Does the Child Behavior Checklist predict levels of preoperative anxiety at anesthetic induction and postoperative emergence delirium? A prospective cohort study.

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Minerva Anestesiol. 2015 Feb;81(2):145-56.

ABSTRACT

Background: Preoperative anxiety at induction and postoperative emergence delirium (ED) in children are associated with postoperative behavioral changes and adjustment disorders. This study's aim is to assess the value of the Child Behavior Checklist (CBCL) score in order to predict anxiety during induction and emergence delirium after anesthesia in children undergoing elective day-care surgery.

Methods: Anxiety at induction, assessed by the modified Yale Preoperative Anxiety Scale (mYPAS), was studied as outcome in 401 children (60.1% male, age range: 1.5 – 16 years). For 343 of these children (59.8 % male, age range: 1.5 – 16 years) ED could be investigated postoperatively, as assessed by the Pediatric Anesthesia Emergence Delirium scale (PAED). Demographic data, healthcare contacts, anesthesia and surgical data were registered. Preoperative emotional/behavioral problems, during the 6 months prior to surgery, were assessed by the CBCL. Hierarchical, multiple regression was used to test whether anxiety and ED could be predicted by CBCL scores.

Results: Children with a higher CBCL score on preoperative internalizing problems (e.g. anxious/depression) showed preoperative more anxiety at induction (P=0.003). A higher CBCL score on preoperative emotional/behavioral problems was not associated with ED.

Conclusions: The CBCL predicted anxiety at induction but not ED.

Keywords: Anxiety, Children, Emergence Delirium, Perioperative Care, Psychological Tests, Surgery

Key messages

- Anxiety at induction and emergence delirium (ED) are important issues in pediatric anesthesia
- This study tested the value of the Child Behavior Checklist (CBCL) as a tool to predict anxiety at induction and ED in a large prospective cohort of children undergoing elective surgery.
  The CBCL predicted anxiety at induction but not ED

INTRODUCTION

Anxiety at induction of anesthesia in children is inevitably a cause of important stress,[1-3] linked to increased pain and higher analgesic requirements[4-6]. Earlier studies suggest that anxiety at induction, emergence delirium (ED) and postoperative behavioral problems might be connected[7-9]. Children between 1 and 5 years of age are the most vulnerable group in developing anxiety at induction[10-12]. Parental anxiety seems an important factor for preoperative anxiety in children[1,13,14]. Fortier *et al*[15] used, among other tools, the Child Behavior Checklist (CBCL) and found that internalizing behavior was predictive for anxiety at induction, in adolescents.

The identification of children at risk for increased anxiety at induction may create an opportunity to tailor pharmacological and psychological support towards their individual needs. Thus postoperative consequences such as ED and behavioral maladjustment might be reduced or prevented. Moreover, preoperative assessment can be a tool for the anesthesiologist to explain to parents perioperative behavioral problems. Until now no studies have been performed to validate an assessment tool in order to identify children at increased risk for preoperative anxiety. This study aims to fill this gap by studying the value of the CBCL, an internationally well-known standardized assessment tool,[16,17] in predicting anxiety at induction and ED in children undergoing elective surgery.

In this study we hypothesized that:1. higher scores on emotional/behavioral problems in children undergoing elective day-care surgery, as measured with the CBCL, are of predictive value for higher levels of anxiety at induction (assessed with the modified Yale Preoperative Anxiety Scale; mYPAS), and 2. that higher scores on emotional/behavioral problems in these children, as measured with the CBCL, are of predictive value for ED (assessed with the Pediatric Anesthesia Emergence Delirium scale; PAED).

MATERIALS AND METHODS

This prospective observational cohort study was conducted at the Queen Paola Children's Hospital in Antwerp, Belgium, with approval from the Institutional Review Board (B009201213439) and in accordance with the Declaration of Helsinki and the STROBE statement for observational studies.

Inclusion and exclusion criteria: Eligible were all consecutive patients undergoing day-care surgery, aged between 1.5 – 16 years who met the following inclusion criteria: 1. an American Society of Anesthesiologists (ASA) physical status I-II; 2. written informed

consent of parents and of children aged ≥ 10 years obtained on the day of surgery; 3. parents with good understanding of Dutch language; 4. without premedication; 5. one parent present during induction. Children with known intellectual disability, suspect of malignant hyperthermia and ASA physical status higher than II were excluded.

Anesthesia procedure: all children received a standardized preparation and an informative preoperative video film just before entering the operating theatre. The anesthetic procedure was left to the discretion of the seven participating pediatric anesthesiologists in charge. All inductions were performed by inhalation of sevoflurane 8 vol.% in 50% oxygen without nitrous oxide. General anesthesia was maintained with sevoflurane and if appropriate a laryngeal mask airway (LMA) or endotracheal tube (ETT) was inserted. Intra-operative pain management included: 1. opioids (fentanyl, pethidine); 2. non-steroidal anti-inflammatory drugs (NSAID's). If necessary, children received regional anesthesia and the intravenous (IV) use of α_2- adrenergic agonist (clonidine) was noted because it can influence the occurrence of ED[18]. For postoperative pain management children received paracetamol IV (20 mg. kg^{-1}). At the end of surgery the inhalation agent was discontinued, the children were extubated awake and transferred to the Post Anesthesia Care Unit (PACU) for further observation.

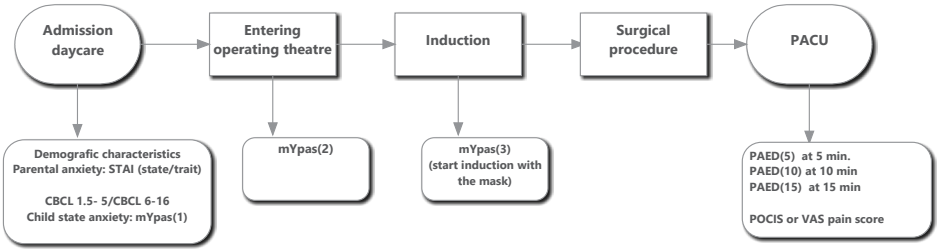
Assessment procedure (Figure 1)

Demographical/medical data were collected on the day of admission (standardized interview performed by a research nurse). The surgical procedures were dichotomized into Ear Nose Throat surgery (ENT) *versus* other, because ED is more common in ENT surgery[18]. Parental education (PE) used as an indicator of socioeconomic status (SES), was classified into three categories (1. no education, elementary school; 2. secondary school; 3. higher education or university).

Predictive assessment tools

Preoperative emotional/behavioral problems during the past 6 months were assessed by the CBCL (Appendix 1) completed by parents prior to surgery[16,17,19]. The CBCL contains respectively 100 (CBCL $1^{1/2}$ – 5 years of age) and 113 (CBCL 6 – 18 years of age) problem items. Each item can be scored by answering either: 1. not true; 2. somewhat or sometimes true; 3. very true or often true. Summary scores on internalizing problems (withdrawn, somatic complaints and anxious/depressed), externalizing problems (rule-breaking and aggressive behavior) and a total problem score were computed. A higher

Figure 1 Flowchart diagram of different moments during assessment



Parental anxiety (Spielberger's State-Trait Anxiety Inventory); CBCL = Child Behavior Checklist/1,5-5 and 6-18 as assessed by the accompanying mother or father; mYPAS = modified Yale Preoperative Anxiety scale at [mYPAS(1)], holding area,[mYPAS(2)] at entrance of the operating theatre and at [mYPAS(3)], induction with mask; PACU, Postoperative Care Unit; PAED = Pediatric Anesthesia Emergence Delirium scale at 5 min. [PAED(5)], 10 min. [PAED(10)] and 15 min. [PAED(15)]; POCIS = Pain Observation Scale for Young Children; VAS = Visual Analogue Score

score indicates more problems. A good validity and reliability for the Dutch version has been confirmed[20]. For all children, the accompanying parent was asked to complete the CBCL.

Parental anxiety was measured with the internationally acknowledged Spielberger State – Trait Anxiety Inventory (STAI) on admission[21] using its two parts: state anxiety (current emotional state) and trait anxiety (general anxiety disposition). The STAI has been validated for a Dutch speaking population[22].

Outcome variables

State anxiety at induction was assessed by the modified Yale Preoperative Anxiety Scale (mYPAS),[23] a structured observational instrument to measure anxiety in the holding area and at induction (Appendix 2). It consists of five domains: activity, emotional expressivity, state of arousal, vocalization and use of parents. These domains have a good to excellent psychometric properties. Adjusted scores range from 23 to 100, with higher scores indicating greater anxiety at induction. The mYPAS was completed at three moments: on admission [mYPAS(1)], in the holding area just before entering the operating theatre [mYPAS(2)] and finally at induction [mYPAS(3)]. All measurements were carried out by three independent observers who received standardized instructions and training in using the mYPAS.

ED was assessed using the Pediatric Anesthesia Emergence Delirium Scale (PAED)[24]. By summing the scores at 5 min [PAED(5)], 10 min [PAED(10)] and 15 min [PAED(15)] the

total score is computed [PAED sum scores]. The PAED is a well-validated instrument for ED with a good internal consistency and reliability (Appendix 3). At all three moments two nurses completed the PAED in the PACU.

Since pain is considered a confounding factor in the ED assessment, it was rated by the Pain Observation Scale for young Children (POCIS)[25] in children aged ≤ 4 year and a Visual Analogue Scale (VAS)[26] in children ≥ 5. Both forms were measured by the PACU nurse. Children with at least moderate pain (POCIS score or a VAS score higher than 3) were removed from the final analysis (Figure 2).

Statistical analysis

A power analysis for multiple regression (GPOWER version 3.1.2) showed that with a power of 0.90 and an alpha of < 0.05, using 15 possible predictors, a total sample size of 171 was sufficient to detect a medium effect size (Cohen's f^2= 0.15). Subsequently our final sample (N.=343) was sufficiently large enough to adequately test the hypothesis that R^2 is different from zero.

Baseline child and parental characteristics such as demographic data and psychological assessment were displayed as means ± standard deviations (continuous data) or as percentages (categorical data). Normality was checked by using a Kolmogorov-Smirnov (K-S) test with Lilliefors significance correction for normal distribution.

To test whether the child's anxiety and ED changed across time, the mYPAS and PAED scores, respectively, were compared at the different time points using Friedman's two-way ANOVA.

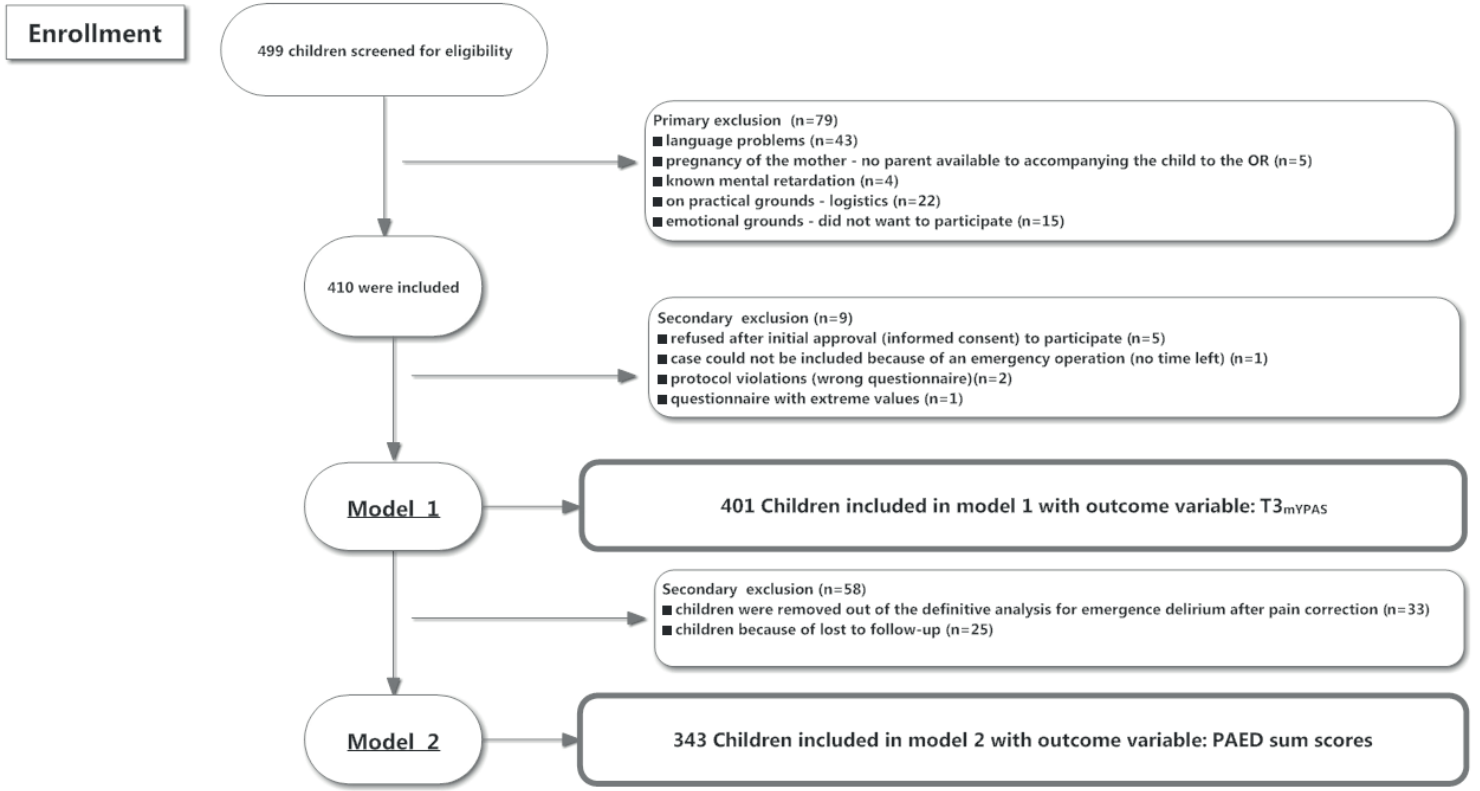
To analyze differences in parental state and trait anxiety between mothers and fathers and, whether there were differences in parental anxiety according to the child's age, *t*-tests were used.

To test for significant associations between all predictors and outcome variables (assumption of multicollinearity, r ≥ .8) a Pearson correlation matrix and also the variance inflation factor (VIF) and tolerance statistics were computed.

Main analyses

Two hierarchical, multiple regression models (forced entry) were constructed: one to explain anxiety at induction (model 1) and the other to explain ED (model 2). In model 1,

Figure 2 Flowchart inclusion of patient inclusion in model 1 and model 2



Model 1: hierarchical multiple linear regression – outcome: child anxiety at induction [mYPAS(3)]
Model 2: hierarchical multiple linear regression – outcome: emergence delirium – PAED = Pediatric Anesthesia Emergence Delirium Scale: PAED sum scores = PAED(5) + PAED(10) + PAED(15)
OR = operating room

with [mYPAS(3)] as the dependent variable, the following predictor variables were first entered into the model: 1. child's age; 2. child's gender; 3. previous experience of the child with anesthesia; 4. the child's state anxiety as assessed on admission [mYPAS(1)]; 5. parental state anxiety; 6. parental trait anxiety; 7. PE; 8. previous parental experience with accompanying a child to induction; 9. parental gender. Afterwards the CBCL summary scores for internalizing problems and for externalizing problems were added to the model. Using raw scores to test how much of the variance in anxiety at induction was explained by these CBCL summary scores, after controlling the other variables.

Similarly, in model 2, with sum scores of PAED as the dependent variable, the predictor variables were entered into two blocks. First, variables 1 to 3 and 5 to 8 as mentioned above for model 1 were entered in model 2, as well as three additional variables; 9. type of surgical procedure (ENT versus other types); 10. use of α_2-adrenergic agonist (clonidine); 11. anxiety at induction (i.e. the outcome variable of model 1). Second, CBCL - internalizing and externalizing problems, were added to the model. R^2 and R^2 change values were calculated to assess how much of the variance in anxiety at induction and ED can be explained by the model after adjusting for other variables.

All analyses were performed with IBM SPSS Statistics for Windows, Version 19.0. Armonk, NY: IBM Corp.

P-values of <0.05 were considered statistically significant.

RESULTS

Patient sample

From January 2011 to February 2012, 499 children were approached. Data of 401 patients were included in model 1 (anxiety during induction) and 343 of them could also be analyzed in model 2 (ED) (Figure 2). Sixty percent was male (mean age: 5.9 years), approximately 40% underwent ENT procedures and for about 55%, it was their first anesthetic experience (Table I).

The child's state anxiety increased significantly from [mYPAS(1)] over [mYPAS(2)] to [mYPAS(3)] (P< 0.0001). The PAED scores at different time points decreased significantly over time (P<0.0001).

Table I Characteristics of the children and accompanying parent

	Children			Accompanying Parent	
	Child model 1	**Child model 2**		**Parent model 1**	**Parent model 2**
N.=401	N.=401	N.=343		N. =401	N.=343
demographic data					
gender boy	241 (60.1%)	205 (59.8%)	gender mother	305 (76.1%)	261(76.1%)
age,[a] months	70.2 ± 40.7	70.3 ± 40.9	parental age,[a] (y)	35,4 ± 6.3	35.4 ± 6.4
weight,[a] kg	22.5 ± 11.9	22.4 ± 11.9			
number of siblings			PE [b]		
≥ 1	329 (82%)	284 (82.7%)	PE 1	34 (8.5%)	30 (8.7%)
			PE 2	176 (43.9%)	146 (42.6%)
			PE 3	161 (40.1%)	143 (41.7%)
			missing values	30 (7.5%)	24 (7%)
child nationality			parental nationality		
Belgian	383 (95.5%)	331 (96.5%)	Belgian	367 (91.5%)	319 (93%)
other	18 (4.5%)	12 (3.5%)	other	31 (7.8%)	21 (6.1%)
			Missing values	3 (0.7%)	3 (0.9%)
surgical procedure					
adenotonsillectomy	153 (38.2%)	128 (37.3%)			
T-tube	43 (10.7%)	31 (9.0%)			
dental surgery	64 (16.0%)	62 (18.1%)			
general surgery	36 (9.0%)	31 (9.0%)			
urology	63 (15.7%)	54 (15.7)			
ophthalmology	13 (3.2%)	10 (2.9%)			
gastroenterology	3 (0.7%)	3 (0.9%)			
orthopaedic surgery	26 (6.5%)	24 (7.0%)			
ASA [c] 1	378 (94.3%)	324 (94.5%)			
ASA [c] 2	23 (5.7%)	19 (4.5%)			
first anesthetic experience	220 (54.9%)	190 (55.4%)			
Sevoflurane Vol. % [a]		3.3 (0.4)			
α_2-receptor agonist (clonidine)		132 (38.5%)			
intra-operative use of opioids		330 (96.2%			
use of IV paracetamol		335 (97.7%)			
use of NSAID [d]		142 (41.4%)			
locoregional anesthesia		52 (15.2%)			
psychological assessment					
child state anxiety [b,e]			parental anxiety [a,f]		
mYPAS(1)	28 ± 8	28 ± 8	state anxiety	38 ± 11	38 ± 10

Table I Characteristics of the children and accompanying parent (continued)

	Children			Accompanying Parent	
	Child model 1	Child model 2		Parent model 1	Parent model 2
mYPAS(2)	38 ± 18	38 ± 17	trait anxiety	34 ± 8	34 ± 8
mYPAS(3)	50 ± 27	50 ± 26			
			parental experience at induction	207 (51.8%)	177 (51.6%)
PAED scale [b,g]					
PAED(5)		12 ± 2			
PAED(10)		9 ± 3			
PAED(15)		6 ± 7			
PAED $_{\text{sum scores}}$		27 ± 7			
CBCL assessment [a,h]					
internalising problems	7.7 ± 6.6	7.7 ± 6.5			
externalizing problems	8.9 ± 7.2	8.9 ± 7.3			
(one accompanying parent report, 76% mothers)					

Model 1: hierarchical multiple linear regression – outcome: child anxiety at induction [mYPAS(3)]; Model 2: hierarchical multiple linear regression – outcome: emergence delirium (Pediatric Anesthesia Emergence Delirium Scale (PAED): PAED sum scores = PAED(5) + PAED(10) + PAED(15), data are expressed as N. (%); [a]data are expressed as mean with ± SD; [b]PE, parental education: PE 1 (no education or primary school), PE 2 (high school), PE 3 (further studies or university); [c]ASA, American Society of Anesthesiologists; [d]NSAID, non steroidal anti-inflammatory drugs; [e]mYPAS, modified Yale Preoperative Anxiety scale at [mYPAS(1)], holding area, [mYPAS(2)] at entrance of the operating theatre and at [mYPAS(3)], induction with mask; [f]parental anxiety (Spielberger's State-Trait Anxiety Inventory); [g]PAED, Pediatric Anesthesia Emergence Delirium scale at PAED(5), PAED(10) and PAED(15) and PAED sum scores = PAED(5) + PAED(10) + PAED(15) ; CBCL, [h]Child Behavior Checklist/1,5-5 and 6-18 as assessed by the accompanying mother or father.

Parental state anxiety was higher in accompanying mothers than in accompanying fathers (P=0.006) whereas no difference between the parents was found in trait anxiety (P>0.05).

In parents of children aged 1.5 to 5 years, state anxiety was higher (N.=249, Mean =39, SD ± 9.7) than in parents of children aged ≥ 6 (N.=150, Mean =35, SD ± 10.2)(P=0.007).

Univariate analyses showed significant associations between the separate predictors CBCL-internalizing and externalizing problems, younger age, state anxiety on admission, parental state anxiety and children's anxiety at induction (Table II).

Furthermore, five predictors were significantly associated with ED [PAED sum scores]: younger age, the child's first anesthetic, externalizing behavior, anxiety at induction and ENT surgery.

Table II Univariate associations between predictor variables and of the child's anxiety during induction respectively emergence delirium

	Model 1	Model 2
prediction variables	**mYPAS(3) [a]**	**PAED sum scores [b]**
Child characteristics		
1. child age (m)	0.43**	-0.25**
2. child gender	0.05	0.06
3. first anesthetic	-0.09	-0.17**
4. preoperative internalizing problems [c]	0.16**	0.03
5. preoperative externalizing problems [c]	0.16**	0.14**
6. [mYPAS(1)] [a]	0.38**	_
7. [mYPAS(3)] [a]	_	0.15**
Parental characteristics		
1. gender accompanying parent	-0.02	0.02
2. previous experience	0.04	0.08
3. state anxiety [d]	0.14**	0.07
4. trait anxiety [d]	0.08	0.00
5. PE [e]	-0.08	0.01
procedure		
1. dichotomy ENT [f] *versus* other surgery	_	0.14**
2. use of α_2- adrenergic agonist (clonidine)	_	0.03

Pearson correlation coefficients: *P<0.05. **P<0.01 (2-tailed); [a] mYPAS, modified Yale Preoperative Anxiety scale at [mYPAS(1)], holding area and at [mYPAS(3)], induction with mask; [b] PAED sum scores, Pediatric Anesthesia Emergence Delirium Scale (PAED) sum scores = PAED(5) + PAED(10) + PAED(15); [c] Child Behavior Checklist/1,5-5 and 6-18 as assessed by the accompanying mother or father; [d] parental anxiety (Spielberger's State-Trait anxiety Inventory); [e] PE, Parental education; [f] ENT, ear-nose-throat surgery.

Multiple regression models

Prediction of child's anxiety during induction (mYPAS(3), model 1, N.=401, Table III)

Preoperative internalizing problems, the child's age, mYPAS(1) and parental education were significant predictors of anxiety at induction (P=0.003). CBCL internalizing problems significantly predicted anxiety during induction, after controlling for the other predictors. One SD difference on the internalizing problem score is associated with a 0.19 SD difference in mean at [mYPAS(3)]. Overall, this model explains 33% of the variance of anxiety at induction as measured with mYPAS.

Prediction of ED (PAED sum scores, model 2, N.=343, Table IV)

Table III Predictors of the child's anxiety during anesthetic induction: results of the final multiple regression model

	Anxiety at induction as measured with mYPAS [mYPAS(3)]					
	Model 1					
Variable	Step 1	*B*	β	Step 2	*B*	β	95% CI for *B*
constant		36.96**			39.78**		[21.42 - 58.14]
child age		-0.25**	-0.37**		-0.26**	-0.39**	[-0.33, - 0.20]
child gender		2.81	0.05		3.02	0.06	[-1.71, 7.76]
first anesthetic		-1.60	-0.03		-1.93	-0.04	[-7.23, 3.38]
[mYPAS(1)] [a]		1.19**	0.35**		1.17**	0.34**	[0.87, 1.47]
parental state anxiety [b]		0.03	0.01		0.00	0.00	[-0.26,0.28]
parental trait anxiety [b]		0.17	0.05		0.07	0.02	[-0.26, 0.39]
PE [c]		-4.00	-0.10*		-4.00	-0.10*	[-7.55, -.36]
previous parental experience		-0.62	0.12		-0.43	-0.01	[-5.60, 4.75]
gender parent		-3.07	-0.05		-3.25	-0.05	[-8.88, 2.15]
preoperative internalizing problems [d]					0.81*	0.19**	[0.33, 1.29]
preoperative externalizing problems [d]					-0.31	-0.08	[-0.75, 0.13]
R^2		.31			.33		
F		17.86**			5.76**		
ΔR^2					.022		
ΔF					12.10		

Note. N.=401. CI = confidence interval. *P<0.05; **P≤0.001. [a][mYPAS(1)] modified Yale preoperative anxiety scale in the holding area; [b]parental anxiety (Spielberger's State-Trait anxiety Inventory); [c]PE, Parental education; [d]preoperative internalizing and externalizing problems - Child Behavior Checklist/1,5-5 and 6-18 as assessed by the accompanying mother or father.

After adjustment for confounders, no association was found between CBCL internalizing, externalizing behavior and ED. Younger age of the child and the first experience with anesthesia were significant predictors of ED. Overall, approximately one tenth of the variance in emergence delirium could be explained by the variables included in the model (R^2 =0.11).

DISCUSSION

This study examined whether CBCL scores, reflecting emotional/behavioral problems during the last 6 months prior to surgery, were predictive of anxiety during induction of anesthesia and of ED in children admitted for day-care surgery. Internalizing problems were indeed significant predictors of anxiety at induction, as were the child's age, parental education and child's state anxiety on admission. Younger age also significantly

Table IV Prediction of postoperative emergence delirium: results of the final linear regression model

	ED at induction as measured with PAED sum scores					
	Model 2					
Variable	Step 1 *B*	β	Step 2	*B*	β	95% CI for *B*
constant	26.63**			25.96**		[19.91, 32.01]
child age	-0.03*	-0.16*		-0.02*	-0.14*	[-0.05, -0.00]
child gender	1.04	0.07		0.93	0.07	[-0.63, 2.49]
first anesthetic	-1.90*	-0.14*		-1.84*	-0.13*	[-3.56, -0.13]
parental state anxiety [a]	0.04	-0.05		-0.04	0.06	[-0.05, 0.13]
parental trait anxiety [a]	-0.02	-0.02		-0.05	-0.06	[-0.16, 0.06]
PE [b]	0.17	0.02		0.31	0.03	[-0.86, 1.48]
previous parental experience	-0.41	-0.03		-0.45	-0.03	[-2.15, 1.26]
gender accompanying parent	-0.08	-0.00		-0.01	-0.00	[-1.81, 1.80]
dichotomy ENT [c] *versus* other surgery	1.53 †	0.11 †		1.52 †	0.11 †	[-.09, 3.01]
use of α_2-adrenergic agonist (clonidine)	0.60	0.04		0.66	0.05	[-0.88, 2.19]
[mYPAS(3)] [d]	0.01	0.05		0.01	0.05	[-0.02, 0.05]
preoperative internalizing problems [e]				-0.01	-0.01	[-0.17, 0.14]
preoperative externalizing problems [e]				0.12 †	0.12 †	[-0.02, 0.26]
R^2	.10			.11		
F	3.03**			1.85		
ΔR^2				.01		
ΔF				1.18		

Note. N.=343. CI = confidence interval. *P<0.05; **P<0.01; †P≤0.1. Sum scores Pediatric Anesthesia Emergence Delirium (PAED) scale = PAED(5) + PAED(10) + PAED(15); [a]parental anxiety (Spielberger's State-Trait anxiety Inventory); [b]PE, Parental education; [c]ENT, ear-nose-throat surgery; [d][mYPAS(3)], modified Yale preoperative anxiety scale at induction; [e]preoperative internalizing and externalizing problems - Child Behavior Checklist/1,5-5 and 6-18 as assessed by the accompanying mother or father.

predicted ED (consistent with earlier findings[18,24]) as did the first anesthetic experience. ED could not be predicted by preoperative emotional/behavioral problems of the child.

Prediction of anxiety during induction

CBCL internalizing problems significantly predicted anxiety at induction. This is in line with the results of a pilot study in adolescents[15]. Also consistent with previous findings, age appeared to be an important risk factor for anxiety at induction[10,11]. Furthermore, anxious behavior already expressed on admission in the holding area [mYPAS(1)], was strongly associated with anxiety at induction. This is consistent with studies documenting that behavior in the direct preoperative period predicted anxiety at induction[2,3,6,27,28].

Finally, parental education appeared to be a factor that influenced anxiety at induction: children of parents with higher education were less anxious. For that matter, it is well-known from previous studies that emotional/behavioral problems (assessed by the CBCL) are associated with parental SES[29,30].

Not all factors included in our model indeed appeared to be predictors of anxiety at induction. In contrast to internalizing problems, externalizing problems did not show up as a predictor of anxiety at induction in our final model 1. Although literature demonstrated that externalizing and internalizing scores are moderately correlated[16,17].

Furthermore, in contrast with earlier findings,[11,30] parental state anxiety was not an independent risk factor for anxiety at induction. Fathers reported less state anxiety compared to mothers, yet no parental gender effect was found. Parental anxiety was higher in parents of children younger than five years than in parents with older children – an outcome that corresponds to preceding findings[31]. However, as Davidson *et al.*[10] pointed out, the child-parental interaction cannot be reflected by taking only parental anxiety into account.

Children undergoing anesthesia display a wide range of distress and non-distress behavior[2] The mYPAS only measures state anxiety[23]. Presumably it is easier to assess anxious behavior at induction in younger children, since they express their anxiety more openly (e.g. by crying) compared to older children, in whom anxiety may be less visible. Rather these older children might not express it openly but tend to keep it to themselves or pretend to be brave.

From a methodological perspective, it is worthwhile mentioning that anxiety and ED were considered as psychological constructs on a continuum. Therefore we used no cut-off scores and we performed multiple rather than logistic regression. Moreover, it is still subject of debate which cut-off value should be used to dichotomize anxiety levels or diagnose ED[32.]

Prediction of ED

The child's age and first experience with anesthesia were found to be independent predictors of ED, which is in line with previous research[33,34]. In contrast with earlier studies[4,7,35] preoperative anxiety was not a significant predictor for ED in the multivariate regression. This may be explained by the use of different non-validated assessment tools for measuring ED in these earlier studies. In line with the proposals of Locatelli *et al*[36],

the present study measured ED with a validated tool, and children with at least moderate pain were excluded from the final analysis to leave out a confounding influence of postoperative pain. Moreover our results are conform to recent findings by Bortone *et al*[37]. Although not statistically significant, there was a trend (P=0.1) towards an increased risk for ED in children with more externalizing problems. An explanation might be that children who are more prone to acting out their behavior, might be more prone to ED. This could be a topic for future research. ED seems to be very limited in time with almost complete disappearance after 15 minutes, which is consistent with earlier findings[35].

A univariate analysis confirmed an association between ENT and ED – consistent with previous reports[8,34] – but this was not sustained in multivariate regression, although it was nearly significant (P =0.06). No association was found with α_2-adrenergic agonist (clonidine) and ED which is in accordance with previous findings[8,18,34].

Strengths and limitations of the study

The strengths of this prospective study include: the large sample size and the use of standardized assessment tools at defined time points. A well-validated screening instrument (CBCL) was used to screen emotional/behavioral problems of children during the preceding 6 months period[16,17]. Another advantage of the CBCL is that it covers a wide range of emotional/behavioral problems and a broad age range (1.5 to 18 years). The broad range of surgical procedures is both an advantage as well as a limitation. Another limitation is that there was no preoperative family visit with the anesthesiologist before the day of surgery.

To what extent the use of only one parent having filled out the CBCL may have influenced our results, is unknown. It would be better to use a multi-informant approach (both parents or even a caregiver or teacher), so that multi-informant information can be combined for the final analysis. For practical reasons it was impossible to organize this in our setting. Having the CBCL completed on the day of surgery could have influenced the accompanying parents' perception and their ratings as to the child's typical behavior.

The anesthesia protocol could not be standardized due to the wide range of surgical procedures, which may have generated biases. This may also have contributed to our findings that the CBCL did not predict ED. For future research it is recommended to investigate the present research questions using more homogenous prospective patient samples and more standardized anesthetic procedures.

CONCLUSIONS

This study has focused attention on the complex relationships between emotional/behavioral functioning of a child and anxiety at induction of anesthesia and emergence delirium. Our data provide a strong body of evidence that CBCL scores *per se* can predict anxiety at induction. Not only is the assessment of anxiety in the direct preoperative period important, but also pre-existing perioperative emotional/behavioral problems related to anxious behavior should be considered. In addition to internalizing problems during the last 6 months prior to surgery, younger age of the child, lower parental education status and anxious behavior on admission are significant predictors of anxiety during anesthetic induction.

Thus the CBCL can provide anesthesiologists insight into the anxiety that the child will experience during induction. It may serve as tool to tailor the anesthesia procedure to the individual needs of emotionally vulnerable children undergoing surgery. As to clinical implications: the CBCL is easy to deliver, takes only 15 minutes to complete. However, in a busy clinical setting, this may be a burden for both the staff and parents. Future research should focus on implementing the CBCL as a tool to screen for preoperative anxiety, by delivering and scoring it in the preoperative period at home, online, in an adequately protected and anonymous web-based area.

APPENDIX 1

The modified Yale Preoperative Anxiety Scale

Activity

1. Looking around, curious, playing with toys, reading (or other age-appropriate behavior); moves around holding area/treatment room to get toys or to go to parent; may move toward operating room equipment
2. Not exploring or playing, may look down, fidget with hands, or suck thumb (blanket); may sit close to parent while waiting, or play has a definite manic quality
3. Moving from toy to parent in unfocused manner, non-activity-derived movements; frenetic/frenzied movement or play; squirming, moving on table; may push mask away or cling to parent
4. Actively trying to get away, pushes with feet and arms, may move whole body; in waiting room, running around unfocused, not looking at toys, will not separate from parent, desperate clinging

Vocalizations

1. Reading (nonvocalizing appropriate to activity), asking questions, making comments, babbling, laughing, readily answers questions but may be generally quiet; child too young to talk in social situations or too engrossed in play to respond
2. Responding to adults but whispers, "baby talk,"only head nodding
3. Quiet, no sounds or responses to adults
4. Whimpering, moaning, groaning, silently crying
5. Crying or may be screaming "no"
6. Crying, screaming loudly, sustained (audible through mask)

Emotional expressivity

1. Manifestly happy, smiling, or concentrating onplay
2. Neutral, no visible expression on face
3. Worried (sad) to frightened, sad, worried, or tearful eyes
4. Distressed, crying, extreme upset, may have wide eyes

State of apparent arousal

1. Alert, looks around occasionally, notices or watches what anesthesiologist does (could be relaxed)
2. Withdrawn, sitting still and quiet, may be sucking on thumb or have face turned into adult
3. Vigilant, looking quickly all around, may startle to sounds, eyes wide, body tense

4. Panicked whimpering, may be crying or pushing others away, turns away

Use of parents

1. Busy playing, sitting idle, or engaged in age appropriate behavior and doesn't need parent; may interact with parent if parent initiates the interaction
2. Reaches out to parent (approaches parent and speaks to otherwise silent parent), seeks and accepts comfort, may lean against parent
3. Looks to parent quietly, apparently watches actions, doesn't seek contact or comfort, accepts it if offered or clings to parent
4. Keeps parent at distance or may actively withdraw from parent, may push parent away or desperately clinging to parent and not let parent go

APPENDIX 2

The Pediatric Anesthesia Emergence Delirium (PAED) scale

1. The child makes eye contact with the caregiver.
2. The child's actions are purposeful.
3. The child is aware of his/her surroundings.
4. The child is restless.
5. The child is inconsolable.

Items 1, 2, and 3 are reversed scored as follows: 4 = not at all, 3 = just a little, 2 = quite a bit, 1 = very much, 0 = extremely. Items 4 and 5 are scored as follows: 0 = not at all, 1 just a little, 2 = quite a bit, 3 = very much, 4 = extremely.

The scores of each item are summed to obtain a total score

APPENDIX 3

The Child Behavior Checklist (CBCL)

Sample of 5 selected items (question)

1. Afraid to try new things 0 – 1 – 2
2. Demands must be met immediately 0 – 1 – 2
3. inattentive, easily distracted 0 – 1 – 2
4. Temper trantrums or hot temper 0 – 1 – 2
5. Wants a lot of attention 0 – 1 – 2

Each item can be scored by answering either: 0 = not true; 1 = Somewhat or Sometimes True; 2 Very True or Often True

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