Can J Anesth/J Can Anesth (2019) 66:966–986
https://doi.org/10.1007/s12630-019-01387-8

REVIEW ARTICLE/BRIEF REVIEW

A systematic review of technology-based preoperative preparation interventions for child and parent anxiety

Revue systématique de l'impact des interventions de préparation préopératoire fondées sur la technologie sur l'anxiété chez l'enfant et ses parents

Jinsoo Kim, BA · Natasha Chiesa, BA · Mateen Raazi, MD · Kristi D. Wright, PhD

Received: 4 July 2018 / Revised: 16 February 2019 / Accepted: 18 February 2019 / Published online: 16 May 2019

Abstract

Purpose *The purpose of this systematic review was to examine the effect of technology-based preoperative preparation interventions on children's and parents' anxiety.*

Sources *PsycINFO, Cochrane, Science Direct, Taylor and Francis, and Pubmed MEDLINE databases were searched. Studies were restricted to those reporting on technology-based preoperative preparation interventions for pediatric patients (0–18 yr old) receiving elective surgery under general anesthesia.*

Principal findings *Thirty-eight studies that provided level II or level III evidence were included (33 randomized-controlled trials and five non-randomized-controlled studies). Of the 38 studies, preoperative anxiety (measured by various indices of anxiety) was significantly reduced in children and parents in 25 and 11 studies, respectively. For children, tablet and handheld devices with interactive components were the most encouraging strategies. Video preparation alone may provide sufficient information to manage preoperative anxiety in parents.*

Conclusion *The available literature is extremely heterogeneous and limits the ability to make definitive conclusions about the efficacy of technology-based preoperative preparation interventions. The available literature suggests that, for children, tablet and handheld devices with interactive capacity may represent a viable option to address preoperative anxiety. The findings are more mixed for parents, with video preparation a possible option. Execution of well-designed, methodologically sound studies is required to facilitate a better understanding of the efficacy of technology-based preoperative preparation.*

Résumé

Objectif *L'objectif de cette revue systématique était d'examiner l'impact des interventions de préparation préopératoire fondées sur la technologie sur l'anxiété des enfants et de leurs parents.*

Source *Les bases de données PsycINFO, Cochrane, Science Direct, Taylor and Francis et Pubmed MEDLINE ont été passées en revue. Les études retenues se sont limitées à celles rapportant des interventions de préparation préopératoire fondées sur la technologie pour les patients pédiatriques (0-18 ans) recevant une chirurgie non urgente sous anesthésie générale.*

Constatations principales *Trente-huit études présentant des données probantes de niveau II ou III ont été incluses (33 études randomisées contrôlées et cinq études non randomisées contrôlées). Parmi les 38 études, l'anxiété préopératoire (telle que mesurée par divers indices d'anxiété) a été significativement réduite chez l'enfant et les parents dans 25 et 11 études, respectivement. Pour les enfants, les tablettes et les appareils portatifs comprenant des composantes interactives constituaient les stratégies*

J. Kim, BA · K. D. Wright, PhD (✉)
Department of Psychology, University of Regina, Regina, SK, Canada
e-mail: Kristi.wright@uregina.ca

N. Chiesa, BA
Department of Psychology, University of Saskatchewan, Saskatoon, SK, Canada

M. Raazi, MD
Department of Anesthesiology, Perioperative Medicine and Pain Management, College of Medicine, University of Saskatchewan, Saskatoon, SK, Canada

donnant les résultats les plus encourageants. La préparation sur vidéo seule pourrait offrir suffisamment d'informations pour prendre en charge l'anxiété préopératoire des parents.

Conclusion *La littérature existante est extrêmement hétérogène et limite notre capacité d'émettre des conclusions définitives quant à l'efficacité des interventions de préparation préopératoire fondées sur la technologie. La littérature disponible suggère que, pour l'enfant, les tablettes et appareils portatifs disposant de capacités interactives pourraient constituer une option viable pour prendre en charge l'anxiété préopératoire. Les résultats sont plus mitigés pour les parents, la préparation par vidéo constituant potentiellement une option. L'exécution d'études bien conçues et rigoureuses d'un point de vue méthodologique est nécessaire afin de mieux comprendre l'efficacité des interventions de préparation préopératoire fondées sur la technologie.*

Anticipation of surgery is often associated with elevated levels of anxiety,[1] wherein preoperative anxiety is experienced in more than 65% of children.[2] Elevated preoperative anxiety has been associated with increased postoperative pain and analgesic dosage,[3] longer and more complicated postoperative recovery,[4,5] and heightened postoperative anxiety.[6] In turn, preoperative anxiety is associated with the development of maladaptive behaviours upon discharge, including separation anxiety, bed-wetting, and sleep difficulties.[2,3,6,7]

Historically, preoperative preparation for outpatient surgery took the form of a preadmission visit to the hospital where eligibility for surgery was assessed, basic information about upcoming surgery and anesthesia was provided, and instructions were given to child and parent regarding preoperative fasting, medications, and postoperative care.[8] This visit may have also included a hospital tour and other preoperative preparation components (e.g., play therapy). Nevertheless, research has suggested that approximately 80% of children undergoing outpatient surgery do not visit the hospital prior to the day of surgery and the majority of traditionally delivered preoperative preparation programs in the US have been eliminated due to costs.[9] Similar statistics are not available for Canada.

Technology has played an increasing role in the preoperative preparation of children and their parents for upcoming surgeries. Technology has been employed to deliver preoperative preparation to address limited personnel and financial resources that have reduced the traditional face-to-face delivery of this information. Specifically, research has shown that many hospitals have supplemented preadmission visits and assessments with preoperative videos.[10-31] Preoperative preparation videos have included information pertaining to preoperative preparation, hospital admission, anesthetic induction, recovery, and emergence after the surgery. These are narrated by peers, adults, or medical professionals. In some, simulated peer-modeling scenes are included where child-actors demonstrate coping behaviours (e.g., react in an adaptive or non-anxious manner) during the potentially fear- and anxiety-inducing hospital experience.[11,12,14,17,22,26-28,30,31]

Most recently, eHealth technologies, such as the use of smartphones or the Internet, have aimed to address limitations in previous preoperative programs (i.e., limitations due to costs or lack of evidence-based components).[32] The Internet, in particular, has significant advantages over other forms of eHealth technologies (i.e., flexibility, ability to update information and to communicate with the patient in real time, and wide accessibility).[33] Other anxiolytic-reducing interventions have included parental presence (PP) in the operating room (OR), preoperative sedative medications (i.e., midazolam), Child Life specialists, verbal distraction techniques by hospital staff, low sensory stimulation (i.e., dimmed light in OR), and/or distraction using a colouring book or storybook.[8,34]

We conducted this systematic review to provide the most up-to-date synthesis of the available literature on the use of technology for preoperative preparation of children for surgery. Our goal was to be more expansive than other reviews[35,36] by exploring the impact of various types of technology-based preoperative preparation programs on preoperative anxiety in both pediatric patients and their parents as well as across various indices of anxiety (i.e., observer-rated, self-report, physiologic) and by presenting the findings collectively.

Methods

This systematic review follows the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement.[37] A research librarian was consulted when developing the selection criteria and search strategy.

Selection criteria

The Participants, Interventions, Comparisons, Outcomes, and Study Design approach was used to form the research questions of this review and to establish the study selection criteria. To be included in the review, the peer-reviewed

article must have reported a study that examined the efficacy of technology-based programs in reducing preoperative anxiety for pediatric patients (0–18 yr old) and/or their parents. We identified technology as videos, tablets, or handheld devices (i.e., tablets or smartphones), Internet or web programs, and virtual reality tools (i.e., video glasses). We included both randomized- and non-randomized-controlled trials that compared technology-based preoperative programs with one or more comparison groups. Comparative groups could receive no intervention, standard hospital procedure (SHP), non-technology-based distraction techniques (i.e., toys, colouring book, puppetry), pharmaceutical interventions (i.e., midazolam), or PP. We examined technology-based preoperative programs that examined anxiety as a study outcome, whether as a primary or secondary outcome. Studies were excluded if they did not meet this criterion and if they were written in languages other than English. Studies were also excluded if the preoperative preparation was intended for adult patients (older than 18 yr) or healthcare professionals, such as nurses or medical students.

Search strategy

PsycINFO, MEDLINE, EMBASE, and CINAHL databases were searched (including all articles published prior to November 16, 2018). The electronic search strategy was conducted by combining subject heading terms with keywords and text words. Search terms were based on five concepts: 1) terms related to anxiety, 2) terms related to preoperative, 3) terms related to technology, 4) terms related to pediatric or children populations, and 5) terms related to parents or guardians. The full list of search term and search strategy for MEDLINE is outlined in the Appendix. The same strategy was used for all the databases but search terms were adjusted according to the database. Additional relevant studies were also retrieved from the reference lists of eligible studies. The searches were limited to peer-reviewed published studies using humans and those written in the English language.

Study selection

The screening process was conducted independently by the first and second authors (J. K. and N. C.) based on the aforementioned search strategy. Duplicate and non-relevant studies were eliminated. Titles and abstracts of each study were initially screened to exclude case studies, abstracts, editorials, and correspondence. Full-text versions of potentially relevant studies were obtained to determine whether the inclusion criteria were met. In the case of disagreement or uncertainty, the fourth author (K.D.W.) was consulted to reach a final resolution. The reviewers met and agreed to the final inclusion of the studies ($n = 38$), resulting in a Cohen kappa of 0.94.

Data extraction

For each study that was included in the final qualitative analysis, the following information was extracted (where applicable): a) author(s), b) year, c) study design, d) sample size and age, e) type of surgical procedure(s), f) type and time of intervention, g) comparison group(s), h) child and parent measure of anxiety, i) child and parent anxiety outcome, j) child anxiety outcome at anesthetic induction, and k) post-hospital behaviour (as measured by the Post Hospital Behaviour Questionnaire [PHBQ]).[38] The heterogeneity of the literature is vast as it pertains to participant characteristics, intervention type and content, and method of assessment or outcome measures (observer-rated, self-report, and physiologic). We expected this heterogeneity to affect our ability to directly assess the magnitude of the effect and clinical meaningfulness of the study findings. As such, we intended to provide a summary of study findings and to subsequently make general (i.e., non-statistical) inferences regarding the effectiveness of the individual mode of deliveries as a whole as they pertain to child and parent groups.

Risk of bias

The potential risk of bias in each study was assessed by assigning a level of evidence, from level I (strong evidence) to level V (weak evidence), based on the quality of the study's design.[39] For the purpose of this review, only level I–III evidence was considered. Level I comprised high quality randomized-controlled trials (RCTs) or systematic reviews of level I studies with consistent results. Level II comprised lesser quality RCTs (i.e., no blinding, improper randomization, or poor follow-up), prospective comparative studies, and systematic reviews of level II studies or level I studies with inconsistent results. Level III encompassed case-control studies, retrospective comparative studies, or systematic reviews of level III studies.

Results

Study characteristics

Our search identified 1,023 articles; 17 additional studies were identified from reference lists of retrieved studies and reviews (see Figure). Of the total 1,039 articles, 893 remained for screening after duplicates were removed. Titles and abstracts of 893 articles were screened to

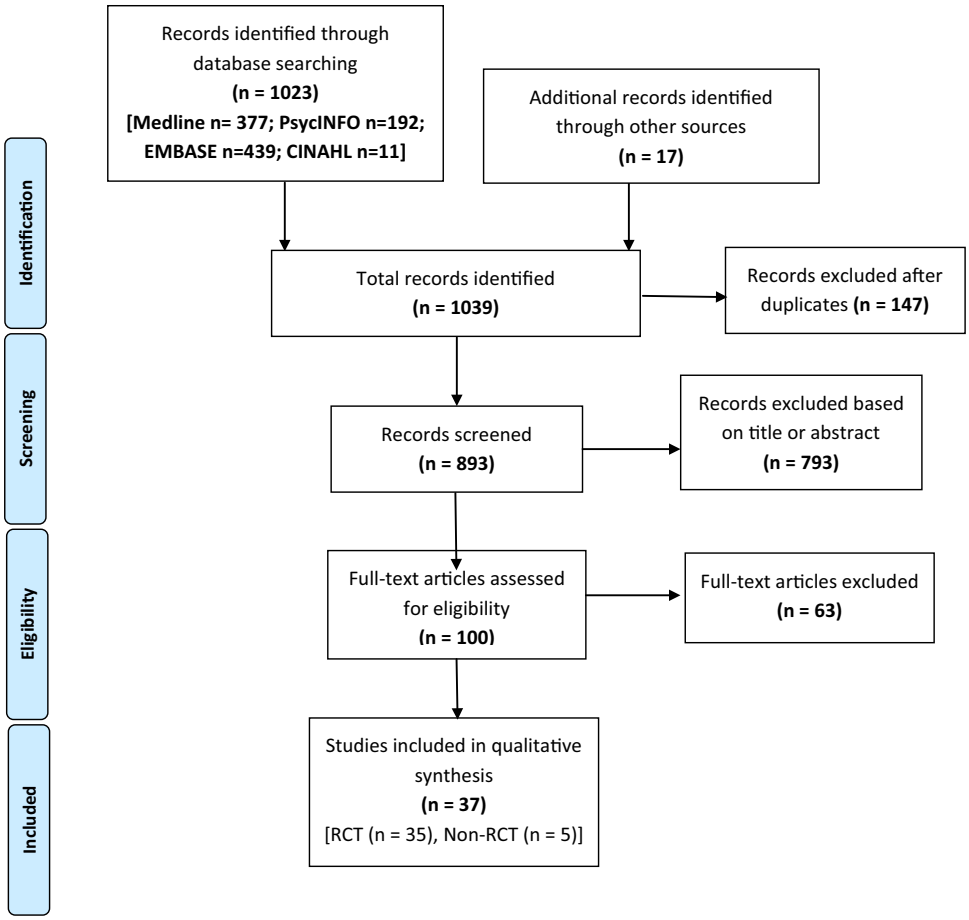

Figure Preferred reporting items for systematic reviews and meta-analyses flowchart of study[32]

exclude 793 articles presented in abstract form, reviews, editorials, or correspondence. One-hundred full-text articles were assessed for eligibility for the inclusion and exclusion criteria. Sixty-three articles were not included for qualitative analysis because they included adult patients, or the program was intended for healthcare professionals or students. The 38 studies that met all the criteria for systematic review are presented in the Table. Of the 38 studies, 33 were RCTs and five were non-randomized control studies (NRS). These studies were published between 1974 and 2018.

Type of intervention

Eligible studies were organized by the type of technology in the Table: a) videos (n = 15),[10-24] b) videos + additional practice material(s) (n = 7),[25-31] c) tablet or handheld device (n = 12),[40-51] d) Internet- or web-based programs (n = 3),[52-54] and e) virtual reality programs (n = 1).[55] These interventions were designed to provide information about hospital setting and/or procedures, behaviour modification via peer-modeling, skills training (e.g., coping skills training), and/or interactive distractions. Preoperative preparation videos with additional practice material(s), such as relaxation audiotapes or informational booklets, were categorized and summarized independent from video intervention alone. Technology-based interventions were compared with SHP, non-medical-related videos, PP, midazolam, and/or non-technology-based interventions. Alternative comparative intervention strategies incorporated verbal distractions, educational pamphlets, OR tours, puppetry, board games, or cartoon books.

Timing, duration, and frequency of intervention

The timing, duration, and frequency of interventions were inconsistent across studies. The interventions were applied from 22 days up to the time of induction (see Table). The duration of the interventions varied considerably as well, ranging from four minutes to one hour. Of the 38 studies, most of the participants were exposed to the intervention only once preoperatively. Three studies required the

Table Characteristics of studies included in the review

Author(s), year	Level of evidence	Study design	Population *n*, age, surgical procedure	Intervention; time introduced	Comparison(s); time introduced	Measure(s) of anxiety		Outcome[a,b,c]			
						Parent	Children	Parent's overall anxiety	Children's overall anxiety	Children's anxiety at induction	PHBQ
Videos											
Vernon and Bailey, 1974[10]	II	RCT	38, 4–9 yr, minor elective operation	Video (*n*=19); 45 min preoperatively	SHP (*n*=19); n/a	n/a	**n/a**	n/a	n/a	n/a	n/a
Melamed and Siegel, 1975[11]	III	NRS	60, 4–12 yr, outpatient surgery (tonsillectomy, hernia, or urinary-genital tract surgery)	16 min peer-modeling video (*n*=30); at hospital admission	12 min non-medical-related video (*n*=30); at hospital admission	n/a	Trait anxiety (Anxiety Scale; CMAS; HFD), state anxiety (PSI; HFRS; ORSA)	n/a	-, +	n/a	n/a
Ferguson, 1980[12]	II	RCT	82, 3–7 yr, elective tonsillectomy	15 min peer-modeling video; at preadmission visit (*n*=21) or hospital admission (*n*=20)	15 min non-medical-related video; at preadmission visit (*n*=20) or hospital admission (*n*=21)	MACL	HFRS, electromyography, ORSA,	+	-, -, -	n/a	+
Abrams, 1982[13]	III	NRS	60, 4–11 yr, day surgery	Slideshow with traditional preparation (*n*=20) or sensation/ mastery explanation (*n*=20); 1 day preoperatively	SHP (*n*=20); n/a	n/a	Checklist of behavioural responses and frequency by anesthesiologist/ nurse	n/a	-	-	-
Peterson *et al.*, 1984[14]	II	RCT	44, 2–11 yr, elective oral surgery	50 min informative peer-modeling video (*n*=12); n/a	SHP (*n*=8); n/a 50 min Informative puppetry (*n*=11); n/a Commercial peer-modeling video with incorrect information (*n*=13); n/a	n/a	Behaviour rating, behaviour checklist, parent self-report	**n/a**	**+, +, -** **-, -, *** **-, -, -**	**n/a**	**n/a**
Pinto and Hollandsworth, 1989[15]	II	RCT	60, 2–12 yr, first-time elective surgery	22 min adult- (*n*=20) or peer-narrated video (*n*=20); 1 hr before admission	SHP (*n*=20); 1 hr before admission	PSI, PARS	PSI, HFRS, ORSA	+, -	+, +, +	n/a	n/a
Durst *et al.*, 1990[16]	III	NRS	59, 2–10 yr, elective day surgery	7 min peer-narrated video (*n*=29); 1 week preoperatively	SHP (*n*=30); 1 week preoperatively	n/a	Child's behaviour rating	n/a	-	-	n/a
Faust *et al.*, 1991[17]	II	RCT	26, 4–10 yr, elective ear tube surgery	10 min peer-modeling slide-tape viewed alone (*n*=9); day of surgery	Modeling slide-tape viewed with mother (*n*=8); day of surgery SHP (*n*=9)	n/a	Heart rate, sweat level,	n/a	+, + +, +	n/a n/a	n/a
Cassady *et al.*, 1999[18]	II	RCT	85 parents of pediatric patients, ambulatory surgery	22 min professionally narrated video (*n*=43); 1 week preoperatively	25 min non-medical-related video (*n*=42); 1 week preoperatively	APAIS, STAI	n/a	+, +	n/a	n/a	n/a

Table continued

Author(s), year	Level of evidence	Study design	Population *n*, age, surgical procedure	Intervention; time introduced	Comparison(s); time introduced	Measure(s) of anxiety		Outcome[a,b,c]			
						Parent	Children	Parent's overall anxiety	Children's overall anxiety	Children's anxiety at induction	PHBQ
Zuwala and Barber, 2001[19]	II	RCT	80, 83–10 yr, myringotomy, tonsillectomy	2 min instructional video + informational pamphlet; day of surgery (*n*=40)	Pamphlet only (*n*=40); day of surgery	Mean arterial pressure, pulse pressure, heart rate, STAI	Parental assessment	+, -, -, -	+	-	n/a
McEwen *et al.*, 2007[20]	II	RCT	111, 0–16 yr, elective surgery	8 min information video (*n*=55); after admission	SHP (*n*=56); 1 day preoperative	APAIS, STAI**	n/a	+, -	n/a	n/a	n/a
Karabulut and Arikan, 2009[21]	III	NRS	90, 9–12 yr, inguinal hernia surgery	12 min informational video (*n*=30); 48 hr preoperatively	SHP (*n*=30); 48 hr preoperatively	STAI	STAIC	+‘	+	n/a	n/a
					30 min educational booklet (*n*=30); 48 hr preoperatively			+	+		
Berghmans *et al.*, 2011[22]	II	RCT	120, 1–7.5 yr, day surgery	4 min peer-modeling video (*n*=60); in holding area	SHP (*n*=60); n/a	APAIS, STAI	VAS	+, +	-	-	n/a
De Armendi *et al.*, 2012[23]	III	RCT	9, n/a, n/a	10 min informational Spanish video (*n*=5); 2 weeks before surgery	SHP (*n*=4)	STAI, APAIS	n/a	n/a[d]	n/a	n/a	n/a
Fernandes *et al.*, 2014[24]	II	RCT	125, 8–12 yr, outpatient surgery	15–20 min educational material (board game, video, or booklet) (*n*=45); after admission	SHP (*n*=35); after admission	STAI	CSWQ	-	+	n/a	n/a
					Non-informative entertainment material (board game, video, booklet) (*n*=45); after admission			-	+		
Videotape + additional practice material											
Zastowny *et al.*, 1986[25]	II	RCT	33, 6–10 yr, elective surgery	22 min informative videotape + 15-min educational videotape with anxiety reducing techniques + preparatory booklet with coping techniques (*n*=11); 1 week before surgery	22 min informative videotape (*n*=11); 1 week before surgery	n/a	Behavioural diary recorded by parents; HFRS; ORSA	n/a	+, +, +	n/a	n/a
					22 min informative videotape + 15 min educational videotape with parent anxiety reducing techniques (*n*=11); 1 week before surgery				-, -, +		

Table continued

Author(s), year	Level of evidence	Study design	Population *n*, age, surgical procedure	Intervention; time introduced	Comparison(s); time introduced	Measure(s) of anxiety		Outcome[a,b,c]			
						Parent	Children	Parent's overall anxiety	Children's overall anxiety	Children's anxiety at induction	PHBQ
Robinson and Kobayashi, 1991[26]	II	RCT	28, 4–13 yr, elective surgery	Peer-modeling video with child and parent coping skills + 15 min relaxation audiotapes and complementary booklet for child and parent (*n*=10); 7 days pre- and postoperatively	Peer-modeling video (*n*=9); 7 days preoperatively	STAI, ORSA, parent diary	HFRS, ORSA	-, -, -	-, -	-, -	n/a
					Peer-modeling video with child coping skills + 15 min relaxation audiotape and complementary booklet for child (*n*=9); 7 days pre- and postoperatively			-, -, -	-, -	-, -	
Ellerton and Merriam, 1994[27]	III	NRS	75, 3–15 yr, elective day surgery	1 hr program (video + hospital tour + informational handout) (*n*=23); 1 week preoperatively	SHP (*n*=53); n/a	VAS	FACES Rating scale	-	+	n/a	n/a
Kain *et al*., 1998[28]	II	RCT	75, 2–12 yr, elective day surgery	OR tour + peer-modeling video + child life preparation (*n*=24); 2–10 days preoperatively	OR tour (*n*=24); 2–10 days preoperatively	STAI, diastolic blood pressure, systolic blood pressure	VAS, mYPAS, serum cortisol	+, +, +,	+, -, -	-, -, -	-
					OR tour + peer-modeling video (*n*=25); 2–10 days preoperatively			+, -, +,	-, -, -	-, -, -	
Huth *et al*., 2004[29]	II	RCT	73, 7–12 yr, tonsillectomy, adenoidectomy, myringotomy	Imagery booklet + video + 30 min audiotape (*n*=36); 2–22 days preoperatively and 1-24 hr postoperatively	SHP and drawing book (*n*=37); 1 week preoperative and 24 hr postoperatively	n/a	STAIC	n/a	+	n/a	n/a
Kain *et al*., 2007[30]	II	RCT	408, 2–10 yr, elective outpatient surgery	20 min ADVANCE preparatory program (*n*=100); 5–7 days preoperatively	SHP (*n*=106); day of surgery	STAI	mYPAS	+	+	+	n/a
					PP (*n*=101); day of surgery			+	+	+	
					0.5 mg·kg^{-1} oral midazolam (*n*=101); day of surgery			+	+	-	

Table continued

Author(s), year	Level of evidence	Study design	Population *n*, age, surgical procedure	Intervention; time introduced	Comparison(s); time introduced	Measure(s) of anxiety		Outcome[a,b,c]			
						Parent	Children	Parent's overall anxiety	Children's overall anxiety	Children's anxiety at induction	PHBQ
Wakimizu *et al.*, 2009[31]	II	RCT	158, 3–6 yr, elective herniorrhaphy	9 min educational video + at-home preparation with complementary booklet (*n*=77); 7 days pre- and postoperatively	9 min educational video (*n*=81); 7 days preoperatively	STAI	FACES Rating Scale	+	+	n/a	n/a
Tablet or handheld devices											
Patel *et al.*, 2006[40]	II	RCT	112, 4–12 yr, elective surgery	Handheld video game + PP (*n*=38); holding area	PP (*n*=36); in OR	n/a	mYPAS	n/a	+	+	-
					PP with midazolam (*n*=38); in holding area			n/a	-	-	
Mifflin *et al.*, 2012[41]	II	RCT	89, 2–10 yr, ambulatory surgery	Video clip streamed from YouTube (*n*=42); at induction	Verbal distraction strategies (*n*=47); at induction	STAI**	mYPAS	-	+	+	n/a
Lee *et al.*, 2012[42]	II	RCT	130, 3–7 yr, elective surgery	Cartoon video clip on tablet (*n*=42); from holding area to induction	SHP (*n*=44); after admission	n/a	mYPAS; VAS	n/a	+, +	+, +	n/a
					toy (*n*=40); from holding area to induction			n/a	*, *	+, +	
Lee *et al.*, 2013[43]	II	RCT	120, 1–10 yr, elective surgery	Smartphone application + 0.05 $mg \cdot kg^{-1}$ intravenous midazolam (*n*=40); in OR	0.15 $mg \cdot kg^{-1}$ intravenous midazolam (*n*=40); in OR	n/a	mYPAS	n/a	+	+	n/a
					smartphone application (*n*=40); in OR				+	+	
Seiden *et al.*, 2014[44]	II	RCT	108, 1–11 yr, outpatient surgery	Tablet-based interactive distraction (TBID) (*n*=57); from parental separation to induction	0.5 $mg \cdot kg^{-1}$ oral midazolam (*n*=51); 15-45 min prior to entering OR	n/a	mYPAS	n/a	+	+	-
Bailey *et al.*, 2015[45]	II	RCT	93, 2–10 yr, elective surgery	Informative video application on iPad (*n*=49); day of surgery	SHP (*n*=44); day of surgery	STAI	mYPAS	-	-	-	n/a
Fernandes *et al.*, 2015[46]	II	RCT	9, 8–12 yr, outpatient surgery	15 min peer-modeling film and interactive activity on tablet (*n*=30); day of surgery	SHP (*n*=30); day of surgery	STAI	CSWQ, SAM, heart rate, blood pressure	+	+, -, -, -	n/a	n/a
					Entertainment video game (*n*=30); day of surgery			-	+, -, -, -		
Kim *et al.*, 2015[47]	II	RCT	117, 2–7 yr, elective surgery	Cartoon video on smartphone (*n*=34); holding area to induction	Parental presence (*n*=33); at induction	STAI	mYPAS	-	+	+	-
					cartoon video on smartphone + parental presence (*n*=37); holding area to induction				+	+	
Liguori *et al.*, 2016[48]	II	RCT	40, 6–11 yr,	6 min video of clown physicians ("clickamco") application on tablet, (*n*=20); day before surgery	SHP (*n*=20); 1 day preoperative	n/a	mYPAS	n/a	+	n/a	n/a
Chow *et al.*, 2017[49]	II	RCT	40, 7–13 yr, outpatient elective surgery	20 min story-telling medicine (STM) application, (n=20); 7 days preoperatively and in holding area	SHP (*n*=20); 7–14 days before surgery	n/a	CPMAS	n/a	+	n/a	n/a

Table continued

Author(s), year	Level of evidence	Study design	Population *n*, age, surgical procedure	Intervention; time introduced	Comparison(s); time introduced	Measure(s) of anxiety		Outcome[a,b,c]			
						Parent	Children	Parent's overall anxiety	Children's overall anxiety	Children's anxiety at induction	PHBQ
Cumino *et al.*, 2017[50]	II	RCT	84, 4–8 yr, elective surgery	Smartphone game applications (*n*=21); holding area	SHP (*n*=21); holding area	n/a	mYPAS	n/a	+	+	n/a
					Informational leaflet (*n*=21); holding area				-	-	
					Smartphone game applications + informational leaflet (*n*=21); holding area				-	-	
Marechal *et al.*, 2017[51]	II	RCT	118, 4–10 yr, ambulatory surgery	Tablet game applications (*n*=60); 20 min before surgery	Midazolam (*n*=58); 20 min before surgery	STAI	mYPAS	-	-	-	-
Internet or web-based programs											
Campbell *et al.*, 2005[52]	II	RCT	198, 3–10 yr, dental surgery	Interactive computer package (*n*=63); before entering OR	SHP (*n*=66); before entering OR	n/a	VAS, MCDAS**	n/a	-, n/a	+, n/a	n/a
					Paper-based cartoon (*n*=63); before entering OR			n/a	+, n/a	-, n/a	
O'Conner-Von, 2008[53]	II	RCT	66, 10–16 yr, elective tonsillectomy	Internet preparatory program (*n*=28); 72 hr preoperatively	SHP (*n*=14); 1 week preoperatively	STAI	STAIC	-	-	n/a	n/a
					No treatment (*n*=24)			n/a	n/a		
Fortier *et al.*, 2015[54]	II	RCT	82, 2–7 yr, outpatient selective surgery	Web-based tailored intervention for preparation of parents and children undergoing surgery (WebTIPS) (*n*=38); 7 days pre- and postoperatively	SHP (*n*=44); n/a	STAI	mYPAS	+	+	+	n/a
Virtual reality											
Kerimoglu *et al.*, 2013[55]	II	RCT	96, 4–9 yr, ambulatory surgery	Video glasses connected to portable media player (*n*=32); day of surgery	0.3mg·kg^{-1} oral midazolam (*n*=32); day of surgery	n/a	mYPAS, heart rate	n/a	-, -	-, -	n/a

Table continued

Author(s), year	Level of evidence	Study design	Population *n*, age, surgical procedure	Intervention; time introduced	Comparison(s); time introduced	Measure(s) of anxiety: Parent	Measure(s) of anxiety: Children	Outcome[a,b,c]: Parent's overall anxiety	Outcome: Children's overall anxiety	Outcome: Children's anxiety at induction	Outcome: PHBQ
					video glasses + midazolam (*n*=32); day of surgery				-, -	-, -	

DS = descriptive study; n/a = not applicable; NRS = non-randomized-controlled study; N/S = not specified; OR = operating room; PP = parental presence; RCT = randomized-controlled trial; SHP = standard hospital preparation; **Baseline measure of trait anxiety

APAIS = Amsterdam Preoperative Anxiety and Information Scale; CC = Coping Cards; CMAS = Children's Manifest Anxiety Scale; CPMAS = Children's Perioperative Multidimensional Anxiety Scale, CSWQ = Child Surgery Worries Questionnaire; EASI = Emotionality, Activity, Sociability, and Impulsivity Temperament Scale; EAS-P = Emotionality, Activity, Sociability Temperament Survey for Children: Parental Reports; ED = emergence delirium (also referred as Post Anesthesia Emergence Delirium; PAED); FAS = Facial Affective Scale, HFRS = Hospital Fears Rating Scale, HFD = Human Figure Drawing Test, IAQ = Imagery Assessment Questionnaire, ICC = Induction Compliance Checklist, MBSS1 = Miller Behavioural Style Scale, MBSS2 = Monitor Blunter Style Scale, MCDAS = Modified Child Dental Anxiety Scale, MACL = Mood Adjective Check List, mYPAS = Modified Yale Preoperative Anxiety, ORSA = Observer Rating Scale of Anxiety, PARS = Parent Anxiety Rating Scale, PHBQ = Post Hospitalization Behaviour Questionnaire, PSI = Palmer Sweat Index, SALT = Standard Anesthetic Learning Test, SAM = Self-Assessment Manikin, SCSI-P = Schoolagers' Coping Strategies Inventory: Parental Version, STAI = Spielberger's State-Trait Anxiety Inventory, STAIC = State-Trait Anxiety Inventory for Children, VAS = Visual Analogue Scale; VPT = Venham Picture Test

a + indicates intervention better than comparison

b – indicates no difference between intervention and comparison

c * indicates comparison better than intervention

d No statistical test was conducted because of extremely small sample size

participants to use the intervention both pre- and postoperatively.[26,29,31] For example, Huth *et al.*[29] advised participants to listen to the mental imagery audiotape after surgery to help manage postoperative pain and discomfort. For Internet- or web-based interventions, the duration and frequency of the individual programs could not be determined because of the flexibility of the participants' usage.

Anxiety scales

Levels of anxiety were measured in both children and parents in 18 studies; anxiety was measured in only children in 16 studies, in only parents in three studies, and in neither children nor parents in one study (an alternative measure includes the Global Mood Scale)[10] (see Table). There was a large variance in the specific measures used to measure anxiety in children. These include empirically validated self-report measures (FACES rating scale[56,57]; Human Figure Drawing Test[58]; State-Trait Anxiety Inventory for Children [STAIC][59]; and Venham Picture Test),[60] observer- or parent-rated (Anxiety Scale[61]; Children's Manifest Anxiety Scale[62]; Children's Perioperative Multidimensional Anxiety Scale [CPMAS][63]; Child Surgery Worries Questionnaire [CSWQ][64]; Hospital Fears Rating Scale [HFRS][11]; modified Yale Preoperative Anxiety [mYPAS][65]; Observer Rating Scale of Anxiety [ORSA][11]; and Visual Analogue Scale [VAS]),[66] and/or physiologic (Palmer Sweat Index [PSI][67]; serum cortisol, heart rate; and electromyography) measures of anxiety. Despite the wide variance in psychometric tools, mYPAS[65] was the most widely used test of children's anxiety in the studies reviewed (i.e., 14 of 34 studies). The observer-rated measure consists of 27 items in five categories of behaviour: 1) activity, 2) emotional expressivity, 3) state of arousal, 4) vocalization, and 5) use of parents. As the gold standard to measure child's level of anxiety in the preoperative setting, mYPAS[65] has showed good construct validity[65] and interrater reliability.[29,68] The measures used to assess parents' anxiety and their time of administration were inconsistent across studies. These included empirically validated self-report measures (e.g., Amsterdam Preoperative Anxiety and Information Scale [APAIS][69]; Mood Adjective Check List [MACL][70]; ORSA[11]; Parent Anxiety Rating Scale [PARS][71]; Spielberger's State-Trait Anxiety Inventory [STAI][72]; and VAS),[66] general anxiety questionnaires or rating scales, and/or physiologic measures (e.g., blood pressure, heart rate, and PSI).[67] The STAI[72] was the most widely used instrument to measure parents' anxiety levels in the studies reviewed (i.e., 18 of 21 studies) preoperatively. This questionnaire is comprised of two separate 20-item, self-

report rating scales for measuring trait (dispositional) and state (situational) anxiety. The psychometric properties of the STAI[72] have been well validated in previous studies.[48,67]

Risk of bias within studies

Level of evidence was used to assess the potential for bias within individual studies (Table).[39] All five non-randomized studies showed a moderately high risk of bias (level III). Thirty-three RCTs showed a moderately low risk of bias (level II), with none of them reaching low risk (level I). Though many RCTs met the criteria for a good quality RCT (allocation concealment and adequate sample size), they were not double-blinded. Of the 33 RCTs, only 11 were single-blinded for outcome assessment and 22 were neither double- nor single-blinded.

Outcomes

The Table provides a summary of the individual study outcomes including overall children's and parents' anxiety during the entire surgical experience, child's anxiety level at anesthetic induction, and post-hospitalization behaviour (as measured by the PHBQ).[38] Overall anxiety outcomes represent anxiety measures collected across multiple time-points during the surgical experience (i.e., at admission, separation from parent prior to entering the OR, in the OR, or after the surgical procedure). The effectiveness of the intervention is presented according to whether anxiety levels in the intervention group were significantly reduced (+), remained the same (-), or increased (*) compared with the comparative control(s).

Children's anxiety levels

A total of 34 studies examined preoperative anxiety in children. There were 29 RCTs and five non-randomized-controlled studies. Twelve videos, seven videos with additional skill training material, 12 tablet or handheld devices, three Internet- or web-based interventions, and one virtual reality tool were evaluated. Individual study outcomes were further examined by the type of intervention (video, video + additional practice, tablet or handheld devices, or Internet- or web-based) and their comparative experimental or control groups. Of the 34 studies, 25 reported significantly lower anxiety levels in one or more anxiety measures for the experimental group compared with the control(s). In addition, of these 25 studies that observed an overall reduction in anxiety, ten studies reported a significant reduction specifically at anesthetic induction (see Table).

Preoperative preparation videos (n = 11)

Of the 11 studies[11-17,19,21,22,24] that examined the anxiolytic effect of preoperative preparation videos in children with a comparative experimental or control group, a significant decrease in anxiety in the experimental group was observed in seven studies.[11,14,15,17,19,21,24] When compared with SHP, four studies (three RCTs[14,15,24] and one NRS)[21] reported a significant reduction in preoperative anxiety while three studies (one RCT[22] and two NRSs)[13,16] reported no significant differences between groups. For example, the RCT by Pinto and Hollandsworth[15] showed that viewing a preoperative preparation video one hour prior to admission significantly reduced anxiety measured by PSI,[67] HFRS,[11] and ORSA[11] at preoperative assessment compared with control patients that did not view a video. Peterson *et al.*'s[14] RCT showed a significant difference in observer-behaviour rating and checklist when comparing an informative peer-modeling videotape with SHP. Children in the SHP control group reported more distress and maladaptive responses than the treatment group. In contrast, Berghmans *et al.*'s[22] RCT showed no significant differences in child anxiety (measured by VAS)[66] between groups that received a peer-modeling video *vs* SHP. Further, two NRSs showed no significant between-group differences in anxiety for those who were preoperatively prepared by a slide show (e.g., traditional explanation or narration of coping-model) *vs* SHP[13] and those prepared by a peer-narrated preoperative preparation video *vs* SHP.[16]

Inconsistent results were observed across the four studies[11,12,14,24] that compared preoperative preparation videos with a non-medical-related video (e.g., entertainment-based video such as *Living Things are Everywhere*[11] *or Starship Access*),[12] or non-informative preoperative intervention[14,24] in children. In an RCT by Fernandes *et al.*,[24] significantly lower levels of anxiety (measured by the CSWQ)[64] for the experimental group who received the preoperative education (via either video, board game, or booklet) *vs* those who received non-informative entertainment material or a control group that did not receive either were observed. No statistical difference within the experimental group was observed, potentially suggesting that no one type of preoperative education (videos, board game, or booklet) was more effective. In one NRS, Melamed and Siegel[11] reported significant reductions in anxiety (PSI,[67] HFRS,[11] and ORSA)[11] in the experimental group who viewed a peer-modeling preoperative preparation video compared with the control group. In contrast, RCTs by Ferguson[12] and Peterson *et al.*[14] did not observe differences in anxiety between experimental groups that received a preoperative peer-modeling video or non-medical-related video. Similar to the results obtained by Fernandes *et al.*,[24] Peterson *et al.*

reported no differences in anxiety based on the mode of informative preoperative program (video *vs* puppetry).

Three studies[14,19,21] examined the mode of preoperative information delivery by comparing anxiety levels in children who received educational videos with anxiety levels in children exposed to educational puppetry,[14] pamphlets,[19] or booklets.[21] Zuwala and Barber's[19] RCT showed significantly lower parent-rated anxiety postoperatively in the experimental group that received an informative video and pamphlet compared with the group that received a pamphlet alone. In an NRS, Karabulut and Arikan[21] found that preoperative training with a video was a more effective method to reduce self-reported anxiety in children (measured by the STAIC)[59] than an educational booklet or SHP. Nevertheless, group differences were not observed in children receiving preoperative information by video or puppetry.[14]

Preoperative preparation videos and additional practice (n = 7)

Of the seven studies[25-31] that examined the combined use of preoperative video clips and complementary learning material (e.g., booklet, audiotape, and handouts), a significant decrease in anxiety was observed in six studies[5,27-31] as a function of the combined, more extensive program. Two studies (one RCT[30] and one NRS)[27] that compared an extensive preoperative program with SHP both reported a significant reduction in the intervention group. For example, an NRS by Ellerton and Merriam[27] observed significantly lower preoperative anxiety on the FACES Rating Scale[56] in children that received the intervention program (video + hospital tour + informational handout) compared with those receiving SHP.

Three out of the four studies[25,26,28,31] supported a more extensive preparation program with a form of technology incorporated when comparing individual components of the program or more frequent practice of the program. In an RCT, Zastowny *et al.*,[25] reported lower anxiety for those in the program with informative preoperative video, anxiety-reducing techniques, and coping skills than with each component alone. In an RCT by Kain *et al.*,[28] children in the most extensive program (OR tour + peer-modeling video + Child Life preparation) exhibited lower anxiety (measured by VAS)[66] in the preoperative holding area than the OR tour alone or the OR tour and peer-modeling video. Further support for the benefit of additional, at-home preparation was observed in a study that incorporated a preparation booklet to be reviewed and practiced at home as frequently as desired leading up to the surgery.[31] In this RCT, Wakimizu *et al.*[31] observed significantly lower anxiety levels measured by the FACES Rating Scale[56] in children that received a preoperative video and complementary booklet to view at home compared with those viewing the same preoperative video once prior to hospitalization. Contrary to the above findings, an RCT by Robinson and Kobayashi[26] did not find significant differences between groups that watched a peer-modeling video alone or watched a peer-modeling video with child coping skills, relaxation audiotape, and informational booklet.

Two studies[29,30] that compared extensive preoperative programs with controls (drawing book,[29] PP,[30] or oral midazolam)[30] both supported use of the intervention. In an RCT by Huth *et al.*,[29] children who received a mental imagery booklet and audiotape along with a preoperative video reported significantly lower anxiety postoperatively (measured by the STAIC)[59] than those who received a drawing book for distraction. Kain *et al.*'s[30] RCT showed significantly lower observer-rated anxiety (measured by the mYPAS)[65] in the experimental group receiving the extensive ADVANCE program compared with comparison groups (SHP, PP, or midazolam). The ADVANCE program consisted of anxiety-reduction skill development, distraction, video-modeling, education, PP, no excessive reassurance, coaching, and exposure. Children in the ADVANCE group were significantly less anxious than the SHP and PP groups during anesthetic induction, but not when compared with the midazolam group.

Tablet or handheld devices (n = 12)

Of the 12 studies[40-51] that examined tablet or handheld device interventions, eight[40-44,47,50,51] tablets or handheld devices consisted of non-medical-related information intended to be a distraction tool and four[41-43] tablets or handheld devices consisted of preoperative information. Overall, ten studies[45,46,48,49] reported between-group differences. Seven[40-44,47,50] of the eight studies[40-44,47,50,51] that examined the anxiolytic effect of tablet or handheld-based distraction found reduced anxiety in the intervention group. Three studies[41,42,50] comparing distraction videos on tablet or handheld devices with SHP observed reduced anxiety in the intervention group. In an RCT, Mifflin *et al.*[41] reported that children who streamed a video clip from YouTube in the OR exhibited significantly lower observer-rated anxiety (measured by the mYPAS)[65] during anesthetic induction than the control group that was exposed to anesthesiologists' usual distraction techniques (e.g., imagery, storytelling, game-playing, non-procedural talk, or humour). An RCT conducted by Lee *et al.*[42] examined the anxiolytic effect of animated cartoon on a tablet personal computer, child's favourite toy, or control condition. Compared with the other groups, children in the

animated cartoon group had the lowest observer-rated anxiety (as measured by the mYPAS)[65] and parent-reported VAS[66] scores at anesthetic induction. In addition, fewer children in the cartoon group had an increase in mYPAS[65] and VAS[66] scores from preoperative holding to the OR, than children in the other groups. Similarly, an RCT Cumino *et al.*[50] reported significantly reduced anxiety in the OR in children who played a game on a smartphone compared with children who received SHP. Nevertheless, no differences between groups were observed when comparing children who received smartphone intervention with those receiving an informational leaflet.

Four studies[40,42,47,50] compared an interactive distraction tool with non-pharmacologic comparative controls (PP,[40,47] toy,[42] and informational leaflet).[50] Studies that compared the intervention with PP reported a significant reduction in anxiety in the experimental group while studies employing toys and informational leaflets saw no significant group differences. For example, in an RCT, Patel *et al.*[40] showed that children who played a handheld video game while their parent was present in the OR had significantly lower observer-rated anxiety (measured by the mYPAS)[65] at induction than children who received PP alone. Similarly, in an RCT, Kim *et al.*[47] reported lower anxiety levels (measured by mYPAS)[65] in the intervention group that watched a cartoon video on a smartphone alone than those who watched in the presence of a parent. Nevertheless, children in the group who were instructed to bring their favourite toy from home exhibited lower anxiety than children who viewed their favourite cartoon video on a tablet.[42]

There were inconsistent results when comparing tablet or smartphone distraction with oral midazolam. Of the four studies[40,43,44,51] comparing an interactive distraction tool, only two[43,44] reported significant differences. In an RCT, Seiden *et al.*[44] reported significantly lower observer-rated anxiety (measured by the mYPAS)[65] at anesthetic induction in children age two to 11 yr old that played video games on a tablet compared with the midazolam group. Similarly, Lee *et al.*'s[43] RCT showed that children who used a smartphone application had significantly lower observer-rated anxiety (measured by the mYPAS)[65] during anesthetic induction than children who received midazolam; nevertheless, the group that received the combination of smartphone and midazolam showed the lowest anxiety levels. In contrast, Patel *et al.*[40] and Marechal *et al.*[51] did not observe group differences between those who received a video game application *vs* oral midazolam in their RCTs.

Of the four RCTs[45,46,48,49] examining a tablet-based preoperative preparation program, three[46,48,49] showed reduced preoperative anxiety. In one RCT, Fernandes *et al.*,[46] reported significantly lower anxiety (measured by the CSWQ)[64] in children who received an interactive tablet-based peer-modeling film and activity modules compared with those receiving a popular entertainment video game or control condition. Another RCT conducted by Chow *et al.*[49] showed preliminary support for a tablet-based storytelling medicine (STM) that included a cartoon peer-narrated clip and an interactive OR storyboard that allowed the child to click and explore relevant medical equipment. Children in the experimental STM group showed significant reductions in anxiety (measured by CPMAS)[63] compared with the control that received SHP. Similarly, Liguori *et al.*[48] reported lower mYPAS[65] scores in the experimental group with access to Clickamico, an educational video-based application on a tablet than the group who received SHP when entering the OR. In contrast, Bailey *et al.*[45] did not observe group differences between children that received an informative video application on an iPad and those who received SHP in their RCT.

Internet- or web-based preoperative preparation (n = 3)

Of the three[52-54] Internet- or web-based interventions, two RCTs[52,54] reported reduced preoperative anxiety and one RCT[53] reported no difference between groups. Campbell *et al.*[52] observed significantly more coping behaviours in the experimental group that received the interactive computer program than the control group at anesthetic induction. A significant increase in coping behaviour was observed postoperatively in the computer group. The interactive computer program consisted of peer-narrated scenes that a child would encounter during a dental general anesthesia visit. In another RCT, Fortier *et al.*[54] reported significantly lower observer-rated anxiety (measured by the mYPAS)[65] in children who received the Web-based Tailored Intervention for Preparation of parents and children undergoing Surgery (WebTIPS) than those who received SHP. Specifically, the intervention group showed significantly lower anxiety entering the OR and during anesthetic induction than the control group. For the WebTIPS program, data obtained from parents in the front end of the program helps inform about anxiolytic interventions on the day of surgery. Further, the program consisted of procedural information, peer-modeling, and coping skills for both child and parent.

An RCT by O'Conner-Von[53] did not find between-group differences in state anxiety (as measured by the STAIC)[59] in adolescent participants who received an Internet-based preoperative preparation program and those that received SHP. Nevertheless, the Internet-based program was tailored for adolescents receiving ear, nose, or throat (ENT) day surgery procedures and was comprised of

procedural information about ENT outpatient surgery, postsurgical care at home, and a list of telephone numbers and available resources.

Virtual reality tools (n = 1)

One RCT[55] examined the anxiolytic effect of a virtual reality tool (via video glasses connected to a portable media player providing cartoon or movie distractions) alone, oral midazolam alone, or combination of both on the day of surgery. Kerimoglu *et al.*[55] did not find differences between groups in observer-rated anxiety (as measured by the mYPAS)[57] and heart rate. Of note, baseline anxiety levels (20 min before OR) were maintained across time for the video glasses group.

Parent's anxiety levels

Twenty-one studies examined preoperative anxiety in parents of children undergoing surgery. Nineteen were RCTs and two were NRSs. Nine videos, five videos with additional teaching material, five tablet-based interventions, and two Internet- or web-based interventions were evaluated. Of the 21 studies, 11 reported significantly lower anxiety levels in one or more measures in the experimental group than in control(s).

Preoperative preparation videos (n = 8)

Of the eight studies[12,15,18-22,24] that examined the effectiveness of preoperative videos in reducing parents' anxiety compared with a comparative experimental or control group, a significant reduction in anxiety levels in the experimental group was observed in seven studies.[12,15,18-22] When compared with SHP, preoperative videos reduced parents' anxiety in four studies.[15,20-22] In their RCT, Pinto and Hollandsworth[15] reported that parents who watched a preoperative video one hour prior to their child's admission exhibited significantly lower PSI[67] prior to surgery than parents who received SHP. Nevertheless, group differences in anxiety (measured by the PARS)[71] were not observed. McEwen *et al.*[20] and Karabulut and Arikan[21] observed significant reductions in anxiety (measured by the APAIS)[69] in parents that viewed an informational video compared with parents that received SHP. Similar results were reported by Berghmans *et al.*[22] in their RCT. In this study, parents who viewed a preoperative video showed significantly lower state anxiety before and after the OR experience (measured by the STAI[72] and APAIS[69] compared with SHP.

Two studies[12,18] that examined anxiety of parents whose children received preoperative videos, non-medical-related videos, or both. reported a significant reduction in anxiety levels in the intervention group. Cassady *et al.*[18] reported that parents whose children viewed a professionally narrated preoperative preparation video exhibited lower state anxiety (measured by the APAIS[69] and STAI)[72] than parents who viewed a non-medical-related video. Ferguson's[12] RCT results showed that parents whose children viewed a peer-modeling preparation video had significantly higher levels of happiness (measured by the MACL)[70] postoperatively than parents whose children viewed a non-medical-related video.

Two studies[19,21] that compared preoperative preparation videos with educational pamphlets or booklets both observed significantly lower anxiety in the experimental group. An RCT by Zuwala and Barber[19] showed significantly lower mean arterial pressure in the preoperative holding area and postoperatively in parents who watched an instructional video and received an information pamphlet on the day of surgery compared with parents who received only the pamphlet. Nevertheless, no statistically significant difference was observed for pulse pressure or heart rate. An NRS by Karabulut and Arikan[21] examined the anxiolytic effect of an informational video, educational booklet, or SHP without either video or booklet. State anxiety (measured by the STAI)[72] was significantly lower in parents in the video and booklet group, with the greatest decrease in the video group 24 hr before the operation.

Contrary to the above findings, an RCT by Fernandes *et al.*,[24] did not find differences in parent state anxiety (measured by the STAI)[72] in parents whose children received various educational materials (board game, video, or booklet) or non-informative entertainment materials (board game, video, or booklet).

Preoperative preparation videos and additional practice (n = 5)

Of the five RCTs,[22-24,26,27] between-group difference in parent anxiety were reported in three studies.[24,26,27] In one RCT, Kain *et al.*[28] reported significantly lower state anxiety levels (measured by the STAI)[72] in parents whose children received the most extensive program (informative OR tour + peer-modeling video + coping skill using Child Life preparation) compared with OR tour or OR tour and peer-modeling video alone, in the preoperative holding area. In addition, parents in the extensive program group showed lower diastolic and systolic blood pressure in the preoperative holding area. Similar results were reported in an RCT that examined a peer-modeling video with a complementary booklet compared with a peer-modeling video alone.[31] Parents of children that received at-home preparation using the booklet reported significantly lower state anxiety

(measured by the STAI)[72] postoperatively. Another RCT by Kain *et al.*[30] compared the extensive ADVANCE program with SHP, PP, or oral midazolam intervention. Parents whose children received the ADVANCE program showed significantly lower state anxiety (measured by the STAI)[72] in the preoperative holding area than the other three groups.

Contrary to the above findings, two RCTs[26,27] reported no significant differences between groups that received a preoperative preparation video alone, or preoperative preparation video with additional skill training. In their RCT, Robinson and Kobayashi[26] showed no significant differences in state anxiety (measured by the STAI)[72] between parents that received a peer-modeling video and coping skills training pre- and postoperatively and those parents that only received a peer-modeling video. Similarly, another RCT showed that anxiety levels (measured by VAS)[66] did not differ between parents who participated in a preoperative program (e.g., preoperative video, hospital tour, and general information handout intended to reinforce program information) and those who received SHP.[27]

Tablet or handheld devices (n = 5)

Of the five studies[41,45-47,51] that examined tablet or handheld interventions, significant between-group differences were reported in one study.[46] An RCT conducted by Fernandes *et al.*,[46] found that parents whose children received an interactive preparation program on a tablet reported significantly lower state anxiety (measured by the STAI)[72] than parents whose children received SHP. Nevertheless, similar levels of anxiety were reported in parents whose children received either the education tablet-based program or the entertainment video game. In contrast, an RCT by Mifflin *et al.*[41] did not observe between-group differences in parent state anxiety (measured by the STAI)[72] in parents whose children received video clip distraction compared with those who received standard verbal distraction. Similarly, RCTs by Bailey *et al.*,[45] Kim *et al.*,[47] and Marechal *et al.*[51] did not observe between-group differences in parent anxiety levels.

Internet- or web-based preoperative preparation program (n = 2)

Two RCTs[53,54] that examined Internet- or web-based preoperative interventions for parent anxiety reported inconsistent results compared with SHP. O'Conner-Von[53] found no difference in parent state anxiety (measured by the STAI)[72] between parents whose children viewed an Internet-based program and those who received SHP. Nevertheless, parents in the experimental group were more satisfied with their child's preparation according to the Satisfaction with Method of Preparation Questionnaire.[53]

Fortier *et al.*'s[54] RCT showed significantly lower levels of parent anxiety in the preoperative holding area for parents who received the web-based program compared with the control group. Nevertheless, group differences were not observed at other time-points, such as during separation from the preoperative holding area to the OR. Intervention adherence was high; all parents in the treatment group accessed at least one of the modules in the program.

Post-hospital behaviour

While additional child and parent outcomes were explored in the studies reviewed, this review included post-hospital behaviour (as measured by the PHBQ)[38] for a number of reasons. First, elevated preoperative anxiety at anesthetic induction is associated with development of maladaptive behaviour post-surgery[3,6,7] and these behaviours are reported to be as high as 30% in pediatric patients.[38] Second, post-hospital behaviour was the most commonly observed outcome across the studies included in the review. The PHBQ[38] is a 27-item parent-rated questionnaire designed to evaluate the six most frequently arising behaviours in children: 1) general anxiety and regression, 2) separation anxiety, 3) anxiety about sleep, 4) eating disturbances, 5) aggression towards authority, and 6) apathy withdrawal.[61] Secondary outcomes of PHBQ[38] were observed in seven studies. While Abrams[13] used a modified 19-item version of the PHBQ,[38] we included the comparable value of the measure in the review. Of the seven studies[12,13,28,40,44,47,51] that examined post-hospital behaviour with the PHBQ,[38] outcomes were collected two days after surgery in one,[13] one to seven days in one,[47] seven to ten days in two,[12,40] seven and 14 days in two,[44,51] and 14 days in one.[28] Of the seven studies, six[13,28,40,44,47,51] did not see a difference in postoperative behaviour between experimental and comparative groups. Patel *et al.*[40] suggest that this may be because all parents in their study were present during anesthetic induction and this may have reduced the likelihood of separation anxiety, which is a common maladaptive behaviour during the postoperative period. In one RCT,[12] significantly lower rates of newly developed maladaptive behaviour were reported in the intervention groups.

Discussion

The objective of the present study was to systematically review studies that examined the efficacy of technology-

based preoperative interventions to address anxiety in pediatric patients receiving elective surgery under general anesthesia and their parents. The present study represents the most up-to-date comprehensive review of the available studies examining the efficacy of technology-based preoperative programs and the effects on both pediatric patients and their parents. Of the total 38 studies included in this review, preoperative anxiety was reduced in children and parents in 25 and 11 studies, respectively. Of the 18 studies that examined preoperative anxiety in both children and parents, eight studies reported significant reductions in anxiety in both children and parents. Our findings showed that all types of technology-based interventions reduced anxiety in children at various levels, but employing tablet and handheld devices had the most consistent effects on anxiety in children. Specifically, ten of 12 of these studies reported significant effects.[45,46,48,49] In terms of study characteristics, all studies employed an RCT design and showed a moderately low risk of bias. Further, the effect of this intervention on anxiety was measured consistently in the reviewed studies—ten of 12 studies utilized the observer-rated mYPAS[65] to assess child anxiety. That said, the content or purpose of the tablet or handheld device intervention was variable. The majority (eight studies) of studies used the intervention primarily to distract, while the remaining four studies utilized this type of technology to deliver a preoperative preparation program. In turn, the non-pharmacologic comparison groups were also variable. These included SHP, informational leaflets, PP, entertainment video games, toys, and verbal distraction. There were inconsistent results when comparing tablet or smartphone interventions with oral midazolam. Results from two RCTs[43,44] showed that playing with an interactive tablet or handheld device in the preoperative period may be as effective as midazolam in reducing preoperative anxiety. These results suggest that the interactive aspects of tablet-based distractions (e.g., video games, smartphone apps, or cartoon video clips) or education (e.g., activity modules or interactive OR storyboards) may be an important consideration in the selection and development of interventions to reduce preoperative anxiety in children. Additional strengths of this approach include the ease of administration, familiarity to the child and parent, accessibility of the product, and low cost of resources. This is not to say that midazolam is not an efficacious anxiolytic nor a cost-effective intervention option; but midazolam has some drawbacks (e.g., memory disturbances)[73] making non-pharmacologic interventions such as smartphones or tablets potentially more favourable options. This speculation requires further evaluation.

Unlike the findings in children, the findings in adults are less straightforward. Preoperative preparation videos were more widely examined and seemingly more effective than SHP, non-medical-related videos, or informational pamphlets/booklets. Although one study did not find between-group differences in the type (board game, video, or booklet) or content (educational or non-informative) of the intervention, parents' anxiety (measured by the STAI)[72] may have been influenced by the child's engagement with the activity.[24] For example, parents of children that received non-informative material may have reported similar levels of anxiety as those who were in the experimental conditions (e.g., board game, video, or booklet) when watching their child engaged and distracted by the activity. Fernandes *et al.*,[46] also found that parents in the experimental comparison (entertainment video game) groups showed similar low levels of anxiety as those in the control group. Anxiety outcomes from studies comparing preoperative preparation videos with additional practice materials were inconsistent. One study[22] examining the use of a preoperative preparation video, additional parent and child coping skills, and a relaxation audio tape did not show significant reductions in parent state anxiety (measured by the STAI,[72] ORSA,[11] and a parent diary). Yet, significant reductions in parent anxiety were observed in other studies that combined the use of preoperative preparation videos with child coping skills[24] or daily practice booklets for the child.[27] Variations in findings may be due to variability in video content but may also reflect the manner in which the parent or child is engaged in the preparation (e.g., level of parent facilitation in completing the tasks and/or skill practice and acquisition). That said, it is important to consider that there was significant variability in methodology (i.e., RCT and NRS), video content, level of bias, anxiety measurement, and comparators (e.g., SHP, non-medical-related videos, or informational pamphlets/booklets) across these studies. This variability makes it difficult to make definitive conclusions. The anxiolytic effect of tablet-, Internet- or web-, or virtual reality-based interventions on parental anxiety were also difficult to discern because of the limited number of studies evaluating parents' anxiety as an outcome measure.

Preoperative preparation videos with additional practice material(s) reduced preoperative anxiety in children in five of the six studies. In contrast to parents, evidence suggests that educational materials (e.g., Child Life preparation, imagery booklet, or audiotape) that facilitate learning of preoperative information and inclusion of acquisition and rehearsal or practice of relevant skills (e.g., coping strategies) appear more effective for children than passive viewing of a preoperative preparation video. Albeit, this subset of studies presents us with similar methodologic concerns articulated earlier (i.e., variability in study characteristics). With respect to the frequency of intervention, many of these studies recommended the

children and parents practice coping skills and relaxation techniques once a day for a week leading up to the surgery; as such there is likely variability in the frequency of practice. Despite the likely variability in coping skills practice, significant positive effects of these combined interventions were observed. There is some support for anxiolytic effect of Internet- or web-based interventions with interactive components as two of the three RCT reported lower child anxiety after exposure to Internet- or web-based intervention. It is important to note that very few efficacy studies have examined Internet- or web-based interventions as this research is in its infancy. Nevertheless, these programs, at least the most recently developed programs (e.g., WebTIPS)[54] are comprehensive, evidence-based, interactive Internet-delivered preoperative programs that provide relevant information regarding surgery, anesthesia, and anxiety that can be accessed and completed in the convenience of the children's and parents' homes. Additional research is required to allow us to assess the efficacy of this approach more thoroughly.

Limitations

This review has several limitations. First, there is a large variance in the type of anxiety measures employed across studies. Of the 38 studies, four studies[10,13,14,16] did not use a validated psychometric measure of anxiety. Rather, professional ratings or opinions of the children's anxiety levels were used to assess the impact of the intervention. The 34 studies that employed a validated measure of anxiety as the outcome differed in the type and combination of measures, including self-report, observer-rated, behavioural, and physiologic measures. In addition, the time-point of measure completion or administration was inconsistent across studies, ranging from three weeks prior to surgery, to various time-points during the day of surgery, to two weeks postoperatively. Of the 34 studies that examined preoperative anxiety in children, only 16 studies examined anxiety levels during anesthetic induction, a period when anxiety has consistently and robustly peaked in surgical patients.[2,3,8] Nevertheless, the current review did not restrict the inclusion of studies based on the type of psychometric measures employed to capture the multidimensional nature of anxiety and expanded the type of studies reviewed.

Second, the timing, duration, and frequency of the interventions were inconsistent across studies. A review of the literature showed that the type of intervention did not determine the timing of the application; for example, Internet- or web-based programs or videos were not necessarily distributed to the patient earlier than a tablet or handheld device would have been. Thus, the anxiolytic effect (i.e., timing, duration, and frequency) of the technology-based interventions could not be determined nor generalized for the type of interventions.

Third, evaluation of some study findings should be viewed conservatively in light of small sample sizes and heterogeneous demographic factors. For example, one RCT conducted by Robinson and Kobayashi[26] used a small sample size (n = 28) with a predominate number of participants in the intervention group that had previous experience of hospitalization (nine out of ten participants). In another RCT, O'Conner-Von[53] observed a non-treatment group (n = 24) that only received preoperative preparation on the day of surgery. The high attrition rates in participants that received the SHP and reasons for non-attendance (e.g., too busy to go into hospital [40%], other commitments [15%], out of the city [15%], issues with finding child care for siblings [10%], unable to go into hospital [5%])[45] suggests that Internet-based preoperative preparation (i.e., preoperative preparation that does not require a pre-hospital visit) may be an effective strategy. Overall, future studies should seek to employ more robust methodologies (i.e., adequate randomization and appropriate sample size) and accessible intervention strategies.

Fourth, there was high variability in the comparative control groups within studies, ranging from SHP, unrelated control film, PP, midazolam, and/or non-technology-based interventions. In addition, although half the studies employed SHP as the control arm, hospital treatment is not standardized across all hospital or surgical settings, so we cannot be sure what interventions were provided to participants in the SHP groups.

Lastly, observer bias was a limitation of studies that utilize only an observer-rated measure, such as the mYPAS,[65] to assess the efficacy of the intervention.[40,44,48,50] While mYPAS[65] is a gold standard measure of observer-rated child anxiety, observer bias may exist in studies that could neither be single- nor double-blinded. Observer bias was reduced in studies that blinded the assessors (e.g., first and/or secondary raters) to the experimental conditions; nevertheless, observer bias may not have been completely mitigated in studies that used parent-rated measures of child anxiety or post-hospital behaviour (e.g., VAS[66] or PHBQ).[38] Since the parents could not be blind to the type of intervention, anticipation of the effects of the intervention may have impacted their assessment of their child's anxiety levels or behaviour.

Clinical implications

The present study represents the most up-to-date comprehensive review of the available studies examining the efficacy of technology-based preoperative programs and the effects on both pediatric patients and parents. Our

findings have provided a number of directions for future research and the clinical application of these programs. Keeping in mind the limitations outlined above, tablet or handheld devices with interactive components represent the strategy with the most encouraging evidence for children. While our review appears to provide evidence to suggest that preparation videos alone may represent a sufficient strategy to manage preoperative anxiety in parents, the studies (and relevant study characteristics) reviewed are extremely heterogeneous, therefore limiting our ability to draw definitive conclusions. Technology as a mode of delivery for preoperative preparation for children and their parents can facilitate an easily accessible, low cost preparation option delivered from a platform that is well-known to the general population.[74] Nevertheless, the content of the intervention delivered via technology requires further attention. Execution of well-designed, methodologically sound studies is required to facilitate a better understanding of the efficacy of technology-based preoperative preparation in general. It would also be advantageous to come to a consensus about choice of assessment measures and comparators to facilitate more fruitful cross study comparisons.

Disclaimer The views expressed in this article are the authors' own and not an official position of the institution or funder.

Conflicts of interest None declared.

Editorial responsibility This submission was handled by Dr. Philip M. Jones, Associate Editor, Associate Editor, *Canadian Journal of Anesthesia.*

Author contributions *Jinsoo Kim* contributed to acquisition of the data, analysis of the data, interpretation of the data, and design of the manuscript. *Natasha Chiesa* contributed to the acquisition of the data. *Mateen Raazi* contributed to the conception and design of the manuscriptstudy. *Kristi D. Wright* contributed to all aspects of this manuscriptstudy, including conception and design; acquisition, analysis, and interpretation of data; and drafting the article.

Source of support This research was conducted with financial support from a research scholarship supported through funding from the Jim Pattinson Children's Hospital Foundation (#96000024).

APPENDIX Search strategy (Medline)

1. ANXIETY/ or DENTAL ANXIETY/ or FEAR/ or PANIC/
2. (anxiet* or anxious).tw.
3. nervousness.tw.
4. fear.tw.
5. panic.tw.
6. distress.tw.
7. STRESS, PSYCHOLOGICAL/
8. ((emotional or psychological) adj1 stress*).tw.
9. PSYCHOLOGICAL TRAUMA/
10. (feel* adj2 (apprehens* or dread or worry or terror)).tw.
11. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10
12. GENERAL SURGERY/ or UROLOGY/
13. (surg* or operat*).tw.
14. PERIOPERATIVE CARE/ or PREOPERATIVE CARE/
15. AMBULATORY SURGICAL PROCEDURES/
16. ((surg* or pre-surg* or operat*) adj1 (procedures or preparation or care)).tw.
17. (preop* or preoperat* or pre-op* or periop* or peri-op*).tw.
18. ((medical or dental or patient) adj1 preparation).tw.
19. SURGICAL PROCEDURES, OPERATIVE/ or ELECTIVE SURGICAL PROCEDURES/
20. (preoperative adj1 (preparation or relaxation or intervention or educat*)).tw.
21. 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20
22. EDUCATIONAL TECHNOLOGY/
23. "tech*".tw.
24. ELECTRONICS/ or ELECTRONICS, MEDICAL/
25. "electronic*".tw.
26. "distract*".tw.
27. "cartoon*".tw.
28. COMPUTER SIMULATION/ or VIRTUAL REALITY/
29. computer simulation.tw.
30. COMPUTER-ASSISTED INSTRUCTION/ or INTERNET/
31. "animat*".tw.
32. TELEVISION/ or VIDEODISC RECORDING/ or VIDEOTAPE RECORDING/
33. television.tw.
34. ((videodisc or videotape or tape) adj1 recording).tw.
35. COMPACT DISKS/ or CD-I/ or CD-ROM/
36. (compact disks or cd-I or cd-rom).tw.
37. HEALTH EDUCATION/ or HEALTH EDUCATION, DENTAL/ or PATIENT EDUCATION AS TOPIC/
38. broadcast.tw.
39. SOFTWARE/ or MOBILE APPLICATIONS/ or USER-COMPUTER INTERFACE/ or VIDEO GAMES/ or WEB BROWSER/ or HYPERMEDIA/
40. software.tw.
41. HEALTH KNOWLEDGE, ATTITUDES, PRACTICE/ or "TREATMENT ADHERENCE AND COMPLIANCE"/
42. VIDEO-AUDIO MEDIA/ or "INSTRUCTIONAL FILMS AND VIDEOS"/ or INTERACTIVE TUTORIAL/ or WEBCASTS/
43. (hypermedia or media based or video-audio media or multimedia or media).tw.

44. video games.tw.
45. (visual aid* or audiovisual aid*).tw.
46. "video*".tw.
47. (cellular phone or smartphone or handheld device*).tw.
48. (Internet or web).tw.
49. "app*".tw.
50. "story book*".tw.
51. (tablet or handheld device*).tw.
52. 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51
53. (pediatric* or p?ediatric*).tw.
54. "child* or kids".tw.
55. (school adj1 (child* or age*)).tw.
56. preschool.tw.
57. "toddler*".tw.
58. (adoles* or teen*).tw.
59. (boy* or girl*).tw.
60. "minors*".tw.
61. (pubert* or pubescen* or prepubescen*).tw.
62. ((primary or elementary or secondary or high) adj1 school*).tw.
63. (parent* or guardian*).tw.
64. mother.tw.
65. father.tw.
66. 53 or 54 or 55 or 56 or 57 or 58 or 59 or 60 or 61 or 62 or 63 or 64 or 65
67. 11 and 21 and 52 and 66
68. limit 67 to english language

References

1. *Davidson A*, *McKenzie I*. Distress at induction: prevention and consequences. Cur Opin Anaesthesiol 2011; 24: 301-6.
2. *Kain ZN, Mayes L, O'Connor TZ, Cicchetti DV*. Preoperative anxiety in children. Predictors and outcomes. Arch Pediatr Adolesc Med 1996; 150: 1238-45.
3. *Kain ZN*, *Caramico LA*, *Hofstadter MB*. Distress during the induction of anesthesia and postoperative behavioral outcome. Anesth Analg 1999; 88: 1042-7.
4. *Kain ZN*, *Mayes LC*, *Caldwell-Andres AA*, *Karas DE*, *McClain BC*. Preoperative anxiety, postoperative pain, and behavioural recovery in young children undergoing surgery. Pediatrics 2006; 118: 651-8.
5. *McCann ME*, *Kain ZN*. The management of preoperative anxiety in children: an update. Anesth Analg 2001; 93: 98-105.
6. *Caumo W*, *Broenstrub JC*, *Fialho L*, *et al*. Risk factors for postoperative anxiety in children. Acta Anaesthesiol Scand 2000; 44: 782-9.
7. *Kain ZN*, *Caldwell-Andrews AA*, *Maranets I*, *et al*. Preoperative anxiety and emergence delirium and postoperative maladaptive behaviors. Anesth Analg 2004; 99: 1648-54.
8. *Wright KD*, *Stewart SH*, *Finley GA*, *Buffett-Jerrott SE*. Prevention and intervention strategies to alleviate preoperative anxiety in children: a critical review. Behav Modif 2007; 31: 52-79.
9. *Kain ZN, Wang SM, Caldwell-Andrews AA, Smith G, Saadat H*. Pre-surgical preparation programs for children undergoing outpatient surgery: current status. Anesthesiology 2006; 105: A955 (abstract).
10. *Vernon DT*, *Bailey WC*. The use of motion pictures in the psychological preparation of children for induction of anesthesia. Anesthesiology 1974; 40: 68-72.
11. *Melamed BG*, *Siegel LJ*. Reduction of anxiety in children facing hospitalization and surgery by use of filmed modeling. J Consult Clin Psychol 1975; 43: 511-21.
12. *Ferguson B*. Preparing young children for hospitalization: a comparison of two methods. J Am Acad Child Psychiatry 1980; 19: 540-1.
13. *Abrams L*. Resistance behaviors and teaching media for children in day surgery. AORN J 1982; 35: 244-58.
14. *Peterson L*, *Schultheis K*, *Ridley-Johnson R*, *Miller DJ*, *Tracy K*. Comparison of three modeling procedures on the presurgical and postsurgical reactions of children. Behav Ther 1984; 15: 197-203.
15. *Pinto PR*, *Hollandsworth JG Jr*. Using videotape modeling to prepare children psychologically for surgery: influence of parents and costs versus benefits of providing preparation services. Health Psychol 1989; 8: 79-95.
16. *Durst LM*. Preoperative teaching videotape. The effect on children's behavior. AORN J 1990; 52: 576-84.
17. *Faust J*, *Olson R*, *Rodriguez H*. Same-day surgery preparation: reduction of pediatric patient arousal and distress through participant modeling. J Consult Clinc Psychol 1991; 59: 475-8.
18. *Cassady JF Jr*, *Wysocki T*, *Miller KM*, *Cancel DD*, *Izenberg N*. Use of a preanesthetic video for facilitation of parental education and anxiolysis before pediatric ambulatory surgery. Anesth Analg 1999; 43: 246-50.
19. *Zuwala R*, *Barber KR*. Reducing anxiety in parents before and during pediatric anesthesia induction. AANA J 2001; 69: 21-5.
20. *McEwen A*, *Moorthy C*, *Quantock C*, *Rose H*, *Kavanagh R*. The effect of videotaped preoperative information on parental anxiety during anesthesia induction for elective pediatric procedures. Paediatr Anaesth 2007; 17: 534-9.
21. *Karabulut N*, *Arikan D*. The effect of different training programs applied prior to surgical operation on anxiety levels. New/Yeni Symposium Journal 2009; 47: 64-9.
22. *Berghmans J*, *Weber F*, *van Akoleyen C*, *et al*. Audiovisual aid viewing immediately before pediatric induction moderates the accompanying parents' anxiety. Paediatr Anaesth 2011; 22: 386-92.
23. *de Armendi AJ, Gillaspy SR, Martinez M, Cure JA, Butt AL, Boekman LM*. Effect of informational Spanish anesthesia video on the level of anxiety and uncertainty with Native Spanish speaking parents. A pilot study. J Okla State Med Assoc 2014; 107: 331-4.
24. *Fernandes S*, *Arriaga P*, *Esteves F*. Providing preoperative information for children undergoing surgery: a randomized study testing different types of educational material to reduce children's preoperative worries. Health Educ Res 2014; 29: 1058-76.
25. *Zastowny TR*, *Kirschenbaum DS*, *Meng AL*. Coping skills training for children: effects of distress before, during, and after hospitalization for surgery. Health Psychol 1986; 5: 231-47.
26. *Robinson P*, *Kobayashi K*. Development and evaluation of a presurgical preparation program. J Pediatr Psychol 1991; 16: 193-212.
27. *Ellerton M*, *Merriam C*. Preparing children and families psychologically for day surgery: an evaluation. J Adv Nurs 1994; 19: 1057-62.
28. *Kain ZN*, *Caramico LA*, *Mayes LC*, *Genevro JL*, *Bornstein MH*, *Hofstadter MB*. Preoperative preparation programs in children: a comparative examination. Anesth Analg 1998; 87: 1249-55.

29. *Huth M*, *Broome M*, *Good M*. Imagery reduces children's postoperative pain. Pain 2004; 110: 439-48.
30. *Kain ZN*, *Caldwell-Andrews A*, *Mayes LC*, *et al*. Family-centered preparation for surgery improves perioperative outcomes in children: a randomized controlled trial. Anesthesiology 2007; 106: 65-74.
31. *Wakimizu R*, *Kamagata S*, *Kuwabara T*, *Kamibeppu K*. A randomized controlled trial of an at-home preparation programme for Japanese preschool children: effects on children's and caregivers' anxiety associated with surgery. J Eval Clin Pract 2009; 15: 393-401.
32. *Wright K*, *Raazi M*, *Walker KL*. Internet-delivered, preoperative, preparation program (I-PPP): development and examination of effectiveness. J Clin Anesth 2017; 39: 45-52.
33. *Palermo TM*, *Wilson AC*, *Peters M*, *Lewandowski A*, *Somhegyi H*. Randomized controlled trial of an internet-delivered family cognitive-behavioral therapy intervention for children and adolescents with chronic pain. Pain 2009; 146: 205-13.
34. *Yip P*, *Middleton P*, *Cyna AM*, *Carlyle AV*. Non-pharmacological interventions for assisting the induction of anaesthesia in children. Cochrane Database Syst Rev 2009; 6(CD006447): 71-134.
35. *Chow CH*, *Van Lieshout RJ*, *Schmidt LA*, *Dobson KG*, *Buckley N*. Systematic review: Audiovisual interventions for reducing preoperative anxiety in children undergoing elective surgery. J Pediatr Psychol 2016; 41: 182-203.
36. *Chow CH*, *Wan S*, *Pope E*, *et al*. Audiovisual interventions for parental preoperative anxiety: a systematic review and meta-analysis. Health Psychol 2018; 37: 746-58.
37. *Moher D, Liberati A, Tetzlaff J, Altman DG; PRISMA Group*. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. Ann Intern Med 2009; 151: 264-9.
38. *Vernon DT, Schulman JL, Foley JM*. Changes in children's behavior after hospitalization. Some dimensions and their correlates. Am J Dis Child 1966; 111: 581-93.
39. *Wright JG, Swiontkowski MF, Heckman JD*. Introducing levels of evidence to the journal. J Bone Joint Surg Am 2003; 85-A: 1-3.
40. *Patel A*, *Schieble T*, *Davidson M*, *et al*. Distraction with a hand-held video game reduces pediatric preoperative anxiety. Paediatr Anaesth 2006; 16: 1019-27.
41. *Mifflin K*, *Hackmann T*, *Chorney JM*. Streamed video clips to reduce anxiety in children during inhaled induction of anesthesia. Anesth Analg 2012; 115: 1162-7.
42. *Lee J*, *Lee J*, *Lim H*, *et al*. Cartoon distraction alleviates anxiety in children during induction of anesthesia. Anesth Analg 2012; 115: 1168-73.
43. *Lee JH*, *Jung HK*, *Lee GG*, *Kim HY*, *Park SG*, *Woo SC*. Effect of behavioral intervention using smartphone application for preoperative anxiety in pediatric patients. Korean J Anesthesiol 2013; 65: 508-18.
44. *Seiden S*, *McMullan S*, *Sequera-Ramos L*, *et al*. Tablet-based Interactive Distraction (TBID) vs oral midazolam to minimize perioperative anxiety in pediatric patients: a noninferiority randomized trial. Paediatr Anaesth 2014; 24: 1217-23.
45. *Bailey KM*, *Bird SJ*, *McGrath PJ*, *Chorney JE*. Preparing parents to be present for their child's anesthesia induction: a randomized controlled trial. Anesth Analg 2015; 121: 1001-10.
46. *Fernandes S*, *Arriaga P*, *Esteves F*. Using an educational multimedia application to prepare children for outpatient surgeries. J Health Commun 2015; 30: 1190-200.
47. *Kim H*, *Jung SM*, *Yu H*, *Park SJ*. Video distraction and parental presence for the management of preoperative anxiety and postoperative behavioural disturbance in children: a randomized controlled trial. Anesth Analg 2015; 121: 778-84.
48. *Liguori S*, *Stacchini M*, *Ciofi D*, *Olivini N*, *Bisogni S*, *Festini F*. Effectiveness of an app for reducing preoperative anxiety in children: a randomized clinical trial. JAMA Pediatr 2016; 170: e160533.
49. *Chow CH*, *Van Lieshout RJ*, *Schmidt L*, *Buckley N*. Tablet-based intervention for reducing children's preoperative anxiety: a pilot study. J Dev Behav Pediatr 2017; 38: 409-16.
50. *Cumino DO*, *Vieira JE*, *Lima LC*, *Stievano LP*, *Silva RA*, *Matthias LA*. Smartphone-based behavioural intervention alleviates children's anxiety during anaesthesia induction: a randomized controlled trial. Eur J Anaesthesiol 2017; 34: 169-75.
51. *Marechal C, Berthiller J, Tosetti S, et al*. Children and parental anxiolysis in paediatric ambulatory surgery: a randomized controlled study comparing 0.3 mg kg^{-1}midazolam to tablet computer based interactive distraction. Br J Anaesth 2017; 118: 247-53.
52. *Campbell C*, *Hosey MT*, *McHugh S*. Facilitating coping behavior in children prior to dental general anesthesia: a randomized controlled trial. Paediatr Anaesth 2005; 15: 831-8.
53. *O'Conner-Von S*. Preparation of adolescents for outpatient surgery: using an internet program. AORN J 2008; 87: 374-98.
54. *Fortier M*, *Bunzli E*, *Walthall J*, *et al*. Web-based tailored intervention for preparation of parents and children for outpatient surgery (WebTIPS): formative evaluation randomized controlled trial. Anesth Analg 2015; 120: 915-22.
55. *Kerimoglu B*, *Neuman A*, *Paul J*, *Stefanov DG*, *Twersky R*. Anesthesia induction using video glasses as a distraction tool for the management of preoperative anxiety in children. Anesth Analg 2013; 117: 1373-9.
56. *Bieri D*, *Reeve RA*, *Champion GD*, *Addicoat L*, *Ziegler JB*. The Faces Pain Scale for the self-assessment of the severity of pain experienced by children: development, initial validation, and preliminary investigation for ratio scale properties. Pain 1990; 41: 139-50.
57. *Wong DL*, *Baker CM*. Pain in children: comparison of assessment scales. Pediatr Nurs 1988; 14: 9-17.
58. *Münsterberg Koppitz E*. Psychological Evaluation of Children's Human Figure Drawings. NY: Grune and Stratton; 1968 .
59. *Spielberger CD*. Manual for the State Trait Anxiety Inventory for Children. Palo Alto, CA.: Consulting Psychologists Press; 1973.
60. *Venham LL*, *Gaulin-Kremer E*. A self-report measure of situational anxiety for young children. Pediatr Dent 1979; 1: 91-6.
61. *Klinedinst JK*. Relationship between Minnesota multiphasic personality inventory and personality inventory for children data from mothers of disturbed children [doctoral dissertation]. [Minneapolis (USA)]. University of Minnesota; 1971.
62. *Scherer MW*, *Nakamura CY*. A fear survey schedule for children (FSS-FC): a factor analytic comparison with manifest anxiety (CMAS). Behav Res Ther 1968; 6: 173-82.
63. *Chow CH*, *Van Lieshout RJ*, *Buckley N*, *Schmidt LA*. Children's Perioperative Multidimensional Anxiety Scale (CPMAS): development and validation. Psychol Assess 2016; 28: 1101-9.
64. *Quiles MJ, Ortigosa JM, Pedroche y Sira Mendez FX*. The child surgery worries questionnaire (Spanish). Psicothema 1999; 11: 601-9.
65. *Kain ZN*, *Mayes LC*, *Cicchetti DV*, *Vagnali AL*, *Finley JD*, *Hofstadter MB*. The Yale preoperative anxiety scale: how does it compare with a" gold standard"? Anesth Analg 1997; 85: 783-8.
66. *Davey HM*, *Barratt AL*, *Butow PN*, *Deeks JJ*. A one-item question with a likert or visual analog scale adequately measured current anxiety. J Clin Epidemiol 2007; 60: 356-60.
67. *Johnson JE*, *Dabbs JM Jr*. Enumeration of active sweat glands: a simple physiological indicator of psychological changes. Nurs Res 1967; 16: 273.

68. *Kain ZM*, *Mayes LC*, *Cicchetti DV*, *et al*. Measurement tool for preoperative anxiety in young children: the Yale Preoperative Anxiety Scale. Child Neuropsychol 1995; 1: 203-10.
69. *Moerman N*, *van Dam FS*, *Muller MJ*, *Oosting H*. The Amsterdam Preoperative Anxiety and Information Scale (APAIS). Anesth Analg 1996; 82: 445-51.
70. *Radloff R*, *Helmreich R*. Groups Under Stress: Psychological Research in Sealab II. NY: Appleton-Century-Crofts; 1968 .
71. *Doris J, McIntyre A, Kelsey C, Lehman E.* Separation anxiety in nursery school children. Proceedings of the 79thAnnual Convention of APA. 1971; 79: 145-8.
72. *Spielberger CD, Gorsuch R, Lushene RE*. STAI Manual for the State-Trait Anxiety Inventory ("self-evaluation questionnaire"). Palo Alto, CA.: Consulting Psychologists Press; 1970.
73. *Stewart SH*, *Buffett-Jerrott SE*, *Finley GA*, *Wright KD*, *Valois Gomez T*. Effects of midazolam on explicit versus implicit memory in a pediatric surgery setting. Psychopharmacology (Berl) 2006; 188: 489-97.
74. *Statistics Canada*. The Internet and Digital Technology. Release date: November 14, 2017. Available from URL: https://www150.statcan.gc.ca/n1/pub/11-627-m/11-627-m2017032-eng.htm (accessed February 2019).