the mask and (2) while asleep for surgery. The FPS-R is the preferred self-report pain measure for school-aged children.[43] Both scales were validated for all ages in the study population; they have demonstrated high convergent validity and test-retest reliability.[41,42]

Views of the Procedure and Preoperative Explanations. Patients completed a 9-item Likert-scale questionnaire with 3 domains: expectations about the procedure, attitudes about anesthesia, and views of preoperative explanations (Appendix C). Experts in child psychology and pediatric anesthesiology reviewed the questionnaire for content validity.

Coping Strategies. Prospective interviews assessed whether patients were prepared to cope adaptively with the stress of induction. Patients answered the prompt, "If you feel scared when the mask goes on your face, what can you do or think about to make yourself feel better? Please tell me all the things you think of." Using a content analysis system constructed *a priori* from pediatric coping strategy literature (Appendix D), 3 investigators independently coded responses from audio recordings and later resolved discrepancies by discussion. The system categorized

specific coping strategies[8,44] within 4 higher-order coping domains: 3 adaptive domains (positive active coping, distraction, and support-seeking) and maladaptive coping.[23,24,45] Coping approaches were compared between groups.

Observer-Rated Behavioral Anxiety at Anesthesia Induction. Patients' behavioral anxiety at anesthesia induction was assessed relative to baseline using the observer-rated modified Yale Preoperative Anxiety Scale-Short Form (mYPAS-SF; Appendix E).[46] The scale was validated for children ages 3 and older, and it has demonstrated high rater reliability.[14,46,47] The mYPAS-SF has 4 domains: activity, vocalizations, emotional expressivity, and state of apparent arousal. Scores range from 22.92-100. Preoperative nurses and operating room circulating nurses blinded to group assignments rated anxiety (n = 14 raters). Preoperative nurses rated baseline anxiety while taking patients' vital signs on initial entry into the preoperative area; circulating nurses rated anxiety at induction by the most extreme behaviors patients exhibited while receiving inhalational induction via an anesthesia mask in the operating room.

Caregiver Satisfaction. Caregivers had the option of accompanying the patient into the operating room for anesthesia induction. Following induction, caregivers completed a 10-item Likert-scale questionnaire assessing satisfaction with the surgical experience (Appendix F). A psychometrically developed caregiver satisfaction questionnaire for pediatric anesthesia[48,49] was adapted by eliminating irrelevant items and adjusting language to improve accessibility. Items were grouped into 4 care domains: preoperative explanations, attentiveness of the medical staff to the family's emotional needs, the operating room experience, and the overall care experience.

Data Analysis

Power Analysis. Sample size was determined with G*Power 3.1.9.7 software (Heinrich Heine University).[50] Power analysis indicated that at least 139 participants were needed to be able to detect a minimum clinically important difference in observer-rated anxiety given $\alpha = .05$ significance and $\beta = .80$ power. This minimum effect size is a Cohen's *d* of 0.48 (Cohen's $f = 0.24$).[46] Approximately 150 participants were recruited to offset anticipated attrition.

Statistical Analyses. Analyses were conducted with SPSS version 27.0 (IBM Corporation). Mann-Whitney *U* tests were conducted to compare nonparametric CFS and FPS-R ratings between groups, and on the Likert-scale questionnaires measuring patient views and caregiver satisfaction. Higher scores on the 5-point Likert agreement scales indicated more positive responses ("Strongly disagree" = 1, "Strongly agree" = 5); items were analyzed individually according to item response theory. Cohen's *d* effect sizes were calculated for patient self-report measures. By convention, a Cohen's *d* of 0.5 is medium and 0.8 is large.[51]

Prospective coping approaches were analyzed with Chi-square tests comparing proportions of patients who generated any coping strategies in a given domain. Krippendorff's α for interrater reliability of the investigators' independent interview content analyses was determined with the KALPHA macro for SPSS.[52]

For observer-rated anxiety, after composite mYPAS-SF scores were calculated,[46] an analysis of covariance (ANCOVA) was performed to evaluate group differences at anesthesia induction with baseline anxiety as the covariate. Separate ANCOVAs were performed for other possible predictors of anxiety.

Exploratory analyses of associations used Spearman's correlations or rank-biserial correlations calculated from Mann-Whitney analyses (Appendix G),[53] as appropriate. By Cohen's conventions for the behavioral sciences, a correlation coefficient of .30 is medium and .50 is large.[51]

Results

Of 169 patients screened for eligibility, 148 completed the study (n = 75 intervention, n = 73 control; Figure 2). All records were complete.

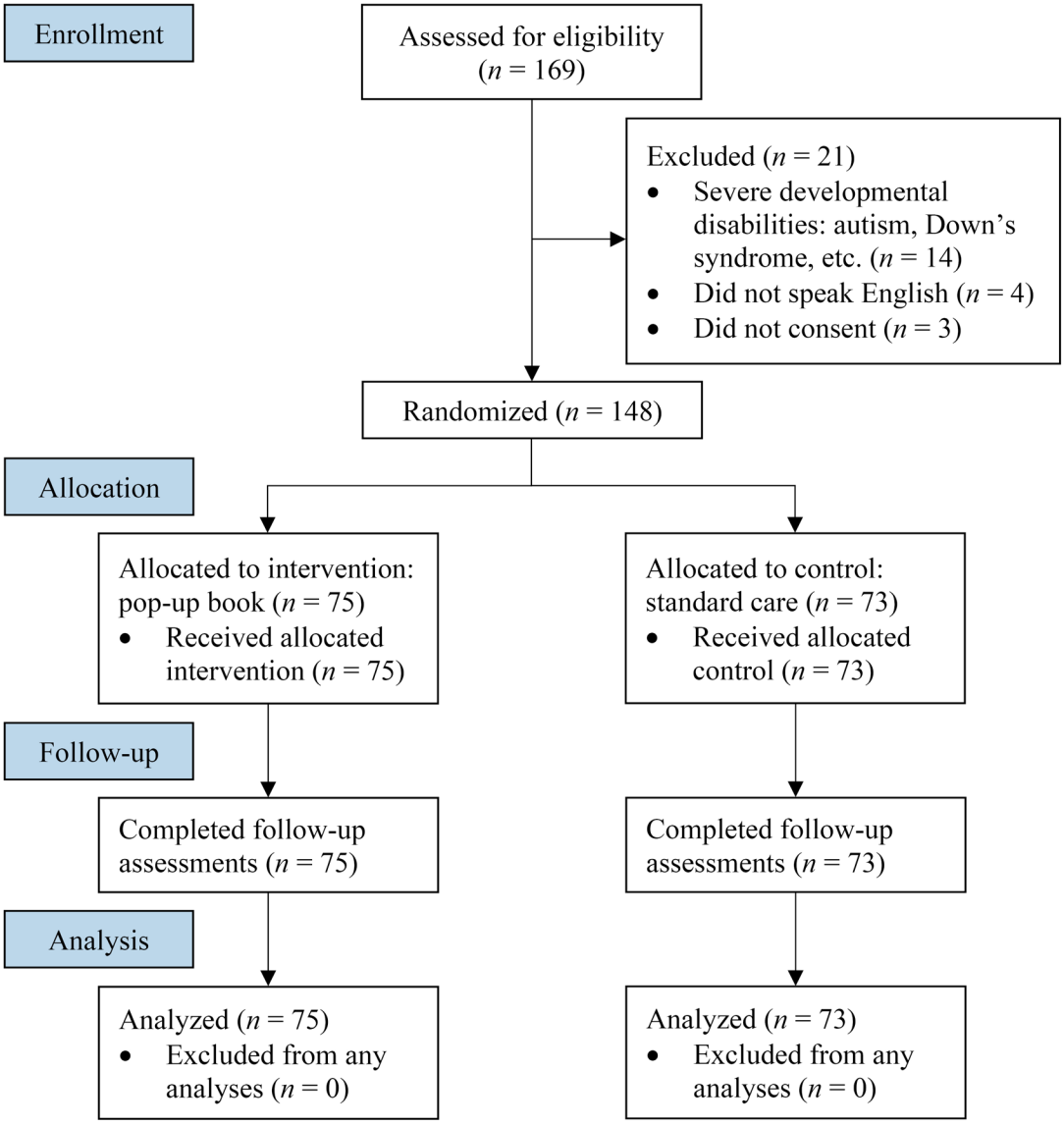


Figure 2
Consolidated Standards of Reporting Trials (CONSORT) flowchart of patient enrollment, allocation, follow-up, and analysis. Allocation was block-randomized by a clinical research coordinator, concealed by a head nurse, and implemented by investigators who were blinded to the assignment list during enrollment. Study groups were balanced (75 intervention, 73 control).

Demographic characteristics did not differ significantly between groups (Table 1). The population included otolaryngology, urology, gastroenterology, and general surgery patients. The mean patient age was 7.64 years (SD = 2.22). A majority of caregivers reported prior experience with their children undergoing surgery (Table 1).

TABLE 1 Patient Demographic Characteristics and Group Comparison

	Total *n* = 148	**Pop-up book** *n* = 75	**Standard care** *n* = 73	*P*
Age	7.64 (2.22)	7.55 (2.37)	7.73 (2.43)	.63
Sex, male (vs. female)	82 (55.4)	45 (60.0)	37 (50.7)	.25
Race				.98
White	77 (52.0)	40 (53.3)	37 (50.7)	
Black	53 (35.8)	26 (34.7)	27 (37.0)	
Asian/Pacific Islander American	11 (7.4)	5 (6.7)	6 (8.2)	
Multiracial	5 (3.4)	3 (4.0)	2 (2.7)	
Other/Unknown	2 (1.4)	1 (1.3)	1 (1.4)	
Ethnicity, Hispanic/Latino	24 (16.2)	10 (13.3)	14 (19.2)	.34
Mood/behavioral conditions[a]	30 (20.3)	16 (21.3)	14 (19.2)	.74
Prior surgical experience				
Patient	83 (56.1)	41 (54.7)	42 (57.5)	.73
Other child in the household	52 (35.1)	23 (30.7)	29 (39.7)	.25
Caregiver present at induction				.39
Mother	112 (75.7)	54 (72.0)	58 (79.5)	
Father	29 (19.6)	16 (21.3)	13 (17.8)	
Other family	3 (2.0)	3 (4.0)	0 (0.0)	
Unaccompanied	4 (2.7)	2 (2.7)	2 (2.7)	
Procedure type[b]				.53
Otolaryngology	109 (73.6)	53 (70.7)	56 (76.7)	
Urology	24 (16.2)	14 (18.7)	10 (13.7)	
Gastroenterology	13 (8.8)	6 (8.0)	7 (9.6)	
General surgery	2 (1.4)	2 (2.7)	0 (0.0)	

Ages are means (SD); all other values are *n* (%). *P* values are from independent-samples t-tests, Chi-square tests, or Fisher's exact tests, as appropriate.
[a]Including anxiety disorders, attention deficit hyperactivity disorder (ADHD), and others.
[b]Otolaryngology procedures included tonsillectomy/adenoidectomy, myringotomy, and others. Urology procedures included circumcision, meatoplasty, and others. Gastroenterology procedures included endoscopy and colonoscopy. General surgery procedures included mastectomy and umbilicoplasty.

Patients who read the pop-up book self-reported significantly less fear of anesthesia induction, with a large effect size ($d = 0.95$; $P < .001$). Three-quarters (74.7%) of pop-up book patients reported no fear, versus only 35.6% of standard-care patients (Figure 3A). Further, pop-up book patients expected significantly less pain both from the anesthesia mask and during surgery, with medium-to-large effect sizes ($d = 0.61$ and 0.79; both $P < .001$). Among pop-up book patients, 94.7% anticipated no pain from the mask and 86.7% anticipated no pain during surgery; the remaining minority of patients anticipated only slight pain (Figure 3B). Conversely, 30.1% of standard-care patients anticipated at least some pain from the mask and 47.9% anticipated some pain during surgery, with responses ranging up to extreme pain for both the mask and surgery (Figure 3B).

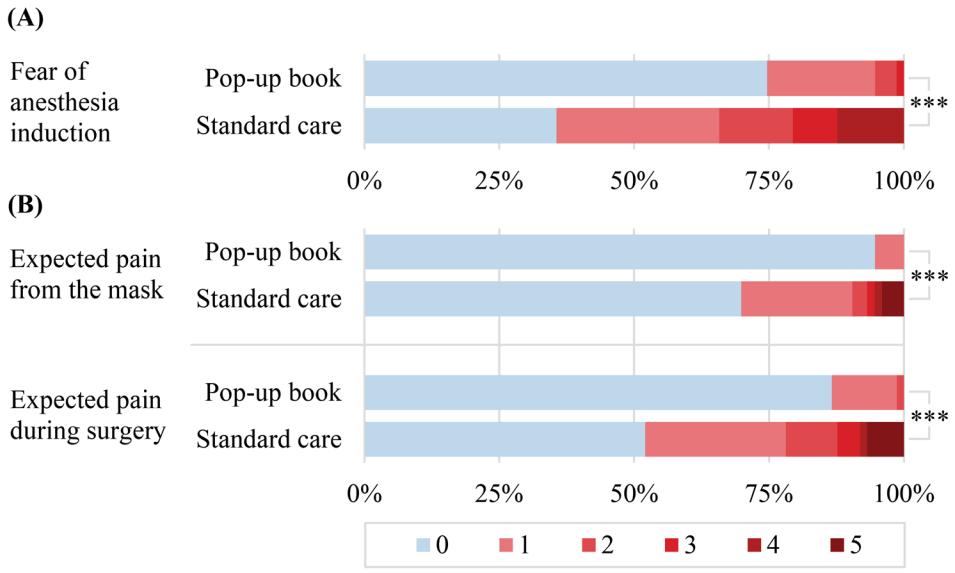


Figure 3
Distributions of (**A**) patients' fear of anesthesia induction, from 0 (no fear) to 4 (extreme fear), and (**B**) expected pain from the anesthesia mask and during surgery, from 0 (no pain) to 5 (extreme pain). Cohen's $d = 0.95$, 0.61, and 0.79, respectively. ***$P < .001$ for differences between groups.

Pop-up book patients expressed significantly more positive expectations about the procedure, with medium-to-large effect sizes (d = 0.69-0.84; $P < .001$; Figure 4A). Pop-up book patients also expressed significantly more positive attitudes about anesthesia, especially greater readiness, with medium-to-large effect sizes (d = 0.58-0.99; $P < .005$; Figure 4B). Patients responded significantly more positively to preoperative explanations from the pop-up book than standard provider consultation in terms of how fun, helpful, and child-focused the explanations were, with medium-to-large effect sizes (d = 0.75-1.20; $P < .001$; Figure 4C).

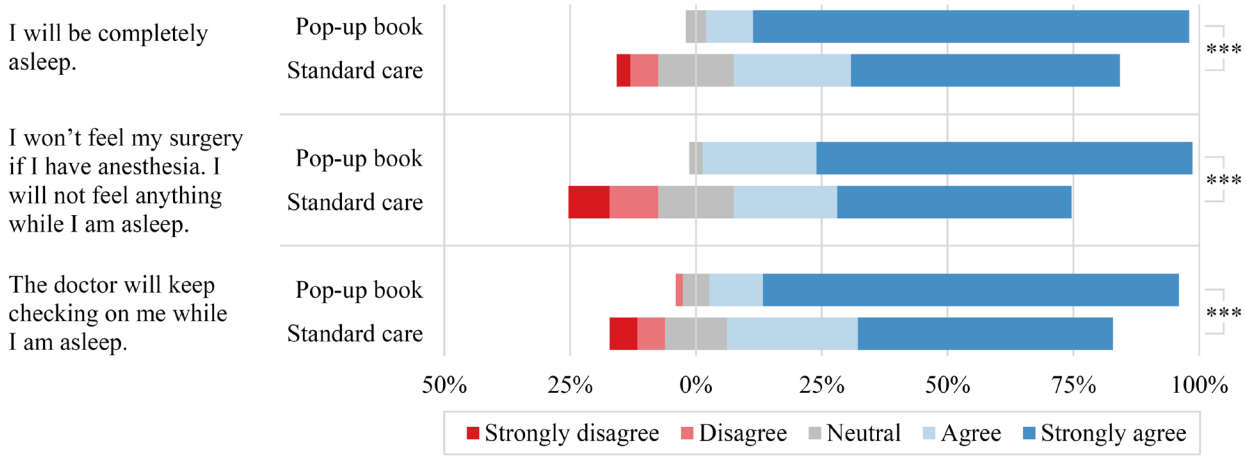


Figure 4A
Distributions of patients' expectations about the procedure after pop-up book education versus standard care. Cohen's d = 0.78, 0.84, and 0.69, respectively. ***$P < .001$ for differences between groups.

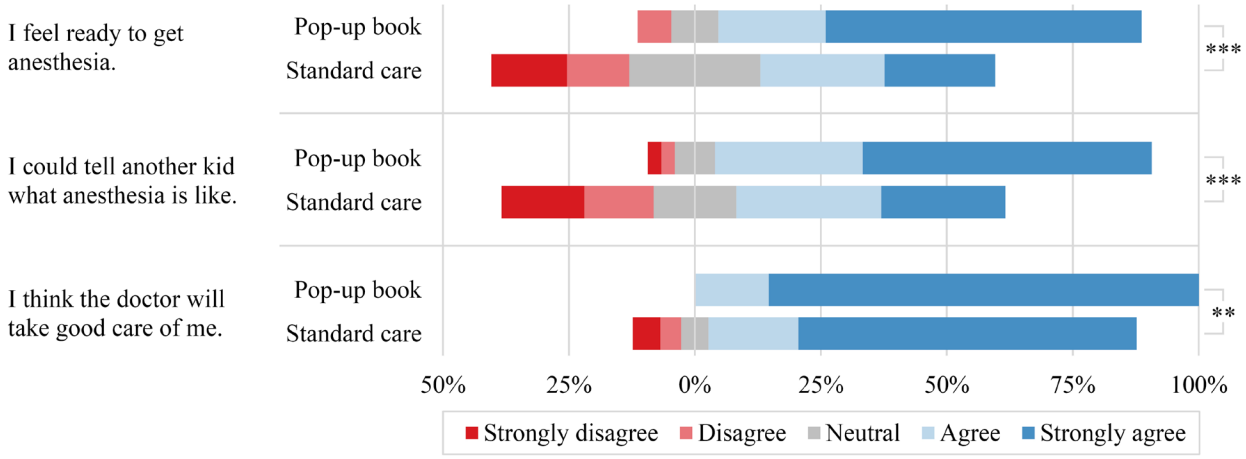


Figure 4B
Distributions of patients' attitudes about anesthesia after pop-up book education versus standard care. Cohen's $d = 0.99$, 0.87, and 0.58, respectively. ***$P < .001$ and **$P < .005$ for differences between groups.

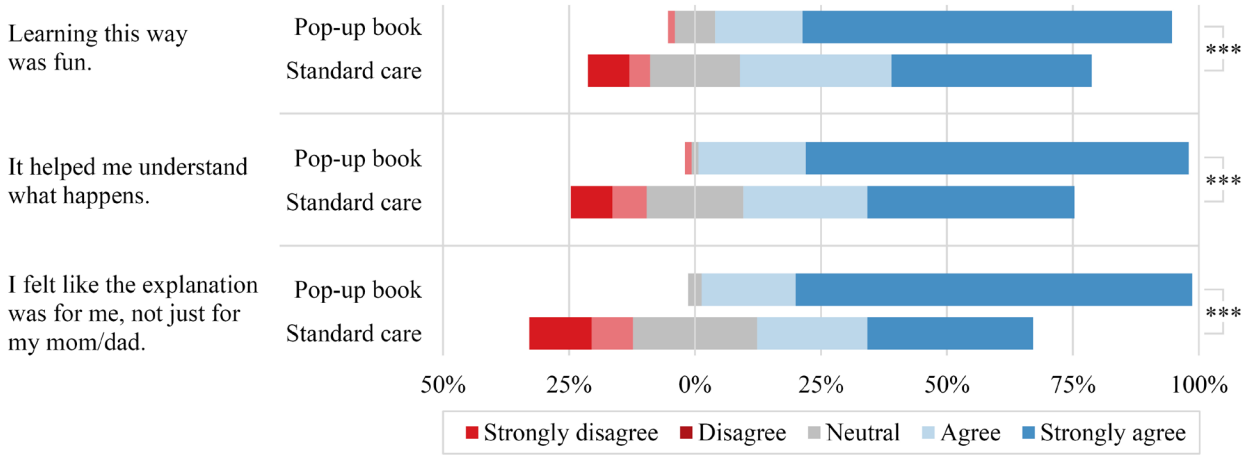


Figure 4C
Distributions of patients' views of preoperative explanations (the pop-up book or standard consultation with an anesthesia provider). Cohen's $d = 0.75$, 0.90, and 1.20, respectively. ***$P < .001$ for differences between groups.

The book strengthened patients' prospective coping strategies. Significantly greater proportions of pop-up book patients versus standard-care patients generated coping strategies in each adaptive coping domain: positive active coping, distraction, and support-seeking (all $P <$ .001; Figure 5). Whereas 28.8% of standard-care patients did not generate any coping strategies, only 2.7% of pop-up book patients did not generate strategies. Caregivers in the pop-up book group more frequently engaged with the patient to brainstorm ideas ($P = .02$). In each adaptive domain, pop-up book patients generated specific strategies from the book and strategies beyond those that the book discussed directly. Interrater reliability was high for all adaptive domains (Krippendorff's $\alpha \geq .95$). Maladaptive coping (e.g., expressing negative emotions) did not differ between groups ($P > .99$); only 2.7% of patients reported maladaptive strategies (Figure 5).

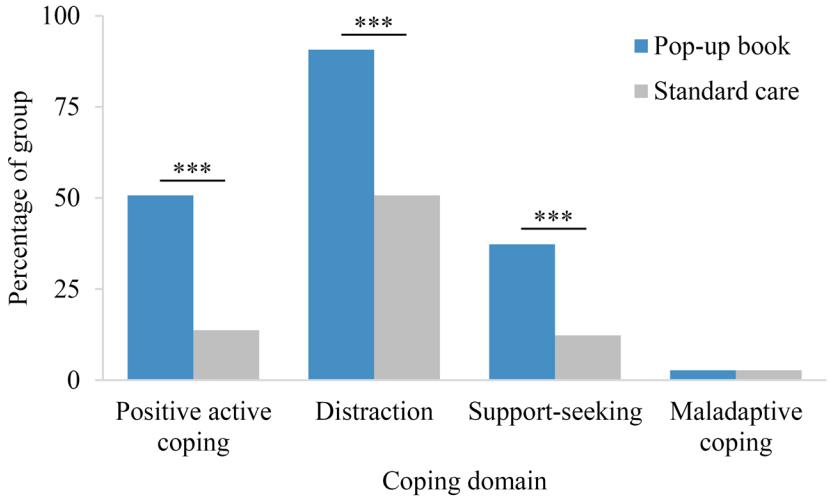


Figure 5
Comparison of prospective coping approaches based on proportions of patients in each group who reported at least one coping strategy in a given coping domain; positive active coping, distraction, and support-seeking are adaptive approaches. ***$P < .001$ for differences between groups.

An exploratory analysis of construct validity examined associations among patients' self-reported fear, procedural readiness, and positive active coping, which is especially relevant to patients' emotional states. Patients who reported less fear tended to report greater readiness: fear was inversely correlated with readiness (r_s = -.53, P < .001; Table 2). Patients who generated positive active coping approaches tended to report less fear and greater readiness: positive active coping was inversely correlated with fear (r_{rb} = -.42, P < .001) and positively correlated with readiness (r_{rb} = .32, P = .001; Table 2). Correlation coefficients were large or medium, indicating good construct validity.

TABLE 2 Correlations of Self-Reported Emotional States and Positive Active Coping

Association	*r*	*P*
Fear vs. procedural readiness[a]	-.53	< .001
Fear vs. positive active coping[b]	-.42	< .001
Procedural readiness vs. positive active coping[b]	.32	.001

[a]Spearman's correlation, r_s

[b]Rank-biserial correlation, r_{rb}

Observer-rated behavioral anxiety during anesthesia induction did not differ between groups (P = .81; Table 3); baseline anxiety was also equivalent. None of the recorded demographic factors were predictive of observer-rated anxiety at induction, including prior experience with surgery (Table 3).

TABLE 3 Observer-Rated Behavioral Anxiety

	Baseline anxiety	Anxiety at induction	*P*
Preoperative education group			.81
Pop-up book (*n* = 75)	27.33 (9.59)	37.00 (21.55)	
Standard care (*n* = 73)	27.80 (9.63)	36.39 (20.64)	
Patient's surgical history			.55
Prior experience (*n* = 83)	28.14 (10.25)	37.85 (22.50)	
No prior surgery (*n* = 65)	26.83 (8.67)	35.22 (19.06)	
Mood/behavioral conditions[a]			.28
Yes (*n* = 30)	28.89 (11.09)	40.97 (25.83)	
No (*n* = 118)	27.22 (9.18)	35.61 (19.61)	
Sex			.07
Male (*n* = 82)	26.60 (8.37)	39.05 (24.02)	
Female (*n* = 66)	28.76 (10.85)	33.78 (16.32)	
Age			.28

Values are means (SD). *P* values are from analysis of covariance (ANCOVA) controlling for baseline anxiety.
[a]Including anxiety disorders, attention deficit hyperactivity disorder (ADHD), and others.

Lastly, the pop-up book significantly increased caregiver satisfaction with the surgical experience across all domains ($P \leq .02$; Table 4). Caregivers in both groups generally viewed the overall care experience at the surgery center positively, but caregivers of pop-up book patients were consistently highly satisfied with each aspect of their experience, whereas satisfaction levels varied more in the standard-care group (Figure 6).

TABLE 4 Caregiver Satisfaction with the Surgical Experience (Item Analysis)

Domain	Item	**Pop-up book** $n = 75$	**Standard care** $n = 73$	*P*
Preoperative explanations	The way my child went to sleep was just like the doctor explained.	4.84 (0.64)	4.60 (0.70)	.001
	I am satisfied with the explanations given for how my child would go to sleep and wake up.	4.93 (0.38)	4.56 (0.76)	< .001
Attentiveness of the medical staff to the family's emotional needs	The doctors and nurses who took care of my child were responsive to our needs and communicated well.	4.96 (0.20)	4.81 (0.43)	.007
	The doctors and nurses made every effort to reduce **my child's** anxiety.	4.96 (0.20)	4.67 (0.67)	< .001
	The doctors and nurses made every effort to reduce **my** anxiety.	4.93 (0.30)	4.67 (0.53)	< .001
	The doctors and nurses who took care of my child demonstrated caring for us and our child.	4.97 (0.16)	4.73 (0.48)	< .001
Operating room experience	Our experience going into surgery was better than we expected.	4.79 (0.53)	4.56 (0.73)	.02
	Overall, I am very satisfied with the way my child went into the operating room.	4.95 (0.23)	4.63 (0.64)	< .001
Overall care experience	I would come back to [this surgery center] if my child needed surgery again.	4.93 (0.30)	4.66 (0.77)	.001
	I would recommend this experience to others if their children needed surgery.	4.93 (0.25)	4.77 (0.51)	.02

Values are means (SD) on a 5-point agreement scale. *P* values are from Mann-Whitney *U* tests.

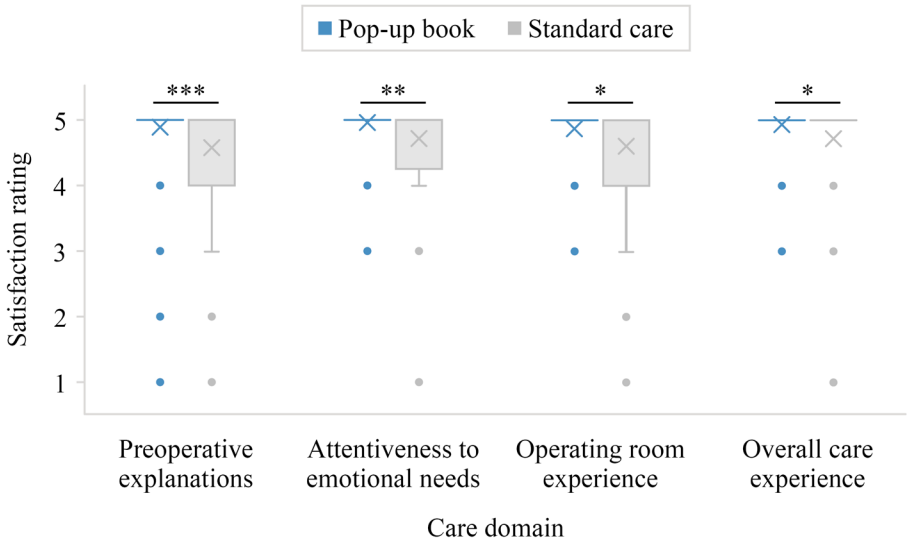


Figure 6
Comparison of caregivers' satisfaction with each aspect of the surgical experience: preoperative explanations, attentiveness of the medical staff to the family's emotional needs, the operating room experience, and the overall care experience. Higher scores indicated more positive responses. Items were analyzed individually; significance levels reflect the highest *P* value within each domain. ***$P \leq .001$, **$P < .01$, and *$P \leq .02$ for differences between groups.

Discussion

This study demonstrated that the educational pop-up book effectively empowers children with positive expectations and coping strategies as they approach surgery. The resource supplies targeted information with elements that enhance learning to help patients navigate unknowns. The book conveys important procedural and sensory information through child-appropriate language, illustrations, and analogies,[22] and it supports active learning through tactile participation and interactive reader response. In these ways, the book engages children in their preoperative education and treatment process. Based on patients' reports, learning from the pop-up book was significantly more fun, more helpful for understanding what to expect, and more child-focused than standard provider consultation. This benefit was seen even at a specialized children's facility with subspecialty pediatric providers skilled in communicating with children

and families. The advantages could be even more pronounced in facilities that treat all age groups, where care is less tailored to pediatric emotional needs.

Even though the book excerpt focused only on anesthesia, it was clinically effective in reducing patients' fear and pain expectations both from anesthesia induction and during surgery. After reading the pop-up book, patients approached surgery with significantly more positive expectations and attitudes, including greater readiness and greater trust in their doctors. These benefits uplift patients' experience during the perioperative period and may also carry a lasting influence on patients' relationships with health care.[54] Childhood health care experiences and attitudes predict continuing health care behaviors: children with more positive experiences and views are more likely to develop good habits in early adulthood, such as attending regular well visits, maintaining hygiene, and avoiding tobacco use.[54]

Further, the book prepared patients to cope adaptively. Pop-up book patients were better-equipped with distraction strategies (e.g., using a comfort toy); support-seeking strategies (e.g., holding a caregiver's hand); and, most importantly, positive active coping strategies. Over 50% of pop-up book patients (versus 13.7% of standard-care patients) generated positive active coping strategies: engaging imaginatively with anesthesia induction, expressing positive ideas about their treatment, overcoming fears, and participating. This active coping approach helps patients engage with the procedure in a self-reliant, constructive manner.[23,24] In this study, positive active coping was significantly associated with less fear and greater procedural readiness, consistent with previous evidence that children's adaptive coping behaviors in the operating room are associated with less anxiety.[14] Therefore, encouraging patients to develop sound coping strategies in advance may increase patients' confidence as they approach surgery.

Reducing preoperative anxiety is also clinically important because children's preoperative anxiety influences distress in the postoperative care unit and pain perceptions during recovery.[1-3] Children who are highly anxious before surgery tend to express more pain postoperatively and consume more opioid and non-opioid analgesics at home.[1] Educational interventions that relieve children's preoperative anxiety can also curb postoperative opioid consumption.[6] Given the prevalence of opioid prescribing for pediatric postoperative pain management,[55] these upstream efforts could help manage opioid overuse among children and decrease the supply of opioids available for abuse and diversion in communities. Minimizing psychological and physiological stress associated with surgery accelerates patients' return to function postoperatively and is a key tenet of Enhanced Recovery After Surgery (ERAS) protocols that have been broadly applied across surgical disciplines in recent years.[56,57]

Although the pop-up book intervention had large effects on patients' own perceptions of their preoperative fear and readiness, the study groups outwardly displayed similar levels of agitation during anesthesia induction. The observer-rated mYPAS-SF scores may have suffered from confounding between observable state characteristics of anxiety and anesthetic-induced disinhibition. During inhalation induction with sevoflurane, patients experience disorientation and physical excitation (which can involve uncontrolled spastic movements).[58] In this study, nurses rated anxiety at induction by the most extreme behaviors exhibited when the anesthesiologist placed the mask, including the excited stage of anesthesia (stage 2). Along with this confound, previous work with the mYPAS has shown that behavioral anxiety at anesthesia induction is difficult to predict, and plausible risk factors explain little of the variability in anxiety scores.[59] In our study, therefore, children's self-reported fear and readiness better reflected their emotional state during the broader preoperative period.

The pop-up book also significantly increased caregivers' satisfaction with the overall care experience and specifically with preoperative explanations. Addressing the caregiver's experience matters for the patient as well: children's anxiety both before and after surgery is linked to their caregiver's preoperative anxiety.[59,60] The pop-up book significantly improved caregivers' perceptions of how attentive the medical staff was to the family's emotional needs, including efforts to reduce the caregiver's anxiety and the child's anxiety. And interestingly, even though observer-rated anxiety at anesthesia induction was not different between groups, caregivers perceived the operating room experience significantly more positively if the family read the pop-up book.

This pop-up book effectively balanced families' educational needs with outpatient workflow and resource constraints. Caregivers often feel unprepared to explain surgery to their child, but they rarely receive guidance on discussing the subject; caregivers may even maladaptively avoid disclosing the upcoming surgery to the patient.[61] This book provides effective education and a structured format for caregiver-child discussion. As surgical volumes shift from well-funded inpatient hospitals to outpatient surgery centers,[62-64] families and providers need education resources compatible with care that emphasizes cost-efficiency and speed.[65] While smaller care centers may not be able to offer intensive interventions or child life programs,[66] providers can implement pop-up books affordably without disrupting medical workflow.

Limitations

The study's limitations were primarily related to the timing of the intervention. All studied preoperative education occurred on patients' day of surgery to standardize intervention

and avoid selection bias that could result from requiring a separate educational visit. Existing literature suggests that pediatric preoperative education is considerably more effective when delivered several days in advance.[67] Other studies have administered education starting 5-7 days before surgery and encouraged patients to revisit the resources (including take-home models, individualized coaching, and caregiver training).[6,15] Notably, of the preoperative education studies reviewed, only these resource-intensive, advance programs reduced observer-rated anxiety when anesthesiologists presented the mask.[6,15] Our intervention may be even more effective if families had longer and more frequent access to the book (e.g., at the clinic and at home). Secondly, this study did not examine postoperative effects because the range of sampled procedures involved different recovery courses.

Future Directions

Further research should explore other possible benefits of the pop-up book as a method for educating patients before surgery. This study focused on the preoperative period, showing that the book helped patients cope with preoperative stressors: the book minimized patients' fears, improved understanding, and strengthened coping skills. It also shaped more positive appraisals of the surgical experience and acute stressors, especially anesthesia induction. The benefits of the book during the preoperative period may lead into related postoperative benefits, both in the short term (recovery outcomes) and the long term (lasting health care attitudes). Procedure-specific research investigating whether this resource could facilitate recovery is warranted; specifically, the book may ameliorate postoperative distress and pain perceptions. Secondly, future studies should give families earlier access to the book and allow them to read and revisit the book throughout the week before surgery. This more extensive intervention could

improve learning consolidation and yield even more effective outcomes. The current study showed that the book can be implemented effectively at the surgery center on the day of surgery, but in practice, providers and caregivers may prefer to supply patients with the book in advance. A study modeling how families would engage with the resource in an unstructured environment as patients prepare for surgery would be useful. Evaluating the advantages of a longer pop-up book that covered the specific surgical procedure and the period surrounding surgery would also be worthwhile.

Conclusion

This study showed that interactive preoperative education delivered via a pop-up book effectively prepared children to face surgery. The interactive book significantly and meaningfully reduced patients' preoperative fear and expected pain, encouraged more positive views of the procedure and preoperative explanations, and promoted adaptive coping strategies. It also significantly improved caregivers' perceptions of the surgical experience. By helping patients understand and cope with surgery, the pop-up book offers a valuable resource for families and health care providers.

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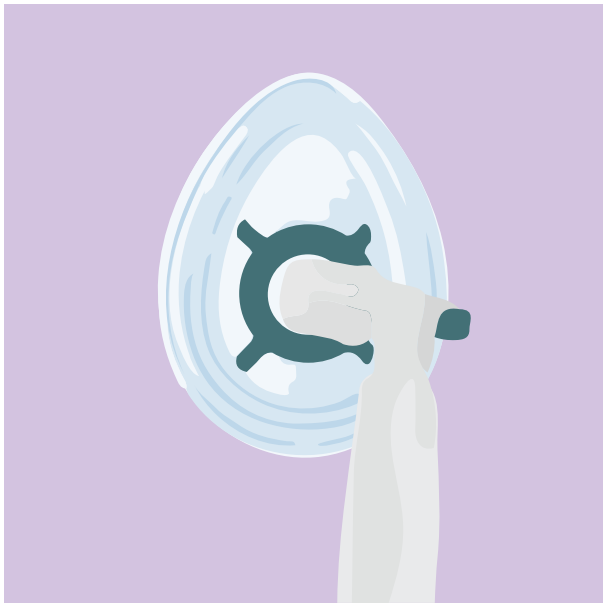
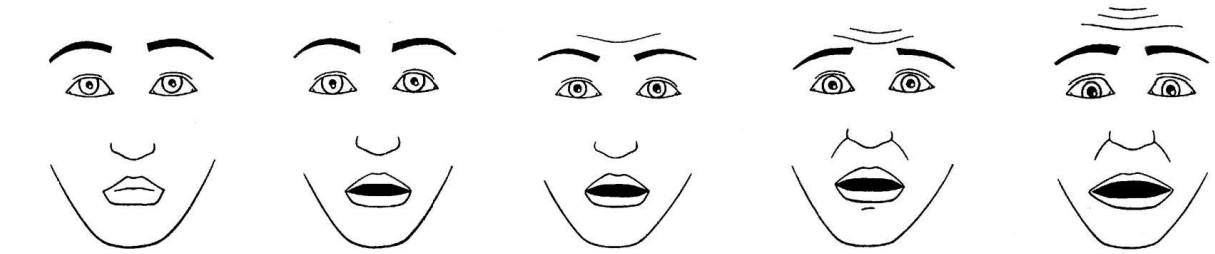
Appendix A. The Children's Fear Scale (CFS)[41]

Script for investigator. "Imagine a doctor using this mask to help you go to sleep. What I would like you to think about is if you will feel scared when the doctor puts this mask on you."



"These faces are showing different amounts of being scared. This face [*point to the left-most face*] is not scared at all, this face is a little bit more scared [*point to second face from left*], a bit more scared [*sweep finger along scale*], right up to the most scared possible [*point to the last face on the right*]. Have a look at these faces and choose the one that shows how scared you will be when the doctor puts the mask on you."



0 **1** **2** **3** **4**

Appendix B. The Faces Pain Scale-Revised (FPS-R)[42]

Script for investigator. "Imagine a doctor using this mask to help you go to sleep. What I would like you to think about is if you think it will hurt when the doctor puts this mask on you."

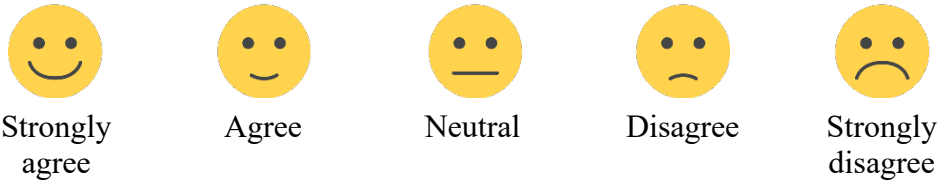
[*Patients viewed the same mask images as above in the CFS, Appendix A.*]

"These faces show how much something can hurt. This face [*point to face on far left*] shows no hurt. The faces show more and more hurt [*point to each from left to right*] up to this one [*point to face on far right*]—it shows very much hurt. Point to the face that shows how much you think you will hurt when the doctor puts the mask on you."

0 **1** **2** **3** **4** **5**

"Okay, now imagine the doctor has helped you go totally asleep. What I'd like you to think about is if you will feel any hurt when you are totally asleep. Let's look at the faces again. Remember, this face [*point to face on far left*] shows no hurt. The faces show more and more hurt [*point to each from left to right*] up to this one [*point to face on far right*]—it shows very much hurt. Point to the face that shows how much you think you will hurt when you are totally asleep."

Appendix C. Patient Questionnaire: Views of the Procedure and Preoperative Explanations



These questions ask about what you think happens when you get anesthesia.

- I will be completely asleep.
- I won't feel my surgery if I have anesthesia. I will not feel anything while I am asleep.
- The doctor will keep checking on me while I am asleep.

These questions ask about how you feel about getting anesthesia.

- I feel ready to get anesthesia.
- I could tell another kid what anesthesia is like.
- I think the doctor will take good care of me.

These questions ask about the way you learned about anesthesia today.

- Learning this way was fun.
- It helped me understand what happens.
- I felt like the explanation was for me, not just for my mom/dad.

Appendix D. Coping Strategies Content Analysis System[8,23,24,44,45]

Coping Domain	Strategy	Definition
Positive active coping strategies (positive cognitive restructuring, seeking information)	Imaginative engagement*	Picturing him/herself in the mask in an imaginative way (e.g., as an astronaut, elephant, or snorkeler)
	Positive affect	Wanting to get better, positive ideas about the procedure
	Overcoming fear	Consoling him/herself, accepting the situation
	Learning and participating	Asking questions, watching, learning, helping, participating, following instructions
Distraction strategies	Focusing on mask scent* or environment	Paying attention to the flavored (e.g., strawberry) scent of the mask or other aspect of surroundings
	Cognitive distraction	Thinking about something pleasant
	Calming techniques	Resting, relaxing, deep breaths, staying still/quiet
	Humor and storytelling	Telling or listening to a joke or story
	Comfort toy/blanket*	Bringing or hugging his/her own comfort object
	Play	Playing, watching television, games, reading, drawing, etc. (excludes use of own comfort toy)
	Reward	Looking forward to gifts or treats
Support-seeking strategies	Parent/family support*	Knowing family is present or using family (e.g., talking, cuddling, holding hands)
	Help from doctor/nurse	Receiving help, consolation, or healing from hospital personnel
Maladaptive coping strategies (avoidance, negative coping strategies)	Cognitive avoidance	Closing eyes, deliberately avoiding thinking about it, wishing/pretending it is not happening
	Avoidant actions	Escaping, hiding, physically resisting
	Expressing negative emotions	Feeling sad/scared, crying, screaming, verbally resisting
–	Unsure/nothing	Does not know what he/she would do or would do nothing

*Mentioned in the pop-up book.

Appendix E. The modified Yale Preoperative Anxiety Scale-Short Form (mYPAS-SF)[46]

The mYPAS-SF evaluates 4 anxiety domains, with higher scores indicating greater anxiety. Each domain score is divided by the domain's maximum possible score (6 for "vocalizations" and 4 for other domains); the sum of these values is divided by 4 domains and multiplied by 100.[46] For example, a minimum composite score is (¼ + ⅙ + ¼ + ¼) / 4 * 100 = 22.92.

Domain	Score	Definition
Activity	1	Looking around, curious, playing with toys, reading (or other age-appropriate behavior); moves around holding area/treatment room to get toys or go to parent; may move toward OR equipment
	2	Not exploring or playing, may look down, may fidget with hands or suck thumb (blanket); may sit close to parent while waiting, or play has a definite manic quality
	3	Moving from toy to parent in unfocused manner, nonactivity-derived movements; frenetic/frenzied movement or play; squirming, moving on table, may push mask away or clinging to parent
	4	Actively trying to get away, pushes with feet and arms, may move whole body; in waiting room, running around unfocused, not looking at toys or will not separate from parent, desperate clinging
Vocalizations	1	Reading (nonvocalizing appropriate to activity), asking questions, making comments, babbling, laughing, readily answers questions but may be generally quiet; child too young to talk in social situations or too engrossed in play to respond
	2	Responding to adults but whispers, "baby talk," only head nodding
	3	Quiet, no sounds or responses to adults
	4	Whimpering, moaning, groaning, silently crying
	5	Crying or may be screaming "no"
	6	Crying, screaming loudly, sustained (audible through mask)
Emotional expressivity	1	Manifestly happy, smiling, or concentrating on play
	2	Neutral, no visible expression on face
	3	Worried (sad) to frightened, sad, worried, or tearful eyes
	4	Distressed, crying, extreme upset, may have wide eyes
State of apparent arousal	1	Alert, looks around occasionally, notices/watches what anesthesiologist does with him/her (could be relaxed)
	2	Withdrawn, child sitting still and quiet, may be sucking on thumb or face turned into adult
	3	Vigilant, looking quickly all around, may startle to sounds, eyes wide, body tense
	4	Panicked whimpering, may be crying or pushing others away, turns away

Appendix F. Caregiver Questionnaire: Satisfaction with the Surgical Experience[48]

Please respond to each of the statements below by marking how much you agree. Each statement concerns some aspect of your child's hospital experience, so we ask that you give an answer to each statement.

Strongly disagree | Disagree | Neutral | Agree | Strongly agree

I would come back to Children's at Satellite Boulevard if my child needed surgery again.

– The way my child went to sleep was just like the doctor explained.
– I would recommend this experience to others if their children needed surgery.
– The doctors and nurses who took care of my child were responsive to our needs and communicated well.
– Our experience going into surgery was better than we expected.
– Overall, I am very satisfied with the way my child went into the operating room.
– I am satisfied with the explanations given for how my child would go to sleep and wake up.
– The doctors and nurses made every effort to reduce my child's anxiety.
– The doctors and nurses made every effort to reduce my anxiety.
– The doctors and nurses who took care of my child demonstrated caring for us and our child.

Appendix G. Calculations for Rank-Biserial Correlations

The rank-biserial correlation is the appropriate measure of association between an ordinal (rank) variable and a dichotomous (biserial) variable. Rank-biserial correlations for exploratory analyses were calculated from Mann-Whitney mean ranks according to Cureton's procedures.[53] For the dichotomous X variable (positive active coping), the 2 categories ("Yes," representing patients who generated positive active coping strategies, and "No," representing patients who did not generate positive active coping strategies) were designated as P and Q, respectively.[53] For the Y distribution of ordinal ratings (fear or procedural readiness, both of which were rated on an ordinal scale), $\overline{Y}_p$ represents the mean rank of fear or readiness ratings among patients who generated positive active coping strategies (i.e., the P category), $\overline{Y}$ represents the mean rank of the entire Y distribution, and $\overline{Y}'$ represents the mean rank of the n_p highest ranks in the Y distribution (in this case, the 48 highest ranks).[53] By nature of ranking procedures, $\overline{Y}$ and $\overline{Y}'$ depend only on the total sample size (n) and the dichotomous X variable.

Rank-Biserial Correlations

Positive active coping	**Yes** $n_p = 48$	**No** $n_q = 100$	$\overline{Y}_p$	$\overline{Y}$	$\overline{Y}'$	r_{rb}	P
Fear	53.39	84.64	53.39	74.5	124.5	-.42	< .001
Procedural readiness	90.67	66.74	90.67	74.5	124.5	.32	.001

Values for the dichotomy are mean ranks from Mann-Whitney analyses; "Yes" is designated as P, and "No" as Q.
$\overline{Y} = (n + 1) / 2$
$\overline{Y}' = n_q + (n_p + 1) / 2$
$r_{rb} = (\overline{Y}_p - \overline{Y}) / (\overline{Y}' - \overline{Y})$