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# A Visual Analogue Scale to assess anxiety in children during anesthesia induction (VAS-I): results supporting its validity in a sample of day care surgery patients

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## ABSTRACT

**Background:** The modified Yale Preoperative Anxiety Scale is widely used to assess children's anxiety during induction of anesthesia, but requires training and its administration is time-consuming. A Visual Analogue Scale, in contrast, requires no training, is easy-to-use and quickly completed.

**Aim:** To provide preliminary support for a Visual Analogue Scale to assess anxiety during induction of anesthesia and to determine cut-offs to distinguish between anxious and non-anxious children.

**Methods:** Four hundred one children (1.5 – 16 years) scheduled for daytime surgery were included. Children's anxiety during induction was rated by parents and anesthesiologists on a Visual Analogue Scale and by a trained observer on the modified Yale Preoperative Anxiety Scale. Psychometric properties assessed were: 1. concurrent validity (correlations between parents' and anesthesiologists' Visual Analogue Scale and modified Yale Preoperative Anxiety Scale scores); 2. construct validity (differences between subgroups according to the children's age and the parents' anxiety as assessed by the State – Trait Anxiety Inventory); 3. cross-informant agreement using Bland-Altman analysis; 4. determine cut-offs to distinguish between anxious and non-anxious children (reference: modified Yale Preoperative Anxiety Scale ≥ 30).

**Results:** Correlations between parents' and anesthesiologists' Visual Analogue Scale on the one hand and modified Yale Preoperative Anxiety Scale scores on the other were strong (0.68 and 0.73 respectively). Visual Analogue Scale scores were higher for children ≤ 5 years compared to children aged ≥ 6. Visual Analogue Scale scores of children of high-anxious parents were higher than those of low-anxious parents. The mean difference between parents' and anesthesiologists' Visual Analogue Scale scores was 3.6, with 95% limits of agreement [-56.1 to 63.3]. To classify anxious children, cut-offs for parents (≥ 37 mm) and anesthesiologists (≥ 30 mm) were established.

**Conclusions:** The present data provide preliminary data for the validity of a Visual Analogue Scale to assess children's anxiety during induction.

*Keywords: Anesthesia, Child, Anxiety, Psychometrics, Pain Measurement, Visual Analogue Scale*

## INTRODUCTION

Preoperative anxiety is an important problem in children undergoing anesthesia[1,2]. It has been associated with emergence delirium and postoperative behavioral changes[3,4]. The highest state anxiety levels during the entire perioperative period are seen at the moment of induction[2,5]. Children with high levels of preoperative state anxiety are assigned higher postoperative pain scores and require more analgesics, both in hospital and at home[5-8]. Furthermore, stressful and anxious experiences may compromise future medical contacts[9].

Children's preoperative anxiety at induction is often assessed with the modified Yale Preoperative Anxiety Scale (m-YPAS)[10-12], which is a well validated tool widely used in research. However, the m-YPAS has some major drawbacks for clinical practice: it should be administered by trained raters, and is lengthy and therefore time consuming.

Visual Analogue Scales (VAS) are widely employed to assess both general anxiety[13] and pre- and postoperative anxiety[14,15]. In contrast to the m-YPAS, they require no training, are simple and not time consuming. Bringuier *et al*[7] previously validated a perioperative VAS for anxiety, for use in children aged 7 – 16 years. Previous research has failed to investigate whether this VAS is also valid to assess perioperative anxiety for younger children. It is important to fill this knowledge gap, bearing in mind that very young children commonly exhibit more overt anxious behavior compared to older children[2,12,16].

Given that anxiety peaks during induction, it would seem best to assess the anxiety level at that moment. By rating anxiety during induction, parents and anesthesiologists focus their attention on the child's anxiety. Consequently, postoperative behavior and pain management could be tailored to the child's needs. This requires a valid, easy-to-use assessment instrument for use by parents and anesthesiologists.

Therefore, the aim of this study was to obtain preliminary evidence for the validity of the VAS-anxiety (VAS-I) for use by anesthesiologists (VAS-IA) and parents (VAS-IP) in children over a broad age range (1.5 – 16 yrs) during induction of anesthesia. More specifically, we aimed to investigate concurrent validity (by assessing correlations between the VAS-IP and VAS-IA, on the one hand, and m-YPAS scores on the other hand) and construct validity (by analyzing differences between subgroups according to the children's age and the parents' anxiety). Furthermore, we aimed to assess cross-informant agreement between VAS-IP and VAS-IA scores and to establish cut-offs for the VAS-IP and VAS-IA to distinguish between anxious children and non-anxious children, with the m-YPAS as reference standard.

## MATERIALS AND METHODS

### Design and setting

This 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 reported following the STROBE statement for observational studies. The data gathering was part of a larger prospective cohort study[12].

### Inclusion and exclusion criteria[12]

Children between the ages of 1.5 – 16 years who underwent daytime surgery between January 2011 and February 2012 and were accompanied by a parent during induction were eligible. Further inclusion criteria were as follows: 1. an American Society of Anesthesiologists 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 a good understanding of the Dutch language; and 4. no premedication. Children with known intellectual disabilities and those suspected of having malignant hyperthermia were excluded.

All parents and children received a standard information brochure and watched an instructive video on the anesthesia procedure immediately prior to entering the operating theatre. Upon admission, the accompanying parent's demographics were registered, and parental anxiety was assessed with Spielberger's State – Trait Anxiety Inventory (STAI)[17]. A cut-off value of ≥ 46 on the state subscale of the STAI was used to distinguish between low and high parental state anxiety[18]. The STAI has been validated for the Dutch population[19].

Seven pediatric anesthesiologists participated in the study. All inductions were performed via sevoflurane inhalation, which is standard practice in our hospital.

### Child anxiety assessment during induction

The child's anxiety during induction was rated by: 1. completion of the VAS-I during anesthesia induction by the attending pediatric anesthesiologist and accompanying parent (VAS-IA, VAS-IP, respectively); 2. completion of the m-YPAS during induction by one of three trained raters.

Both the VAS-IP and VAS-IA consist of a 100-mm horizontal line with two extremes, '*not anxious*' (left) and '*very anxious*' (right), on which the parent or anesthesiologist marks the point that represents their perception of the child's anxiety. An independent researcher determined the score by measuring the distance in millimeters from the left-hand extreme to the marked point (Figure 1).

**Figure 1** ● Visual Analogue Scale Anxiety during Induction (VAS-I).

**Not anxious**　　　　　　　　　　　　　　　　　　　　**Very anxious**

The m-YPAS[10] is a structured observational instrument to measure anxiety both in the holding area and during induction. It consists of five domains: activity, emotional expressivity, state of arousal, vocalization and use of parents (children seek support by parents), each with 4 or 6 items. The single summary score ranges from 23 to 100 and is obtained by summating the partial weights of each category. The m-YPAS has good to excellent psychometric properties, as documented by Kain and co-workers[10]. The authors reported good inter- and intra-observer agreement (κ statistics ranging between 0.63 and 0.90), high concurrent validity (correlation with the STAI for children: coefficient r = 0.79), and high construct validity of the instrument. To identify anxious children, they determined a cut-off value of 30[2].

### Statistical analysis

Parental and child demographic characteristics and psychological scores are presented as means and standard deviations, as medians with interquartile range or as numbers and percentages (categorical data).

We set out to describe the concurrent validity of the VAS-I, which involves comparing a new measure to an existing, valid measure. Therefore we assessed correlations between on the one hand both the VAS-IP and VAS-IA and on the other hand the m-YPAS, using Pearson's correlation coefficients and two-tailed tests of significance ($H_0$:population correlation coefficient zero). According to Cohen's criteria[20], correlations of 0.10 - 0.29 are considered small, 0.30 – 0.49 medium and above 0.50 large.

Construct validity can be understood as the extent to which an instrument measures the construct or concept that it is designed to measure. This can be established by studying whether the instrument is sensitive to differences between subgroups that are known

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to score differently from each other (referred to as known-groups validity). To this aim we created two subgroups according to the children's age [1.5 – 5 yrs vs. 6 – 16 yrs] and parents' anxiety level [cut-off value of ≥ 46 on the state subscale of the STAI]. Based on literature[2,12], it was hypothesized that younger children and children of anxious parents would score higher on the VAS-I. For these analyses, Mann-Whitney *U* tests were used.

Then we determined cross-informant agreement, which reflects the strength between ratings of two different types of raters on an instrument. The agreement between parents and anesthesiologists was analyzed using a Bland-Altman plot (showing the mean difference and the 95% limits of agreement).

Lastly, receiver operating characteristic (ROC) curves were calculated to determine cut-offs on the VAS-IP and VAS-IA to distinguish between anxious and non-anxious children, with the m-YPAS as reference (cut-of value on m-YPAS ≥ 30). The optimal cut-offs on the ROC for the VAS-IP and VAS-IA were chosen according to the Youden index method, which means that we choose the point of the ROC-curve as a cut-off where the equation "sensitivity + specificity – 1" is maximal.

All analyses were conducted with IBM SPSS Statistics for Windows, Version 19.0 (Armonk, NY, USA; IBM Corp.) and MedCalc Statistical Software version 14.12.0 (MedCalc Software bvba, Ostend, Belgium; http://www.medcalc.org; 2014).

## RESULTS

During the study period 410 children were approached. Of these, 9 children could not be included, due to practical or logistic reasons (n = 4) or refusal after initial approval (n = 5). The final sample consisted of 401 children, with a mean age of almost 6 years and a male predominance (60%). Approximately 76% of the accompanying parents were mothers, and 52% had previous experience with induction (Table 1). Four hundred parents completed a VAS-IP and the seven attending anesthesiologists made 397 VAS-IA assessments. Table 2 presents scores on the VAS-IA, VAS-IP and m-YPAS, broken down for the child's age category and parental anxiety level.

### Concurrent validity

Strong positive correlations were found between the VAS-IP and m-YPAS (N = 400; r = .67; *P* = .000) and between the VAS-IA and m-YPAS (N = 397; r = 0.79; *P* =.000)**.**

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**Table 1** ● Characteristics of the children and accompanying parent(s) during induction

| | Children | | Accompanying parents |
|---|---|---|---|
| | N. =401 | | N. =401 |
| **demographic data** | | **demographic data** | |
| | | | |
| sex, male | 241 (60.1%) | sex, mother | 305 (76.1%) |
| age, months | 70.2 ± 41 | parental age (yrs) | 35.4 ± 6 |
| native Belgian | 383 (95.5%) | native Belgian | 367 (91.5%) |
| | | **education** | |
| | | no education / primary school | 34 (8.5%) |
| | | high school | 176 (43.9%) |
| | | further studies / university | 161 (40.1%) |
| | | missing values | 30 (7.5%) |
| | | **previous experience with induction** | 207 (51.8%) |
| **surgical procedure** | | | |
| adenotonsillectomy | 153 (38.2%) | | |
| dental surgery | 64 (16.0%) | | |
| urology | 63 (15.7%) | | |
| T-tube | 43 (10.7%) | | |
| general surgery | 36 (9.0%) | | |
| orthopedic surgery | 26 (6.5%) | | |
| ophthalmology | 13 (3.2%) | | |
| gastroenterology | 3 (0.7%) | | |
| | | | |
| [a]ASA 1 | 378 (94.3%) | | |
| [a]ASA 2 | 23 (5.7%) | | |
| | | [b]**anxiety assessment,** | |
| | | STAI - state anxiety | 37.8 ± 11 |
| | | STAI - trait anxiety | 34.4 ± 8 |

Data are expressed as means with ± standard deviationsRO or as numbers (percentages); [a]ASA, American Society of Anesthesiologists; [b]STAI, Parental anxiety (Spielberger's State-Trait Anxiety Inventory) – state sub-scale.

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## Construct validity

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### VAS-I scores in relation to age group

The VAS-IP scores assigned to younger children (1.5 – 5 yrs) were higher than the scores assigned to older children (6 – 16 yrs) (medians of 44.5 versus 25.0 respectively; *P* = 0.0005). This held for the VAS-IA scores as well (medians of 45.0 versus 10.0; *P* < .0001) (Table 2).

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**Table 2** • Assessments of children's state anxiety during induction

| | All Children | Aged 1.5 –5 yrs. | Aged 6–16 yrs. |
|---|---|---|---|
| | N. = 401 | N. = 250 | N. = 151 |
| [a]m-YPAS | 40.0 [28.3-73.3] | 50.0 [31.7-86.7] | 28.0 [23.3-46.7] |
| [b]VAS-IP | 40.0 [9.25-44.0] | 44.5 [15.0-73.0] | 25.0 [5.0-55.5] |
| [c]VAS-IA | 20.0 [6.0-75.0] | 45.0 [10.0-81.0] | 10.0 [2.5-28.5] |
| | **Non-anxious parents** | **Anxious parents** | |
| | [d]**STAI state subscale < 46** | [d]**STAI state subscale ≥ 46** | |
| | N. = 314 | N. = 86 | |
| [a]m-YPAS | 37.0 [28.3-73.3] | 47.5 [33.3-76.7] | |
| [b]VAS-IP | 30.0 [8.0-63.0] | 57.0 [23.5-84.5] | |
| [c]VAS-IA | 18.0 [6.0-70.0] | 35.0 [10.0-83.0] | |

Data are expressed as medians with interquartile range (IQR); [a]mYPAS, modified Yale Preoperative Anxiety scale during induction with mask; [b]VAS-IP, Visual Analogue Scale Anxiety during Induction by parents; [c] VAS-IA, Visual Analogue Scale Anxiety during Induction by the anesthesiologist; [d]STAI, Parental anxiety (Spielberger's State-Trait Anxiety Inventory) – state subscale.

### *VAS-I scores in relation to parental anxiety level*

Based on their STAI state scores, 86 (21.5%) parents were classified as high-anxious (mean STAI score = 53 ± 6), and 314 (78.5%) as low-anxious (mean STAI score = 34 ± 6).

The VAS-IP ratings for children of high-anxious parents were higher than those for children of low-anxious parents (medians of 57.0 versus 30.0; $P = 0.0006$). This pattern was also found for the anesthesiologists' scores (medians of 35.0 versus 18.0; $P = 0.024$) (Table 2).

### Cross-informant agreement

To determine the agreement between the parents' and the anesthesiologists' ratings of the children's anxiety, a Bland-Altman plot was constructed (Figure 2). In this graphical method, the differences between the two scores (i.e. the VAS-IP and VAS-IA) are plotted against the averages of the two scores. As shown, the mean difference between the VAS-IP and the VAS-IA is 3.6 (standard deviation = 30.5), the VAS-IP being the highest on average. The 95% limits of agreement between the two ratings ranged from -56.1 to 63.3. There seemed to be no obvious pattern of agreement over the range of the measurements.

**Figure 2** • Cross-informant agreement
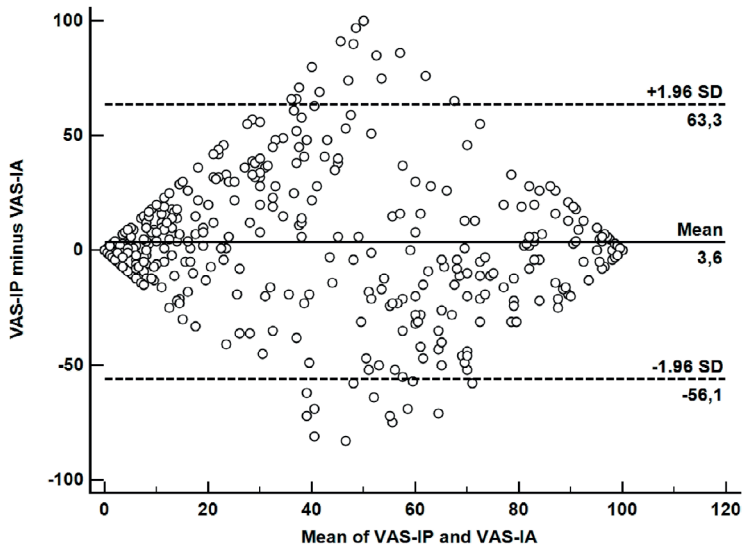


Bland-Altman plot showing the mean difference and the 95% limits of agreement. VAS-IP, Visual Analogue Scale Anxiety during Induction by parents; VAS-IA, Visual Analogue Scale Anxiety during Induction by anesthesiologists

## Cut-offs on the VAS-IP and VAS-IA

As assessed with the m-YPAS, 269 children (67.2%) were anxious during induction. The sensitivity and specificity of the VAS-IP and VAS-IA for predicting anxiety were assessed using an ROC analysis in order to identify the optimal cut-offs. The *ROC curve analysis for parents* (VAS-IP: area under the curve [AUC] = 0.83; [95% CI: 0.79-0.87], *P* = 0.000) (*Figure* 3) identified a score of > 37 mm on the VAS-IP as the cut-off to distinguish between anxious and non-anxious children. For this cut-off, the sensitivity (true positive rate) was 70%, and the specificity (true negative rate) was 86%, with negative predictive value of 58% and a positive predictive value of 91%. The *ROC analysis for anesthesiologists* (VAS-IA: AUC = 0.82; [95% CI: 0.78-0.86], *P* = 0.000) identified a VAS-IA score > 30 mm as cut-off, with a sensitivity of 61%, a specificity of 95%, a negative predictive value of 54% and a positive predictive value of 95%.

**Figure 3** ● Cut-points on the VAS-IP and VAS-IA to distinguish between anxious and non-anxious children using the m-YPAS as reference (cut-off value on m-YPAS ≥ 30).
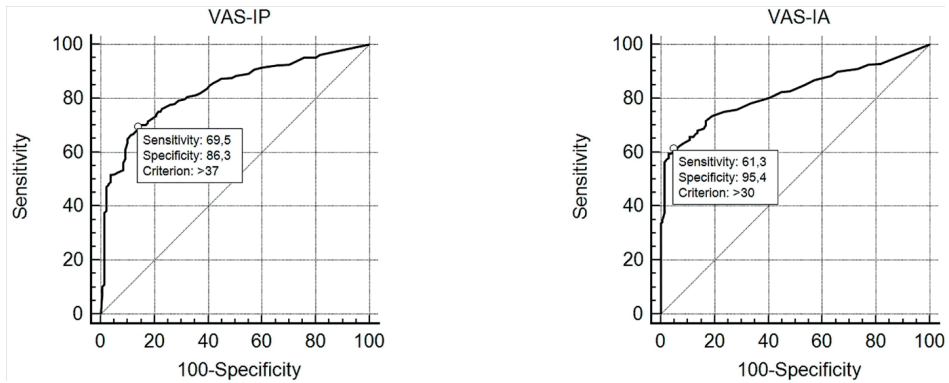


Comparison of receiver operating characteristic (ROC) curves for VAS-IP and VAS-IA for sensitivity (true-positive rate) and 100-specificity (false-positive rate)

## DISCUSSION

The results of this study provide preliminary data supporting the validity of the VAS-I to detect perioperative anxiety during anesthesia induction. This is of clinical importance, since children's perioperative anxiety has been associated with emergence delirium and post-hospital behavior changes. Moreover, perioperative anxiety is a crucial component of postoperative pain management [4,6,7]. In spite of this, the issue is significantly under-appreciated[4].

To assess the concurrent validity of the VAS-I, we compared the VAS-I to the m-YPAS. The results were encouraging, in that strong correlations were found both between the VAS-IA and the m-YPAS and between the VAS-IP and the m-YPAS. In a previous study investigators found that an anxiety VAS in the *holding area* could not satisfactorily predict a child's anxiety during induction as measured with the m-YPAS[14]. In contrast, we found a strong correlation between the VAS-I and the m-YPAS. This suggests that induction might be the best time to assess a child's anxiety. Indeed, children's state anxiety peaks during induction[2,8,11,12,16].

Construct validity of the VAS-I was considered in relation to a child's age group and parental anxiety. It is well established that a child's anxiety state as measured with the m-YPAS at induction is higher in toddlers and very young children when compared to older children and adolescents[2,12,16]. We hypothesized that the same pattern could be found in our sample, using the VAS-I. Our findings confirmed this hypothesis: VAS-I

scores were higher in the children aged up to 5 years compared to the children aged 6 to 16 years. This may be interpreted as a first indication of the construct validity of the scale. Moreover, this suggests that the VAS-I could be useful for a much broader age range (1.5 to 16 years) than previously reported[7], thus including the children who are too young to verbalize their emotions. Secondly, in a previous research study, parental anxiety was found to be associated with higher child anxiety during induction[2,12]. This study confirmed that high-anxious parents reported higher scores on the VAS-IP as compared to low-anxious parents, which further supports the construct validity of the VAS-I. The simultaneously obtained anesthesiologists' ratings on the VAS-IA and m-YPAS scores were also higher for children of high-anxious parents than for children with low-anxious parents, indicating that this finding does not reflect a reporter bias on the side of the parents. The correlation between our findings and previously established patterns is supportive of the construct validity of our scale.

Analysis of cross-informant agreement showed that the mean difference between the VAS-I ratings of parents and anesthesiologists was quite small (3.6 on a 100-point scale), while there was no strong relationship between the difference and the magnitude of the ratings.

To assess the sensitivity and specificity of the VAS-I for predicting anxiety, an ROC analysis was performed. This analysis identified optimal cut-offs of 37 mm for the VAS-IP and 30 mm for the VAS-IA. Establishing cut-offs is important from a clinical perspective, as they permit identification of children with high anxiety levels during induction. Further studies are required in different settings and with different populations to establish the accuracy and appropriateness of these cut-offs.

We suggest that it is worthwhile for parents to complete the VAS-I. Other rating systems, such as the Pediatric Anesthesia Behavior score[11], do not require a parental rating. Having parents rate their child's anxiety levels potentially makes them more aware of their child's vulnerability. This strategy fits well with the concept of family-centered pediatric perioperative care based on collaboration between patients, families and health care professionals and the involvement of parents in the care of their child[21]. Anxiety management is an important component in this approach. Once it is known that a child has shown high perioperative anxiety, both the anesthesiologists and the parents will be aware that the child is at risk for higher postoperative pain levels[6,11]. Completing the VAS enables the anesthesiologists and parents to focus their attention towards more vulnerable, highly anxious children. In a busy surgical day-care center, it may be more feasible to complete the easy and quick VAS-IA and VAS-IP than the time-consuming m-YPAS.

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The strengths of this study include the large sample size, broad age range, and a wide variety of surgical procedures. Some limitations of the study need to be addressed. The VAS-I was tested in a single institution on a specific population and this study does not prove validity with respect to its use in a wider context. Also, none of the children received premedication and all inductions were performed by inhalation. It is unknown to what extent this approach could have influenced the results. From a more general point of view, validation of a new scale is a complex matter because it requires information concerning reliability (inter-rater, intra-rater, test-retest and internal consistency) and validity (content, construct and criterion related). In this study, not all different forms of validity have yet been tested, therefore future research is needed to confirm the validity of the VAS-I. Furthermore, no analyses of reliability were carried out. It would have been interesting, for example, to gain insight in the intra-rater reliability, but this fell outside the scope of the study.

## CONCLUSIONS

The data of this study provide some indication for the validity of the VAS-IP and VAS-IA to assess children's state anxiety during induction. These assessments take only a few seconds to complete and their results can be incorporated into global patient management.

## DISCLOSURES

## ACKNOWLEDGEMENTS

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