Acta Anaesth. Bel., 2024, 75 (3): *229-245*

Narrative review

Assessment tools used to measure postoperative behavioral changes in children, a narrative review

B. Wolfs[1], J. Berghmans[2], M. Coppens[3]

[1]University Hospital Ghent, Department of Anesthesiology and Perioperative Medicine, Corneel Heymanslaan 10, 9000 Ghent, Belgium; [2]ZNA Cadix Antwerp, Department of Anesthesiology and Perioperative Medicine, Kempenstraat 100 2030 Antwerpen; [3]University Hospital Ghent, Department of Anesthesiology and Perioperative Medicine, Corneel Heymanslaan 10, 9000 Ghent, Belgium.

Corresponding author: Britt Wolfs, University Hospital Ghent, Department of Anesthesiology and Perioperative Medicine, Corneel Heymanslaan 10, 9000 Ghent, Belgium. E-mail: britt.wolfs@uzgent.be

Abstract

Context: **Previous studies have shown a high prevalence of postoperative behavior changes in children. To assess postoperative behavior changes, various tools have been used and the understanding of their psychometric characteristics namely validity, reliability and norming is essential.**
Objective: **To provide an overview of the different assessment tools used to measure postoperative behavior changes in children and their psychometrics.**
Methods: **Data sources: MEDLINE, EMbase, Web of Science and Google Scholar.**
Study selection: inclusion of studies published between January 1995- June 2023 and searched with the following key terms: 'anesthesia', 'postoperative behavior' and 'child' and MESH terms 'postoperative period', 'behavior' and 'child'.
Data extraction and data synthesis: a data extraction form was used and due to heterogeneity, the findings are presented as a narrative review.
Results: **In the final analysis, 57 articles were withheld and 11 assessment tools identified which were used to measure postoperative behavior changes. In the majority of these studies, the Post Hospitalization Behavior Questionnaire (PHBQ) and its adaptation namely the Post Hospitalization Behavior Questionnaire for ambulatory surgery (PHBQ-AS) were used.**
Although frequently applied, the validity, reliability and norming of both questionnaires have not been well established. Other tools like the Child Behavior Checklist, the Strengths and Difficulties Questionnaire and Infant/Toddler Sensory Profile have been well validated and are reliable. However, these tools were not specifically designed for assessment of postoperative behavior changes in children after surgery.
Conclusions: **There is a lack of well validated and reliable tools to assess postoperative behavior in children both for clinical and research purposes.**

Keywords: **anesthesia, postoperative period, child, child behavior.**

Introduction

Anesthesia in children might have a profound impact on the child's behavior and is characterized by postoperative behavior changes[1-58]. Assessing such alterations in the child's behavior after surgery could be regarded as a measure of the psychological influence on the child's wellbeing [48]. These changes are often mild and transient, but still a significant proportion of children exhibits persistent behavior modifications lasting for weeks, months or even years[11,35,38,42]. Most commonly, these behavioral changes occur in children aged between 1 to 4 years and are marked by heightened vulnerability due to dependence on parents and awareness of parental absence[32,38,42,48].

Prolonged postoperative maladaptive behavioral changes in children are of concern and if they persist for an extended period they might interfere with their emotional and cognitive development or negatively affect children's responses to subsequent medical care[11,13,26,32,41].

Postoperative behavior changes include, among other, general and separation anxiety, tantrums, fear of strangers, eating problems, nightmares, night terrors and bedwetting[11,20,56].

The incidence may occur in up to 60% of all children undergoing general anesthesia and persistence is noted in 15%-40% at two weeks postoperatively[20,26,42,56].

Several potential risk factors for negative postoperative behavior have been described such as younger age, type of surgery, postoperative pain, preoperative child's state/trait anxiety, separation anxiety, increased parental state/trait anxiety, overnight admission, lower birth order, preparation through discussions with the anesthetist, pain and previous bad experiences of health care are all found to be significantly related to more behavioral chan ges[11,13,20,25,26,33,35,48,53,59].

Furthermore, common preoperative risk factors might be associated as well with emergence delirium. Some studies found that emergence delirium (not further discussed here) after surgery increased the risk for postoperative behavior changes[20,33].

Apparently, postoperative behavior changes in children are of great importance and should be assessed and monitored accordingly.

Over the past thirty years several assessment tools have been used to measure postoperative behavior changes in children and their psychometric characteristics are highly relevant because invalid, unreliable or nonnormative tests can lead to inaccurate estimations and make comparisons between studies extremely difficult[41].

When using a questionnaire or an observation tool, it is vital to know the psychometric characteristics of the instruments, namely: validity, reliability and norming.

1. Validity is defined by the accuracy of a measure or whether the instrument assesses what it is supposed to measure and the following four criteria should be fulfilled[60]:

a. Face validity which indicates whether the test includes appropriate items that measure what should be measured, for example the question 'Does your child need a pacifier?' is a good question for one year old children but not for eight year olds 41;

b. Validity of content which includes any methods that focus on the content of the test, for example, items should be convincing for both experts and patients;

c. Validity of criterion which includes any strategies that measure the correlation of the test with a 'gold standard' questionnaire of the same topic;

d. Validity of construct, which is defined as the experimental demonstration that a test indeed measures the construct it claims to be measuring[41,61].

2. Reliability of a diagnostic procedure refers to the consistency of a measure. Formulated differently, under the same circumstances, a similar method should yield the same results. If not, the assessed method is unreliable and will be biased. Four general classes of reliability exist:

a. Inter-rater reliability assesses the degree to which different raters award consistent estimates of the same phenomenon but this does not take into account the fact that there is always a possibility that the raters give similar judgments based on chance[60];

b. Test-retest reliability is defined as the consistency of a measure over time;

c. Parallel-forms reliability assesses the consistency of the results of two equivalent tests measuring the same content;

d. Internal consistency reliability assesses the consistency of results across items within a test and is represented by a Cronbach's alpha coefficient, a higher value (typically above 0.70) suggests good internal consistency, meaning the items measure the same underlying concept[41,60,61].

3. Norming refers to the applicability of the test concerning selective criteria such as age range and gender[41].

The aim of this narrative review is to provide a global overview of psychometric characteristics of various assessment tools used to measure postoperative behavior of children.

Methodology

A systematic search was conducted across electronic databases including MEDLINE, Embase, Web of Science and Google Scholar and the following inclusion criteria were used:

1. Articles published between January 1995 and June 2023, focusing on the pediatric population (0-18 years);

2. Key search terms 'anesthesia', 'postoperative behavior' and 'child' along with Boolean operators (OR/AND) and MESH terms 'postoperative period', 'behavior' and 'child';

3. Studies evaluating surgical intervention or medical diagnostic procedures under anesthesia.

4. English and French-speaking literature were considered for inclusion.

Two independent reviewers (BW and JB) assessed the title and abstract of each study. Any discrepancies were resolved through discussion for final inclusion.

Data extraction encompassing publication details, study design, population, specific assessment tools for postoperative behavior and their psychometric

characteristic (validity, reliability and norming) were noted in a tailored data extraction form. Due to the heterogeneity of data, the findings will be presented in a narrative form.

Results

Electronic database searches retrieved a total of 2,319 articles (Figure 1) and of which 2 additional articles were obtained through citation tracking and screening reference lists.

A total of 184 studies were obtained and checked as potentially relevant studies of which

61 articles without postoperative behavioral tools were excluded. Moreover 3 non-English articles were excluded and an additional 9 were omitted due to the unavailability of full text. Assessment tools for postoperative behavioral changes were used in 57 articles (Table I).

In order of frequency:

1. In 46 studies the Post Hospitalization Behavior Questionnaire (PHBQ) was used to measure postoperative behavior changes in children and in 5 of these, a translated version was used. A further 3 studies described a 'modified version';
2. The Post Hospitalization Behavior Questionnaire for ambulatory surgery (PHBQ-AS) is an adaptation of the PHBQ and was used in 4 studies;
3. Three studies utilized the Child Behavior Checklist (CBCL) to evaluate postoperative behavior. Furthermore in 7 studies the CBCL was used as a scale to determine the behavior and emotional functioning of children in the preoperative setting and this was compared to observed postoperative behavior changes;
4. The Strengths Difficulties Questionnaire (SDQ) appeared in 2 studies;
5. The Infant/Toddler Sensory Profile (ITSP) and Conners Comprehensive Behavior Rating Scales (CBRS) were only used in 1 study;
6. The following scales were only used as a comparative tool: the Children's Behavior Questionnaire-Short Form (CBQ-SF); Functional Disability Inventory (FDI); Comprehensive Psychopathological Rating Scale (CPRS); Behavior Assessment for Children 3rd edition (BASC-3) and the Behavior Rating Inventory of Executive Function (BRIEF).

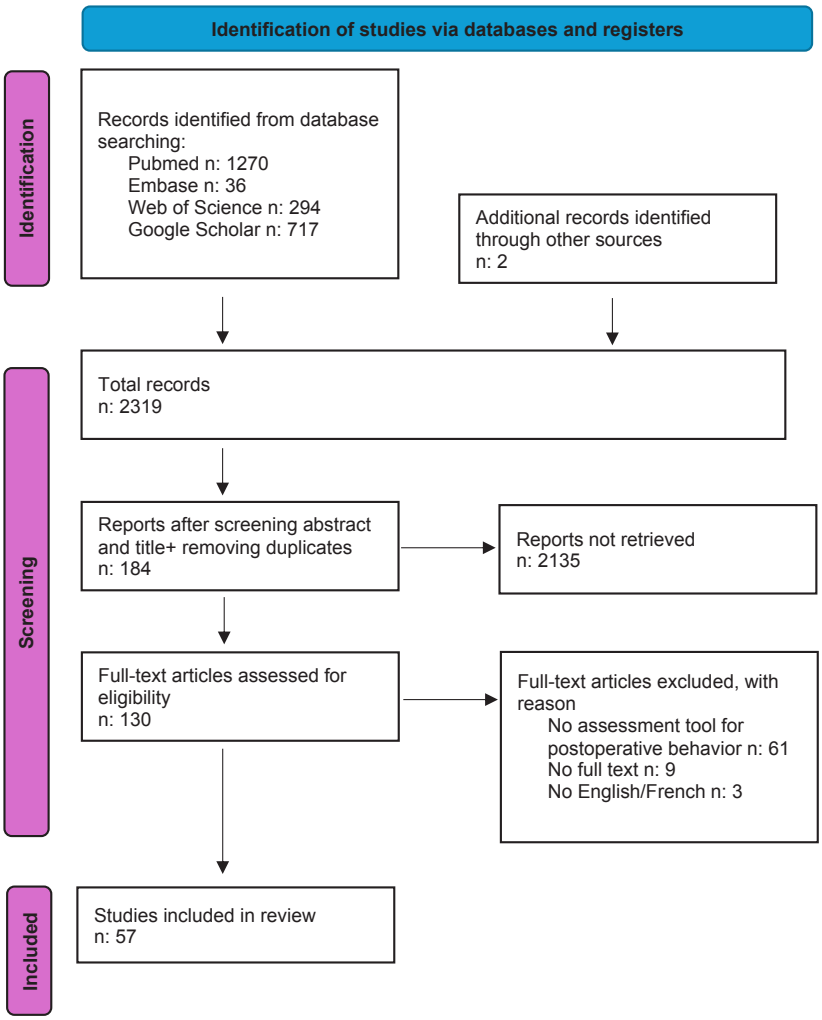

Fig. 1 — PRISMA flow chart.

Table I.

First author	Year	RCT/ cohort	Population	D/H/B	Other assessment tools	Assessment tools postoperative behavior	Results
YanYing [75]	2023	cohort	n: 1670 age: 6-12Y	D	mYPAS, VAS	PBHQ-AS d1+ d14+ d30	d1 14%, d14 4,5% d30 2,1%
Zickerman [77]	2023	cohort	n: 115 age: 2-7Y	D	mYPAS, FLACC, FPS-R	PHBQ 1w+ 4w+ 26w	Score ³ 4/5: negative behavior Cut off ³ 3 new negative behaviors 1w: 19/115
Li [78]	2023	cohort	n: 192 age: 2-12Y	H	PAB, PAED, FLACC	PHBQ d3	Cut off ³ 7 negative behavior changes d3 44,8%
Quintao [1]	2023	RCT	n: 175 age: 1-12 Y	D	mYPAS, VAS, PAB, PAED, FLACC	PHBQ- AS d1+ d7+ d14	Cut off ³ 4/5 negative behavior changes d1: 57/164, d2: 57/164, d7: 49/164, d14: 44/164
Shi [79]	2022	cohort	n: 86 age: 2,5-6Y	B		BASC-3 preop+ 3 months post op +PHBQ 3 months post op	PHBQ: no significant maladaptive behaviors 3 m postop BASC-3: significant improvement of internalizing problems
Zickerman [80]	2022	RCT	n: 115 age: 2-8Y	D	mYPAS	PHBQ Swedish version 25 items w1+ m1+ m6	Cut off >3 behavior changes w1: clonidine 20,3% midazolam 12,5%
Lee-Archer [37]	2022	RCT	n: 248 age: 2-7Y	D		SDQ preop+ d3+d14+ d28 PHBQ-AS d3+d14+ d28	PBHQ-AS cut off score 3,2= negative behavior SDQ cut off score > 12= increased risk of problem behavior baseline: SDQ>12: 26,6% d3: PHBQ-AS >3: 53%, SDQ >12: 21,4% d14: PHBQ-AS >3: 43,1%, SDQ >12: 24,9% d28: PHBQ-AS >3: 32,6%, SDQ >12: 16%
Kim [33]	2021	cohort	n: 100 age: 2-7Y	B	mYPAS , PAED, FLACC	CBCL preop+ d7	7d: 18,9% negative behavior changes
Houben [74]	2021	cohort	n: 222 age: 1-7Y	B	PAED	German version of PHBQ d14 postop	Cut off PHBQ positive result= 5/27: d14: 14%
Uhl [53]	2019	cohort	n: 260 age: 2,1-7,4Y	B	FLACC, Wong-Baker Faces scale, PAED	CBQ-SF d0, PHBQ d2+14d	d2: 0 to 17 (M = 3.43, SD = 3.50). d14: 0 to 15 (M = 1.89, SD = 3.15)
Lopez [42]	2019	cohort	n: 75 age: 1-6Y	?		PHBQ d10 post op	At least one negative change: 67%, At least one positive change: 11%, Both negative and positive changes: 7%, No change 23%

Table I (Continued).

Shi [81]	2019	cohort	n: 90 age: 2-7Y	B	mYPAS, PAED, FLACC	PHBQ d1+ d7+d30	Cut off positive score PHBQ= >0 d1: 60%, d7: 46,7%, d30: 17,8%
Gomez-Pesquera [14]	2019	cohort	n: 198 age: 2-12Y	B		PHBQ d7	D7: 38,8%
Luo [43]	2018	cohort	n: 177 age: 2-12Y	H	EASI, mYPAS, PAED, VAS, FLACC	PHBQ d14 + d30	Cut off ³1/5= change, ³7= significant deterioration in behavior Negative behavior: d14 60,5% + d30: 46,5%, Improved behavior: d14: 2,3% +d30: 2,4%
Berghmans [9]	2018	cohort	n: 160 age: 1,5-5Y	D	PPPM, FLAC-C,mYPAS, STAI, APAIS,	CBCL Dutch version preop PHBQ (only 4 questions about sleep) d1+d2+d3+ d10	Woke up at night d1: 36%, d10: 16% Resisted to go to sleep d1: 15%, d10: 4,7% Being afraid of the dark d1: 2,8%, d10: 0,8% Having trouble getting to sleep d1: 11,1%, d10: 3,9%
Selvadurai [46]	2018	RCT	n: 31 age: 1,5-8Y	B	CSHQ, PPPM	CBCL d0+ 3m, BRIEF d0+3m, CBRS d0 +3m, PHBQ d7	Surgical group had significantly higher scores in externalizing behaviors and global executive functioning compared with the control group
Aykut [3]	2018	RCT	n: 63 age: 3-8Y	D	ERC, WSS, OPS, PAED	CPRS d0	Negative behaviors= 3.5-fold higher in children with high anxiety levels preop
Lee- Archer [38]	2018	RCT	n: 234 age: 2-7Y	D	EAS, STAI, mYPAS, PAED, FLACC	PHBQ-AS + SDQ d3+ d14+ d28	Cut off ³3 Dexmedetomidine does not reduce postoperative behavior problems
Hatipoglu [82]	2018	cohort	n: 99 age: 5-12Y	D	mYPAS	PHBQ Turkish version d7	Cut off= any change Anxious child has 1,03 times greater risk of adopting negative postoperative behaviors
Berghmans [8]	2018	cohort	n: 70 age: 1,5-2,5Y	D	ITSP, VAS, Watcha scale, FLACC, NRS	CBCL preop, ITSP d0+ d14	Total problems score and the CBCL Internalizing Problems score were statistically significant predictors of changes in sensory processing over time
Lin [40]	2018	RCT	n: 70 age: 3-12Y	D	CEMS, APAIS, Children's postoperative behavior scale	Children's posthospital behavior: telephone follow up d14	d14: preop preparation: 1/35, no preop preparation: 0/35 exhibited negative behaviors
Jenkins [17]	2015	cohort	n: 1064 age: 2,3-12Y	D	FDI	PHBQ d1, d2, d3, w1, w2 PHBQ-AS d1, d2, d3, w1, w2	Significant correlation between the PHBQ and the FDI (Pearson's r (87) = 0.48, p< .001)

Table I (Continued).

Batuman [6]	2015	RCT	n: 42 age: 5-12Y	D	mYPAS	PHBQ d7	informative video presentation resulted in less postoperative behavior problems one week after surgery
Kim [83]	2015	RCT	n: 117 age: 2-7Y	D	mYPAS, STAI, CHEOP, PAED	PHBQ d1+ d14	cut off ³1/27, d1: 49+ d14 14%
Hilly [15]	2015	cohort	n: 56 age: 3-18Y	B	mYPAS, VAS, FPS, PAED	PHBQ (26 items=> 1 item in relation with sibling excluded) d7	Cut off >6/26 3.6% vs 35.7% in case vs control groups
Stipic [50]	2015	RCT	n: 64 age: 6-12Y	D	BAI	PHBQ 27 items d1+d3+d7+d14 +6 months	Cut off ³1/27 d1: 80%, 6months 43%
Beringer [10]	2014	cohort	n: 102 age: 2-12Y	D	mYPAS, PAED, PAB	PHBQ d1+ d7	d1: 52%, >7 changes: 9%= significant d7: 22% >7 changes: 3%= significant
Beringer [84]	2013	cohort	n: 102 age: 2-12Y	D	mYPAS, PAED, PAB	PHBQ d1+ d7	Cut off: ? Total negative behavior change: 55%
Kil [32]	2013	RCT	n: 100 age: 1-5Y	D	mYPAS, ICC, PAED, CHEOPS, FLACC	PHBQ d1-7	Cut off: ? Total 83,8% in control group, 85% in chloral hydrate group
Fortier [85]	2012	cohort	n: 288 age: mean age 5,5Y	D		PHBQ relative d1+ d3+ d7	Cut off: ? 83% total
Power [86]	2012	cohort	n: 131 age: 2-12Y	D	mYPAS, STAI, EASI, SDQ preop,	PHBQ d2+ w2+w4	Cut off ³1/27 d2: 73%, w2: 43%, w4: 32%
Fortier [13]	2010	cohort	n: 260 age: 2-12Y	D	STAI, EASI, mYPAS, PPPM, NRS	CBCL preop PHBQ d1+d2+d3+d7+ d14	Cut off ³ 1 d1: 80,4%, d14: 33%
Faulk [73]	2010	cohort	n: 400 age: 1-12Y	D	mYPAS, PAED	PHBQ d3-5	Cut off ³7/27 d3-d5: 8,8%
Tait [51]	2010	cohort	n: 268 age: 4-17Y	B		PHBQ + 10 additional items based on Revised Conners' Parent Rating Scale w1	Cut off ³1/37 With ADHD w1: 52%, without ADHD 31,6%
Lardrer [36]	2010	cohort	n: 300 age: 2-8 Y	D	CHEOPS	PHBQ w2	Cut off ³2/27 Parent absent at PACU: 45,8%, parent present at PACU: 29,3%

Table I (Continued).

Howard [16]	2010	cohort	n: 89 age: 3-12 Y	D	PedsQL	PHBQ d0+ d7+ d30	Cut off: ? Negative behavioral changes d7: 25%, d30 was 19%. Positive behavioral changes at d7: 24%, d30: 29%.
Amouroux [87]	2009	cohort	n: 64 age: 4,3+-2,4Y			PHBQ d1+ d7	Cut off ³1/27 d1: 75%, d7: 40,6%
Akinci [88]	2008	RCT	n: 100 age: 2-10Y	D	STAI	PHBQ d7	Cut off: ? No differences in postoperative behavioral changes between presence of the mother at induction or not
Karling [29]	2007	cohort	n: 340 age: 2-13Y	B	VAS	Preop CBCL PHBQ (25 items, relative form) d14	Cut off ³1 /27 d14: 34.4 new onset of negative behaviors+ 27.3% had new positive behavior.
Karling [28]	2008	cohort	n: 340 age: 2-13Y	B		CBCL Swedish version preop + d14 PHBQ (25 items) Swedish version d14	Cut off: PHBQ total score ≤ 76= no problematic behavior PHBQ total score > 76= deterioration in behavior Association between PHBQ and CBCL is weaker for older children
Steinmetz [49]	2007	RCT	n: 39 age: 4-6 month	H		Self report question-naire to assess changes in the infant's sleep pattern 1w+ 2w+ 3w	Longest continuous sleep was significantly longer in the sevoflurane group (median 7.2 h) compared with the propofol–remifentanil group
Stargatt [48]	2006	cohort	n: 1250 age: 3-12 Y	B	STST/ STAI/ VAS/ mYPAS	PHBQ absolute version d3 +d30	Cut off ³7/27= significant negative behavior change d3: 24%, d30 16%
Bal [4]	2006	RCT	n: 120 age: 2-10 Y	D	STAI	PHBQ d7	Only 14 questions, cut off: ? No difference
Kain [19]	2005	RCT	n: 102 age: 3-10Y	B	mYPAS, ICC, STAI, EASI, PPPM	PHBQ d1-7	Cut off ³1/27 d1: 68% with halothane, 58% with sevoflurane d7: 15% with halothane, 14% with sevoflurane
Kain [22]	2004	cohort	n: 791 age: ?	B	mYPAS/ STAI / EASI	PHBQ d1+ d2+ d3+ d7+ d14 post op	Cut off: ? Children with intense preoperative anxiety showed significantly more maladaptive behavior changes after surgery than did children with less preoperative anxiety.
Keaney [31]	2004	cohort	n: 120 age: pre-school	D	STAI, OR-BRS	PHBQ d1+ d7+ d30	Cut off: ? d1: 58,3%, d7: 46,8%, d30 38,3%

Table I (Continued).

Tripi [52]	2004	RCT	n: 92 age: 1,5-9Y	D		PHBQ w1+ w4	Cut off: ? Mean: 1,9+- 1,3 SD
Aguilera [2]	2003	RCT	n: 110 age: 2-14Y	D		"a question-naire" w2	Cut off= > 1 type of behavioral disturbance. w2: 28% in the intravenous, 48% in the inhalation group
Kain [18]	2002	cohort	n: 169 age: 3-9Y	D	Actigraph, MBSS, EASI, STAI, mYPAS	PHBQ d0+ d14	Cut off ³1/27 d14: 20.1% nightmares and waking up
Tuomilehto [89]	2002	cohort	n: 300 age: 1-10Y	D		PHBQ d0+ w1+ w3	Cut off ³1 w1: 1-18%, w3 1-4% postoperative behavioral changes (positive and negative)
Foesel [12]	2001	cohort	n: 458 age: <8Y	B		Modified PHBQ = 10 questions	Cut off= Yes/ No/ do not know=> ³1/10 d7: halothane 16,1% vs sevoflurane 25,7% negative postoperative behavioral change
Kain [90]	2001	RCT	n: 70 age: 2-7Y	D	mYPAS, ICC; EASI, STAI	PHBQ d1+ d2+ d3+ d7+ d14	Cut off: ? Behavioral changes did not differ based on the coping style of the parent
Kain [27]	1999	cohort	n: 91 age: 1-7Y	B	EASI, STAI, mYPAS,	PHBQ d0+ d1+ d2+ d3+ d7+ d14 post op	Cut off ³1 new criterion d1: 67%, d2: 45%, d14: 23%
Kain [26]	1999	RCT	n: 86 age: 2-7Y	B	EASI, mYPAS	PHBQ d1+ d2+ d3+ d7+ d14	Cut off: ? d1 80% vs 65%, d2 72% vs 40%, d3 55% vs 28%, d7 56% vs 32%, d14 32% vs 30%
McGraw [45]	1998	RCT	n: 70 age: 1-10Y	D		Nightmares/ food rejection/ fussiness/ anxi-ety/ negativity/ bed-wetting w1	w1: placebo 18% vs midazolam 50% negative postoperative behavioral changes
Margolis [44]	1998	RCT	n: 102 age: ?	D	Global Mood Score	PHBQ preop+ d14	Postoperatively, control group showed a slight increase in aggression (from 8.8 to 9.0) while children in the interactive teaching book group exhibited less aggression (8.4 to 8.0) than their preoperative baseline (P=0.05)
Kotiniemi [35]	1997	cohort	n: 551 age: 4m-13,4Y	B		Adapted PHBQ 17 items d1, d2, d3, w4	d1: problematic postoperative behavioral changes: 47%, beneficial changes: 17% w4: problematic postoperative behavioral changes: 9%, beneficial changes: 9%

D= day case/ H= hospitalization/ B=both; PHBQ: Post Hospitalization Questionnaire; PHBQ- AS: Post Hospitalization Questionnaire for Ambulatory Surgery; PAB: Pediatric anesthesia behavior scale; mYPAS: modified Yale Preoperative Anxiety Scale; VAS: visual analog scale; PAED: Pediatric Anesthesia Emergence Delirium Scale; FLACC: Face, Legs, Activity, Cry, Consolability; BASC-3: Behavior Assessment System for Children, third edition; ITSP: Infant/ Toddler- Sensory Profile; FDI: Functional Disability Inventory; CPRS-RS: Conners' Parent Rating Scale Revised Short Form; SDQ: Strength and Difficulties Questionnaire; ED: emergence delirium; CBQ-SF: Children's behavior questionnaire- Short Form FLA; CSHQ: Children's Sleep Habits Questionnaire; BRIEF: Behavior Rating Inventory of Executive Function; CPRS-48: Conners Parent Rating Scale -48: ERC: Emotion Regulation Checklist: WSS: Wilton Sedation Scale: OPS Objective Pain Scale; CEMS: the Children's Emotional Manifestation Scale; CHEOP: Children's Hospital of Eastern Ontario Pain; FPS: Face Pain Scale; BAI: Beck Anxiety Inventory; PAB: Pediatric Anesthesia Behav-ior; ICC: Induction Compliance Checklist; ORBRS: Operating Room Behavior Raving Scale; MBSS: Miller Behavioral Style Scale; PedsQL: Pediat-ric Quality of Life Inventory Generic Core Scales Version 4.0.

Table II shows an overview of these different assessment tools and their psychometric characteristics.

Vernon's Post Hospitalization Behavior Questionnaire (PHBQ)

The PHBQ was developed in 1966 by Vernon et al. from a study in 387 children[62]. This parent-reported questionnaire comprises 27 items categorized into

Table II.

Scale	General/ Norming	Validity	Reliability
PHBQ, Vernon et al. 1966 [62]	Parent-rated 1 month to 16 years 28 items, six categories of anxiety	- face validity: only of younger children - validity of the construct: to small sample, not for all age groups	Test-retest reliability tested in small sample R=0.65 Cronbach's alpha=0.82
PHBQ-AS Jenkins et al. 2015 [17]	1064 children 1,97-12 years 11 items	Jenkins et al. [17]: - validity of criterion: correlation between the PHBQ-AS and FDI = significant Lee Archer et al. [37]: - validity of criterion: correlation between the PHBQ-AS with the SDQ: weak- to-moderate	Jenkins et al.: - Cronbach's alpha=0.8 Lee Archer et al.: - Cronbach's alpha=0.79
CBCL, Achenbach and Edelbrock 1991 [63]	1.5 to 18 years CBCL 11/2-5 years of age: 100 items CBCL 6-18 years of age: 113 items	Validity of content=good Validity of criterion=good Validity of construct=good	Reliability is high, with most test-retest r= >0.80 Cronbach's alpha=?
SDQ, Goodman 1997 [91]	Parents or teachers reported/ self-completion 2-17 year olds 25 items are divided between 5 scales	Validity of criterion=good No construct validity with respect to surgery	Test-retest reliability=0.62 Cronbach's alpha=0.73
ITSP, Dunn 2002 [65]	Parent-reported 0-3 years of age	Validity of content= good	test- retest reliability= acceptable r=0.74- 0.84 Cronbach's α= 0.42-0.71
CBQ-SF, Rothbart 2001 [66]	Caregiver reported 262 children 3 to 7 years of age long form: 195 items shorter form: 94 items	Validity of criterion=good Validity of content=good	Test-retest reliability=? Cronbach's alpha=0.77
FDI, Walker and Green 1991 [67]	Parent-rated 8-20 years 15 items	Claar et al. [68]: - Validity of criterion: child vs parent- report= significant	Claar et al.: Test-retest reliability r=0.64 Cronbach's alpha=0.92
CPRS, Asberg and Schalling 1979 [92]	Specialist and non-specialists No age limit 65 items	Perris [69]: 'Validity'='satisfactory'	Perris: Inter-rater reliability='acceptable'
CBRS, Connors 1999 [70]	Teachers and parent-rated/ self-completion 3-17 years	Validity of criterion='moderately to strong'	Test-retest reliability=0.56 to 0.96 Cronbach's alpha=0.69 to 0.97 Inter-rater reliability=0.50 to 0.89
BASC-3, Reynolds 2015 [71]	Parent-rated 2-5 years: 139 items >6 years: 175 items	'Validity'='acceptable'	Test-retest reliability='high' Cronbach's alfa='high'
BRIEF, Gioia 2012 [72]	Parental-rated and teacher-rated and self-reported 5-18 years 86 items	Validity of criterion=good	Test-retest reliability=0.82 for parents, 0.88 for teachers Cronbach's alfa=0.80-0.98

PHBQ: Post Hospitalization Behavior Questionnaire; PHBQ- AS: Post Hospitalization Behavior Questionnaire- Ambulatory Surgery; CBCL: The Child Behavior Checklist; SDQ: Strength and Difficulties Questionnaire; ITSP: Infant/Toddler Sensory Profile; CBQ-SF: Children's Behavior Questionnaire- Short Form; SDQ: Strength and Difficulties Questionnaire; FDI: Functional Disability Inventory; CPRS-48: Comprehensive Psychopathological Rating Scale; CBRS: Conners Comprehensive Behavior Rating Scales; BASC-3: Behavior Assessment for Children 3e Ed; BRIEF: Behavior rating inventory of executive function.

six dimensions:
1. general anxiety and regression; 2. separation anxiety; 3. eating disturbance; 4. aggression toward authority; 5. apathy/withdrawal; 6. anxiety about sleep. It utilizes a Likert scale to assess the frequency of behaviors ranging from 'never' to 'always'.

This instrument is specifically designed to assess developmental regression and behavioral alterations following hospital discharge in a population with an age range from 1 month to 16 years old[62].

The PHBQ exists in two versions, an absolute and a relative version. In the absolute version, the parents fill out the questionnaire before and after hospitalization[11,48] and in the relative version, where the questionnaire is only filled out after the intervention, parents are required to assess each item relative to their recollection of the child's pre-anesthetic behavior[11,48].

Several criteria of validity of the PHBQ have not been met. Face validity has not been approved for all ages as many of the questions reflect behavior only attributed to younger children (i.e. 'Does your child need a pacifier?'). Furthermore, validity is only tested by comparing the total score achieved from the questionnaire with psychiatric interviews of 20 children aged between 2 to 10, 5 years old[41,55]. This aspect is very important as the postoperative behavioral modifications of a child differ considerably with age[41].

Although a good agreement with psychiatric interviews with parents as informant of preschool children exists and can point to a good validity of content[20,26], the validity of construct was not demonstrated because the sample was very small and not representative of all age groups[41,55,62].

Furthermore, the reliability of the PHBQ has not been well demonstrated.

Test-retest reliability was only based on a very small cohort of 37 children aged between 3 to 11 years and internal consistency numbers (Cronbach's alpha) ranged between 0.46 and 0.73[62], which is lower than the recommended values[60]. Although a more recent study by Karling et al. discovered that the PHBQ has a better internal consistency compared to the findings of the original study[29,38].

Post Hospitalization Behavior Questionnaire for ambulatory surgery (PHBQ-AS)

The PHBQ-AS[17] was developed as adaptation of the original PHBQ to increase its applicability to outpatient children[1,37]. The revision process was based on an retrospective reexamination of an existing database[17], incorporating data from 17 studies conducted over 15 years[38]. The original 27 items were downsized to 11 items without subscales[17,62].

In this retrospective analysis, the authors mainly focused on the validity of criterion. Correlations between the original PHBQ, the PHBQ-AS and the Functional Disability Inventory (FDI) seemed to be significant and additional information or support to the validity of the PHBQ-AS was not provided[17].

Furthermore, Lee Archer et al. investigated the validity of the PHBQ-AS by correlating the PHBQ-AS with the Strength and Difficulties Questionnaire (SDQ)[37]. They only found a weak correlation between the PHBQ-AS and the SDQ on day 3 (r=0.2), a moderate correlation on day 14 (r=0.42), and weak-to-moderate correlation on day 28 (r=0.34)[37].

Reliability of the PHBQ-AS seemed to be good with an internal consistency (Cronbach's alpha of 0.80)[17]. No measures of test-retest reliability were done.

The Child Behavior Checklist (CBCL)

The CBCL is a parent-reported and teacher-reported questionnaire and is a valuable tool for the assessment of behavioral and emotional problems in children[41].

The CBCL is a two-part instrument, encompassing a social competence scale and a behavior/emotional problems scale. The behavioral/emotional portion consists of 100 items for children aged 1.5 to 5 years and 113 items for those aged between 5 to 18 years, offering a comprehensive assessment of various dimensions[29,33]. It assesses internalization, externalization, sleeping and other problems. Higher scores indicate more problematic behavior[9,33,46].

The psychometric properties of the scale have been extensively evaluated.

Content validity was supported by an extensive process of selection and refinement[63]. Criterion related validity and construct validity was supported by concurrent and predictive associations with a variety of measures of the Diagnostic and Statistical Manual of Mental Disorders (DSM) system[33,63].

Reliability is found to be high, with most test-retest values between 0.80 and 0.90.

The CBCL has been translated and validated in several languages and the Dutch version of CBCL has demonstrated good validity and reliability, expanding its cross-cultural applicability[7].

Strength and Difficulties Questionnaire (SDQ)

The SDQ has emerged as an instrument of assessment of psychological adjustment among

young people with applications ranging from screening and clinical assessment to research.

The SDQ is designed for children aged between 2–17 years and comprises 25 items distributed across five scales, encompassing both positive and negative indicators[38]. The questionnaire divides problem behaviors into internalizing (comprising emotional and peer-related issues) and externalizing problems (encompassing conduct and hyperactivity-inattention concerns)[37].

Validity of criterion was shown by comparing the SDQ with the CBCL[64].

Reliability is good with an internal consistency (Cronbach's alpha of 0.73) and with an acceptable test-retest reliability after 4–6 months[64].

Infant/Toddler Sensory Profile (ITSP)

Sensory processing of the child has an impact on the child's ability to learn, show adaptive social functioning at home and participate in play[8]. Consequently, changes in sensory processing might influence postoperative behavior changes.

The ITSP was developed to investigate sensory processing in infants and toddlers aged between 7 to 36 months. It consists of 48 structured questions with response categories ranging from 1 ('almost always') to 5 ('almost never') and two open questions. The assessment covers five key processing sections, including auditory, visual, tactile, vestibular, and oral sensory reactions. Additionally, the ITSP allows for the calculation of four independent quadrant scores: 1. weak registration; 2. sensation-seeking; 3. sensory sensitivity; 4. sensory avoiding. A low threshold score, derived from the summation of quadrant 3 and 4 scores, provides further insights into sensory processing.

Lower scores on the quadrant scores (i.e. below the reference range for healthy peers) indicate higher frequencies of these behaviors than in 'healthy' children, whereas higher scores indicate the opposite[8].

The ITSP has been reported to have excellent content validity according to expert panels who assessed congruence between test items and the intended domains measured[65].

The test-retest reliability for all quadrant scores and overall sensory processing is deemed acceptable[8].

Internal consistency of the ITSP was adequate for general, auditory and tactile processing with Cronbach's alpha coefficients ranging from 0.63 to 0.71, whereas visual, vestibular and oral sensory processing sections had poor internal consistency ranging from 0.42 to 0.55 65. The ITSP 7-36 months has been validated in Dutch[8].

Children's Behavior Questionnaire-Short Form (CBQ-SF)

The CBQ-SF is a validated instrument tailored for children aged between 3-8 years and serves as a valuable tool for measuring temperament of the child. This questionnaire, completed by parents and guardians prior to surgery, aims to measure key temperament dimensions, including negative affectivity, effortful control and surgency based on children's typical reactions to a variety of situations[53].

The validity of criterion was established by taking items adapted from previously existing questionnaires, including the Infant Behavior Questionnaire and the Physiological Reactions Questionnaire[66].

A small group of parents were asked to complete the questionnaires out loud to comment on problematic items and suggest revisions to ensure the validity of content[66]. For reliability, internal consistency estimates of the CBQ scales have been reported in several sources with a mean internal consistency estimate of 0.77 across all 15 scales[66]. Test-retest reliabilities have not yet been performed but there is a very high level of stability in parental ratings[66].

Functional Disability Inventory (FDI)

The FDI is a 15-item instrument which assesses illness-related activity limitations in children and adolescents with a variety of pediatric conditions[67]. The FDI can be completed by children aged between 8-20 years or can be administered to parents to report on child functioning. For each item respondents are asked to rate the physical difficulty in completing each activity stated (e.g. eating regular meals, sleeping at night, doing chores at home). Five different response options are possible: 'no trouble', 'a little trouble', 'some trouble', 'a lot of trouble', and 'impossible' 67. A total score is obtained by summing all 15 items, producing a possible range of scores from 0-60, with higher scores indicating increased functional disability.

The psychometric properties were investigated by Claar et al. and the validity of criterion in child versus parent-reported measures was significant[68].

Reliability is good with an internal consistency (Cronbach's alpha) of 0.92 and test-retest values were acceptable[68].

Comprehensive Psychopathological Rating Scale (CPRS)

The CPRS serves as an instrument in both clinical and research settings, specifically tailored for assessing the behavioral profiles of children

grappling with neurodevelopmental disorders, with a particular emphasis on Attention-Deficit/ Hyperactivity Disorder (ADHD). Developed to offer a nuanced understanding of a child's emotional and behavioral attitudes, the CPRS is designed to provide both qualitative and quantitative insights into psychopathological manifestations[3].

The CPRS encompasses five distinct subscales, with a total of 65 items, to comprehensively evaluate various aspects of a child's behavior. These subscales include conduct problems, learning problems, anxiety, impulsive/hyperactive behavior, and psychosomatic feelings[3].

A study from Perris et al.[69] 1979 showed 'satisfactory validity' and 'acceptable' inter-rater reliability, which was not further specified.

Conners Behavior Rating Scales (CBRS)

The CBRS assesses behavioral, emotional and social concerns in children. Scores are provided for domain-specific behavioral scales including Attention-Deficit Hyperactivity Disorder (ADHD), defiance/aggressiveness and social functioning/ peer relations[46].

The validity of criterion was supported by examining the relationship between CBRS scores and other related measures for diagnosing ADHD. Overall, scales that assess similar constructs, tended to be intercorrelated moderately to strongly[70].

Both internal consistency and test-retest reliability are very good with Cronbach's alpha coefficients ranging from 0.69 to 0.97 and 2 to 4-week test-retest reliability coefficients ranging from 0.56 to 0.96. Inter-rater reliability coefficients ranged from 0.50 to 0.89[70].

Behavioral Assessment System for Children, 3rd Ed. (BASC-3)

BASC-3 stands as a multi-method, multidimensional parent rating system designed to evaluate the behavior of children aged between 2 to 25 years. The BASC-3 has gained prominence as a valuable instrument for assessing a broad spectrum of behavioral domains, with attention to its predictive validity for Attention-Deficit/ Hyperactivity Disorder[47]. The parent rating scales gather descriptions of the child's observed behavior, accessing numerous aspects of behavior and personality, including positive (adaptive) and negative (clinical) dimensions. Child behaviors are rated on a 4-point scale of behavioral frequency from 'never' to 'almost always'[71].

Research conducted by Shi et al. suggests that while the BASC-3 and the CBCL demonstrate similar validity in assessing behavioral problems in children[47]. The BASC-3 has a high internal consistency with most Cronbach's alpha coefficients exceed 0.8 and with a high test-retest reliability[47].

Behavior Rating Inventory of Executive Function (BRIEF

BRIEF is a parent-reported questionnaire designed to assess executive function behaviors in children 46. Executive function is an umbrella construct that refers to interrelated neuropsychological functions that are responsible for purposeful, problem-solving, goal-directed behavior. Parents and/or teachers assess executive function at home and in school. The BRIEF is applicable in children aged from 5 to 18 years[72]. Each version consists of 86 items scored 'never', 'sometimes', or 'often' in eight clinical scales.

The BRIEF demonstrated high levels of validity and reliability. Test-retest reliability is 0.82 for parents, 0.88 for teachers and internal consistency in high ranges are also good[72].

Discussion

Postoperative behavior changes in children are very common and constitute an important issue from a clinical and qualitative point of view. For a correct assessment of postoperative behavioral changes in children, a pivotal role lies in the availability of well-validated and reliable scales with appropriate normative data. Following an extended literature search 11 scales were identified as tools used for the assessment of postoperative behavior changes in children.

The most frequently used assessment instrument to quantify postoperative behavior changes in children is the PHBQ and it is often considered as a so-called gold standard. Despite its frequent application in research, the validity of the PHBQ has never been adequately established. The reliability is limited or at least questionable and normative data are lacking. Its widespread utilization in research and clinical practice attests to its popularity and acceptance within the scientific community[41]. The PHBQ focuses on subtle behavioral changes following stressful events, making it a preferred tool.

However, a standardized definition of postoperative behavior changes has not been formulated.

Some studies using the PHBQ define postoperative behavior changes as any form of deterioration in behavior, while other studies set a minimum number of negative behaviors that need to be observed before a diagnose of problematic behavioral change is present[38]. Kain et al.[20] defined

postoperative behavioral change as having at least one positive answered question on the PHBQ, while Faulk et al.[73] stated that at least seven questions must be answered positively to diagnose postoperative behavior changes.

This matter might explain why the incidences of postoperative behavior changes reported by Faulk (8.8%) was lower compared to Kain's investigations (respectively 54% and 78.4%)[16,20,73,74]. The absence of a consensual cut-off score for clinically significant symptoms and variations in the definition of post-hospitalization behavior change across all studies adds complexity to its interpretation. Comparison between studies is difficult because some studies use the absolute version and other studies the relative version of the PHBQ[48]. It has been suggested that the relative version, as originally described by Vernon et al.[62], might be more sensitive but may also be more subjective[38].

Overall, most children with reported negative postoperative behavior only showed between one and three changes on the PHBQ[16].

In general, also parents may be a source of bias because they might assess their child's behavior according to their own expectations 55 and this can be a potential for exaggerated reporting of behavior disturbances and that this in fact may reflect children's normal reactions to stressful medical interventions[16].

Furthermore, some behaviors described in the PHBQ are considered problematic at older age but are regarded as normal during early childhood. This issue is further pointed out by Howard et al. who states that the same items and dimensions are used, regardless age, which implicates high rates of missing data for questions which are clearly not appropriate for the age of the child (i.e. 'Does your child need a pacifier?' might not be applicable for a teenager)[16]. Consequently, older children might react to hospitalization in a negative way but this reaction might not be detected by the PHBQ[29].

Caution is required when the PHBQ is uniformly used in children of all ages.

The PHBQ contains 27 questions, which is less practical and a burden for everyday clinical practice[50].

To overcome this problem, the PHBQ-AS has been developed as an adaptation of the original PHBQ but also the PHBQ-AS lacks thorough validation and reliability because it is based on a retrospective data analysis of the original PHBQ[1,17,38,75].

Although the PHBQ-AS is a shortened version of the original PHBQ (11 items), it might be more relevant, practical or more efficient. The PHBQ-AS limits the parents' burden and has an increased potential for using it in clinical settings[17]. Whereas there is no gold standard instrument available, the original study of Jenkins et al. compared the PHBQ-AS to the PHBQ and the FDI, but the FDI is not designed to detect changes after anesthesia[17].

Until additional validation occurs, both the PHBQ and the PHBQ-AS may not be suitable for broad applications in behavioral research following anesthesia.

Furthermore both the PHBQ and the PHBQ-AS do not cover somatic problems 41 and the PHBQ has not yet been shown to be predictive for long-term emotional/behavioral disturbances or to be associated with an impairment in social, family or school functioning[16].

It is also important to remember is that the PHBQ is developed to assess negative response to hospitalization overall, rather than after surgery or anesthetic interventions[53].

In contrast with the PHBQ and PHBQ-AS the CBCL, which assesses emotional and behavioral functioning of a child during the preceding 6 months, is a well validated and reliable instrument for which norming data for ages 1.5-5 years and 6-18 years exist[28]. Cross-informant correlations were good or better than found in a meta-analysis of many other instruments[33]. The CBCL exhibits good clinical value in predicting preoperative anxiety and provides insights into long-term behavior after exposure to general anesthesia[7,8,13,33]. Changes in CBCL scores are considered a valuable parameter for assessing post hospitalization behavioral changes in children, contributing to the understanding of the impact of hospitalization on their psychological well-being[28,29,33].

The CBCL is also used as a quantitative evaluation of psychological treatment efficacy by comparing pre- and post-intervention scores[33].

A main consideration is that the CBCL faces criticism for inducing parental fatigue and potential observer bias due to its reliance on a single parent's input. Its primary focus is on psychiatric or general behavioral problems that may limit the scope in capturing the full spectrum of child behavior, especially in the context of post-hospitalization adjustments[28,33]. Subtle behavioral changes following stressful events will not be measured with the CBCL, where the PHBQ has a better focus on these type of behaviors[28].

Furthermore, the CBCL is also often used to assess emotional behavioral functioning of the child preoperatively. This preoperative assessment of the CBCL can serve as a predictor for later comparison to other assessment tools which measure postoperative behavior changes[8,9,13,28,29,33,46].

The SDQ as compared to the CBCL, has a better ability for detecting hyperactivity and inattention problems and is equally good at detecting other problems[38]. Furthermore, the SDQ's burden is less and might therefore be the preferred tool by parents as it is quicker and easier to administer[37-39]. The SDQ has not been shown to have construct validity with respect to surgery or use in a postoperative setting which raises questions about its applicability in assessing behavioral adjustments specific to the post-hospitalization period. Researchers and healthcare professionals must be careful when considering using the SDQ in the context of a postoperative setting[37].

Sensory processing changes after anesthesia may lead to potential changes in the child's postoperative behavior. Children under anesthesia may exhibit diminished reactions to sensory input, potentially leading to misinterpretation of their behavior as withdrawn or passive. However, these sensory processing changes (reflected by higher scores on the ITSP) do not necessarily imply more problematic behavior[8].

The results obtained by the ITPS should be viewed as a continuum of experiences rather than inherently problematic, emphasizing the importance of a nuanced perspective when using the ITSP (8). In a systematic review of assessments of sensory processing, the ITSP is recommended because of sound psychometric properties and excellent content validity but interpretation of the results requires an expert opinion[76].

The CBQ-SF, the FDI, the CPRS, the CBRS, the BASC-3 and the BRIEF were only used once or twice as a comparative tool for assessing post hospitalization behavior changes. All these scales evaluate a broad spectrum of developmental and acquired neurological conditions but none of these are really validated in a postoperative setting. The FDI is not designed for children, which makes it hard to use.

As a final remark, we need to draw attention to the variation in existing translations. Non-validated or nonreliable translations are used in various studies. These translations might be somewhat different from the original scales and might be influenced by different cultural aspects[29,50,74]. In fact, the influence of cultural factors may limit the ability to make comparisons between studies in different nations[29].

Limitations

This narrative review is not an in-depth study of postoperative behavior changes in children but only focuses on the psychometric characteristics and the strengths/weaknesses related to the different used scales found in literature. The main goal of the authors is to give the reader a comprehensive overview of the different assessment tools and to inform readers about potential gaps in this research area.

Conclusion

Postoperative behavior changes in children are frequently described and the assessment of this behavior changes presents a complex challenge.
There is a lack of easy to use, well validated and reliable tools which take into account specific child development issues. A 'one for all' scale might not be suitable.

Despite its widespread application, the PHBQ and PHBQ-AS both lack validity, reliability and norming, but they might be useful to assess temporary postoperative behavior changes. In contrast tools like the CBCL, the SDQ and the ITSP are well validated and reliable tools but are not specifically designed to assess postoperative behavior changes in children. Although these instruments might be useful tools in assessment of persistent behavior changes.

Future research should aim for standardized criteria and improved validation, reliability and norming. Careful consideration of the unique features of each instrument is vital for making informed choices in clinical and research settings.

References

1. Quintão VC, Carlos RV, Cardoso PFN, Zeferino SP, Kulikowski LD, Lee-Archer P, Carmona MJC. Comparison of intravenous and inhalation anesthesia on postoperative behavior changes in children undergoing ambulatory endoscopic procedures: A randomized clinical trial. Paediatric anaesthesia 2023; 33: 229-35.
2. Aguilera IM, Patel D, Meakin GH, Masterson J. Perioperative anxiety and postoperative behavioural disturbances in children undergoing intravenous or inhalation induction of anaesthesia. Paediatric anaesthesia 2003; 13: 501-7.
3. Aykut A, Işık B. Emotion regulation and premedication success relationship in children who underwent general anesthesia. Turk J Med Sci 2018; 48: 217-22.
4. Bal N, Saricaoglu F, Uzun S, Dal D, Celebi N, Celiker V, Aypar U. Perioperative anxiety and postoperative behavioural disturbances in children: comparison between induction techniques. Eur J Anaesthesiol 2006; 23: 470-5.
5. Banchs RJ, Lerman J. Preoperative anxiety management, emergence delirium, and postoperative behavior. Anesthesiol Clin 2014; 32: 1-23.
6. Batuman A, Gulec E, Turktan M, Gunes Y, Ozcengiz D. Preoperative informational video reduces preoperative anxiety and postoperative negative behavioral changes in children. Minerva anestesiologica 2016; 82: 534-42.
7. Berghmans JM, Poley M, Weber FVDVM, Adriaenssens P, Klein J, Himpe D, Utens E. Does the Child Behavior Checklist predict levels of preoperative anxiety at anesthetic induction and postoperative emergence delirium? A prospective cohort study. Minerva anestesiologica 2015; 81: 145-56.

8. Berghmans JM, Poley MJ, van der Ende J, Rietman A, Glazemakers I, Himpe D, Verhulst FC, Utens E. Changes in sensory processing after anesthesia in toddlers. Minerva anestesiologica 2018; 84: 919-28.
9. Berghmans JM, Poley MJ, van der Ende J, Veyckemans F, Poels S, Weber F, Schmelzer B, Himpe D, Verhulst FC, Utens E. Association between children's emotional/behavioral problems before adenotonsillectomy and postoperative pain scores at home. Paediatric anaesthesia 2018; 28: 803-12.
10. Beringer RM, Segar P, Pearson A, Greamspet M, Kilpatrick N. Observational study of perioperative behavior changes in children having teeth extracted under general anesthesia. Paediatric anaesthesia 2014; 24: 499-504.
11. Cohen-Salmon D. [Perioperative psychobehavioural changes in children]. Ann Fr Anesth Reanim 2010; 29: 289-300.
12. Foesel T, Reisch HJ. Postoperative behavioural changes in children: comparison between halothane and sevoflurane. Paediatric anaesthesia 2001; 11: 719-23.
13. Fortier MA, Del Rosario AM, Rosenbaum A, Kain ZN. Beyond pain: predictors of postoperative maladaptive behavior change in children. Paediatric anaesthesia 2010; 20: 445-53.
14. Gómez-Pesquera E, Poves-Alvarez R, Martinez-Rafael B, Liu P, Alvarez J, Lorenzo-López M, Fierro I, Gómez-Sánchez E, Heredia-Rodriguez M, Gómez-Herreras JI, Tamayo E. Cerebral Oxygen Saturation and Negative Postoperative Behavioral Changes in Pediatric Surgery: A Prospective Observational Study. J Pediatr 2019; 208: 207-13.e1.
15. Hilly J, Hörlin AL, Kinderf J, Ghez C, Menrath S, Delivet H, Brasher C, Nivoche Y, Dahmani S. Preoperative preparation workshop reduces postoperative maladaptive behavior in children. Paediatric anaesthesia 2015; 25: 990-8.
16. Howard K, Lo E, Sheppard S, Stargatt R, Davidson A. Behavior and quality of life measures after anesthesia for tonsillectomy or ear tube insertion in children. Paediatric anaesthesia 2010; 20: 913-23.
17. Jenkins BN, Kain ZN, Kaplan SH, Stevenson RS, Mayes LC, Guadarrama J, Fortier MA. Revisiting a measure of child postoperative recovery: development of the Post Hospitalization Behavior Questionnaire for Ambulatory Surgery. Paediatric anaesthesia 2015; 25: 738-45.
18. Kain ZN, Caldwell-Andrews A, Wang SM. Psychological preparation of the parent and pediatric surgical patient. Anesthesiol Clin North Am 2002; 20: 29-44.
19. Kain ZN, Caldwell-Andrews AA. Preoperative psychological preparation of the child for surgery: an update. Anesthesiol Clin North Am 2005; 23: 597-614, vii.
20. Kain ZN, Caldwell-Andrews AA, Maranets I, McClain B, Gaal D, Mayes LC, Feng R, Zhang H. Preoperative anxiety and emergence delirium and postoperative maladaptive behaviors. Anesthesia and analgesia 2004; 99: 1648-54.
21. Kain ZN, Caldwell-Andrews AA, Mayes LC, Weinberg ME, Wang SM, MacLaren JE, Blount RL. Family-centered preparation for surgery improves perioperative outcomes in children: a randomized controlled trial. Anesthesiology 2007; 106: 65-74.
22. Kain ZN, Caldwell-Andrews AA, Weinberg ME, Mayes LC, Wang SM, Gaal D, Saadat H, Maranets I. Sevoflurane versus halothane: postoperative maladaptive behavioral changes: a randomized, controlled trial. Anesthesiology 2005; 102: 720-6.
23. Kain ZN, Caramico LA, Mayes LC, Genevro JL, Bornstein MH, Hofstadter MB. Preoperative preparation programs in children: a comparative examination. Anesthesia and analgesia 1998; 87: 1249-55.
24. Kain ZN, Mayes LC, Caldwell-Andrews AA, Alexander GM, Krivutza D, Teague BA, Wang SM. Sleeping characteristics of children undergoing outpatient elective surgery. Anesthesiology 2002; 97: 1093-101.
25. Kain ZN, Mayes LC, O'Connor TZ, Cicchetti DV. Preoperative anxiety in children. Predictors and outcomes. Arch Pediatr Adolesc Med 1996; 150: 1238-45.
26. Kain ZN, Mayes LC, Wang SM, Hofstadter MB. Postoperative behavioral outcomes in children: effects of sedative premedication. Anesthesiology 1999; 90: 758-65.
27. Kain ZN, Wang SM, Mayes LC, Caramico LA, Hofstadter MB. Distress during the induction of anesthesia and postoperative behavioral outcomes. Anesthesia and analgesia 1999; 88: 1042-7.
28. Karling M, Hägglöf B. Child behaviour after anaesthesia: association of socioeconomic factors and child behaviour checklist to the Post-Hospital Behaviour Questionnaire. Acta Paediatr 2007; 96: 418-23.
29. Karling M, Stenlund H, Hägglöf B. Child behaviour after anaesthesia: associated risk factors. Acta Paediatr 2007; 96: 740-7.
30. Karstädt N, Crozier TA, Horn M, Naxer S, Schittkowski MP. Postoperative Behaviour after Primary Strabismus Surgery in Children: Is There an Influence of Intraoperative Topical Anaesthesia? Klin Monbl Augenheilkd 2020; 237: 1194-201.
31. Keaney A, Diviney D, Harte S, Lyons B. Postoperative behavioral changes following anesthesia with sevoflurane. Paediatric anaesthesia 2004; 14: 866-70.
32. Kil HK, Kim WO, Han SW, Kwon Y, Lee A, Hong JY. Psychological and behavioral effects of chloral hydrate in day-case pediatric surgery: a randomized, observer-blinded study. J Pediatr Surg 2012; 47: 1592-9.
33. Kim J, Byun SH, Kim JW, Kim JY, Kim YJ, Choi N, Lee BS, Yu S, Kim E. Behavioral changes after hospital discharge in preschool children experiencing emergence delirium after general anesthesia: A prospective observational study. Paediatric anaesthesia 2021; 31: 1056-64.
34. Kotiniemi LH, Ryhänen PT. Behavioural changes and children's memories after intravenous, inhalation and rectal induction of anaesthesia. Paediatric anaesthesia 1996; 6: 201-7.
35. Kotiniemi LH, Ryhänen PT, Moilanen IK. Behavioural changes in children following day-case surgery: a 4-week follow-up of 551 children. Anaesthesia 1997; 52: 970-6.
36. Lardner DR, Dick BD, Crawford S. The effects of parental presence in the postanesthetic care unit on children's postoperative behavior: a prospective, randomized, controlled study. Anesthesia and analgesia 2010; 110: 1102-8.
37. Lee-Archer PF, Gibbons K, Reade M, von Ungern-Sternberg BS, Long D. Comparison of two measures of behavior change in children after day surgery. Paediatric anaesthesia 2022; 32: 62-66.
38. Lee-Archer PF, von Ungern-Sternberg BS. Postoperative behavior change in children: All sorted or a tangled mess of spaghetti? Paediatric anaesthesia 2018; 28: 578-79.
39. Lee-Archer PF, von Ungern-Sternberg BS, Reade M, Betts M, Haenke D, Keys A, Rance T, Gibbons K, Long D. The effect of dexmedetomidine on postoperative behaviour change in children: a randomised controlled trial. Anaesthesia 2020; 75: 1461-68.
40. Lin CJ, Liu HP, Wang PY, Yu MH, Lu MC, Hsieh LY, Lin TC. The Effectiveness of Preoperative Preparation for Improving Perioperative Outcomes in Children and Caregivers. Behav Modif 2019; 43: 311-29.
41. Lopez U, Habre W. Evaluation of intraoperative memory and postoperative behavior in children: are we really measuring what we intend to measure? Paediatric anaesthesia 2009; 19: 1147-51.
42. Lopez U, Martin J, van Assche M, Fleury Schubert A, Fournet M, Quartier V, Habre W, Van der Linden M. Classification of postoperative behavior disturbances in preschool children: A qualitative study. Paediatric anaesthesia 2019; 29: 712-20.

43. Luo R, Zuo Y, Liu HB, Pan Y. Postoperative behavioral changes in Chinese children undergoing hypospadias repair surgery: A prospective cohort study. Paediatric anaesthesia 2019; 29: 144-52.
44. Margolis JO, Ginsberg B, Dear GL, Ross AK, Goral JE, Bailey AG. Paediatric preoperative teaching: effects at induction and postoperatively. Paediatric anaesthesia 1998; 8: 17-23.
45. McGraw T, Kendrick A. Oral midazolam premedication and postoperative behaviour in children. Paediatric anaesthesia 1998; 8: 117-21.
46. Selvadurai S, Maynes JT, McDonnell C, Cushing SL, Propst EJ, Lorenzo A, Lim A, Meltzer LJ, Lu Z, Horner RL, Narang I. Evaluating the effects of general anesthesia on sleep in children undergoing elective surgery: an observational case-control study. Sleep 2018; 41.
47. Shi Y, Macoun S, Hanson AC, Schroeder DR, Kirsch AC, Haines KM, Zaccariello MJ, Warner DO. Longitudinal assessment of behaviour in young children undergoing general anaesthesia. British journal of anaesthesia 2022; 129: 740-46.
48. Stargatt R, Davidson AJ, Huang GH, Czarnecki C, Gibson MA, Stewart SA, Jamsen K. A cohort study of the incidence and risk factors for negative behavior changes in children after general anesthesia. Paediatric anaesthesia 2006; 16: 846-59.
49. Steinmetz J, Holm-Knudsen R, Eriksen K, Marxen D, Rasmussen LS. Quality differences in postoperative sleep between propofol-remifentanil and sevoflurane anesthesia in infants. Anesthesia and analgesia 2007; 104: 779-83.
50. Stipic SS, Carev M, Kardum G, Roje Z, Litre DM, Elezovic N. Are postoperative behavioural changes after adenotonsillectomy in children influenced by the type of anaesthesia?: A randomised clinical study. Eur J Anaesthesiol 2015; 32: 311-9.
51. Tait AR, Voepel-Lewis T, Burke C, Doherty T. Anesthesia induction, emergence, and postoperative behaviors in children with attention-deficit/hyperactivity disorders. Paediatric anaesthesia 2010; 20: 323-9.
52. Tripi PA, Palermo TM, Thomas S, Goldfinger MM, Florentino-Pineda I. Assessment of risk factors for emergence distress and postoperative behavioural changes in children following general anaesthesia. Paediatric anaesthesia 2004; 14: 235-40.
53. Uhl K, Litvinova A, Sriswasdi P, Zurakowski D, Logan D, Cravero JP. The effect of pediatric patient temperament on postoperative outcomes. Paediatric anaesthesia 2019; 29: 721-29.
54. Voepel-Lewis T, Mitchell A, Malviya S. Delayed postoperative agitation in a child after preoperative midazolam. J Perianesth Nurs 2007; 22: 303-8.
55. Watson AT, Visram A. Children's preoperative anxiety and postoperative behaviour. Paediatric anaesthesia 2003; 13: 188-204.
56. Yuki K, Daaboul DG. Postoperative maladaptive behavioral changes in children. Middle East J Anaesthesiol 2011; 21: 183-9.
57. Zainal Abidin H, Omar SC, Mazlan MZ, Hassan MH, Isa R, Ali S, Hassan SK, Marzuki A. Postoperative Maladaptive Behavior, Preoperative Anxiety and Emergence Delirium in Children Undergone General Anesthesia: A Narrative Review. Glob Pediatr Health 2021; 8: 2333794x211007975.
58. Zickerman C, Brorsson C, Hultin M, Johansson G, Winsö O, Haney M. Preoperative anxiety level is not associated with postoperative negative behavioral changes in premedicated children. Acta Anaesthesiol Scand 2023; 67: 706-13.
59. Fortier MA, Chorney JM, Rony RY, Perret-Karimi D, Rinehart JB, Camilon FS, Kain ZN. Children's desire for perioperative information. Anesthesia and analgesia 2009; 109: 1085-90.
60. Verhulst FC. Kinder- en jeugdpsychiatrie: onderzoek en diagnostiek: Koninklijke van Gorcum B.V., 2009.
61. Souza AC, Alexandre NMC, Guirardello EB. Psychometric properties in instruments evaluation of reliability and validity. Epidemiol Serv Saude 2017; 26: 649-59.
62. Vernon DT, Schulman JL, Foley JM. Changes in children's behavior after hospitalization. Some dimensions of response and their correlates. Am J Dis Child 1966; 111: 581-93.
63. Holmes CL, Michelle & Smith, Avis & Pinne, Susan & Neese, Paula. (2014). A Model for Creating a Supportive Trauma-Informed Culture for Children in Preschool Settings. Journal of Child and Family Studies. 24. 10.1007/s10826-014-9968-6. A Model for Creating a Supportive Trauma-Informed Culture for Children in Preschool Settings. Journal of Child and Family Studies 2014.
64. Goodman R, Meltzer H, Bailey V. The Strengths and Difficulties Questionnaire: a pilot study on the validity of the self-report version. Eur Child Adolesc Psychiatry 1998; 7: 125-30.
65. Dunn W, Daniels DB. Initial Development of the Infant/Toddler Sensory Profile. Journal of Early Intervention 2002; 25: 27-41.
66. Putnam SP, Rothbart MK. Development of short and very short forms of the Children's Behavior Questionnaire. J Pers Assess 2006; 87: 102-12.
67. Walker LS, Greene JW. The functional disability inventory: measuring a neglected dimension of child health status. Journal of pediatric psychology 1991; 16: 39-58.
68. Claar RL, Walker LS. Functional assessment of pediatric pain patients: psychometric properties of the functional disability inventory. Pain 2006; 121: 77-84.
69. Perris C. Reliability and validity studies of the comprehensive Psychopathological Rating Scale (CPRS). Prog Neuropsychopharmacol 1979; 3: 413-21.
70. Conners CK. Clinical use of rating scales in diagnosis and treatment of attention-deficit/hyperactivity disorder. Pediatric Clinics of North America 1999; 46: 857-70.
71. Reynolds C, Kamphaus R. Behavior assessment system for children. Bloomington. MN: Pearson 2015.
72. Gioia GA, Isquith PK, Guy SC, Kenworthy L. Brief 2: Behavior rating inventory of executive function. 2015.
73. Faulk DJ, Twite MD, Zuk J, Pan Z, Wallen B, Friesen RH. Hypnotic depth and the incidence of emergence agitation and negative postoperative behavioral changes. Paediatric anaesthesia 2010; 20: 72-81.
74. Houben A, Ghamari S, Fischer A, Neumann C, Baehner T, Ellerkmann RK. Pediatric emergence delirium is linked to increased early postoperative negative behavior within two weeks after adenoidectomy: an observational study. Braz J Anesthesiol 2021.
75. YanYing P, ShenLing L, XiaoHan P, YunBo X, Xin T, GuoYan L, Yan C, Lei H. Incidence and risk factors associated with negative postoperative behavioral changes in children undergoing painless gastroscopy. BMC Pediatr 2023; 23: 371.
76. Eeles AL, Spittle AJ, Anderson PJ, Brown N, Lee KJ, Boyd RN, Doyle LW. Assessments of sensory processing in infants: a systematic review. Dev Med Child Neurol 2013; 55: 314-26.
77. Zickerman C, Brorsson C, Hultin M, Johansson G, Winsö O, Haney M. Preoperative anxiety level is not associated with postoperative negative behavioral changes in premedicated children. Acta Anaesthesiol Scand 2023.
78. Li L, Zhang J, Li J, Ren Y, Gao Z, Gao J, Zhang F, Wang F, Zheng T. Development of a nomogram to predict negative postoperative behavioral changes based on a prospective cohort. BMC anesthesiology 2023; 23: 261.
79. Shi Y, Hanson AC, Schroeder DR, Haines KM, Kirsch AC, Macoun S, Zaccariello MJ, Warner DO. Longitudinal assessment of cognitive function in young children undergoing general anaesthesia. British journal of anaesthesia 2022; 128: 294-300.
80. Zickerman C, Hult A-C, Hedlund L, Winsö O, Johansson G, Haney M. Clonidine versus midazolam premedication and postoperative negative behavioral changes in younger

children: a randomized controlled trial. Anesthesia & Analgesia 2022; 135: 307-15.
81. Shi M, Miao S, Gu T, Wang D, Zhang H, Liu J. Dexmedetomidine for the prevention of emergence delirium and postoperative behavioral changes in pediatric patients with sevoflurane anesthesia: a double-blind, randomized trial. Drug Des Devel Ther 2019; 13: 897-905.
82. Hatipoglu Z, Gulec E, Lafli D, Ozcengiz D. Effects of auditory and audiovisual presentations on anxiety and behavioral changes in children undergoing elective surgery. Nigerian journal of clinical practice 2018; 21: 788-94.
83. Kim H, Jung SM, Yu H, Park SJ. Video Distraction and Parental Presence for the Management of Preoperative Anxiety and Postoperative Behavioral Disturbance in Children: A Randomized Controlled Trial. Anesthesia and analgesia 2015; 121: 778-84.
84. Beringer RM, Greenwood R, Kilpatrick N. Development and validation of the P ediatric A nesthesia B ehavior score–an objective measure of behavior during induction of anesthesia. Pediatric Anesthesia 2014; 24: 196-200.
85. Fortier MA, Tan ET, Mayes LC, Wahi A, Rosenbaum A, Strom S, Santistevan R, Kain ZN. Ethnicity and parental report of postoperative behavioral changes in children. Pediatric Anesthesia 2013; 23: 422-28.
86. Power NM, Howard RF, Wade AM, Franck LS. Pain and behaviour changes in children following surgery. Archives of disease in childhood 2012: archdischild-2012-301378.
87. Amouroux R, Cohen-Salmon D, Gooze R, Rousseau-Salvador C, Annequin D. Douleur et troubles comportementaux après adénoïdectomie et pose d'aérateurs transtympaniques chez l'enfant. Ann Fr Anesth Reanim. Elsevier, 2009: 11-15.
88. Akinci SB, Köse EA, Ocal T, Aypar U. The effects of maternal presence during anesthesia induction on the mother's anxiety and changes in children's behavior. Turk J Pediatr 2008; 50: 566-71.
89. Tuomilehto H, Kokki H, Ahonen R, Nuutinen J. Postoperative behavioral changes in children after adenoidectomy. Archives of Otolaryngology–Head & Neck Surgery 2002; 128: 1159-64.
90. Kain ZN, Wang SM, Mayes LC, Krivutza DM, Teague BA. Sensory stimuli and anxiety in children undergoing surgery: a randomized, controlled trial. Anesthesia and analgesia 2001; 92: 897-903.
91. Goodman R. The Strengths and Difficulties Questionnaire: a research note. J Child Psychol Psychiatry 1997; 38: 581-6.
92. Asberg M, Schalling D. Construction of a new psychiatric rating instrument, the Comprehensive Psychopathological Rating Scale (CPRS). Prog Neuropsychopharmacol 1979; 3: 405-12.

doi.org/10.56126/75.3.54