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Original Research Article

Preoperative Anxiety Scales and Their Predictive Value for Anesthetic Requirements: A Prospective Observational Study

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Abstract

Background: Preoperative anxiety is a prevalent psychological response among surgical patients that may influence perioperative outcomes and anesthetic consumption. Various validated instruments exist for quantifying anxiety levels, yet their utility in predicting anesthetic requirements remains incompletely characterized in contemporary clinical practice.

Methods: This prospective observational study enrolled 150 adult patients (ASA I-III) scheduled for elective surgery under general anesthesia. Preoperative anxiety was assessed using the State-Trait Anxiety Inventory (STAI), Amsterdam Preoperative Anxiety and Information Scale (APAIS), and Visual Analog Scale for Anxiety (VAS-A). Anesthetic requirements were standardized using bispectral index (BIS) monitoring. Primary outcomes included propofol induction dose, intraoperative fentanyl consumption, and sevoflurane end-tidal concentration requirements.

Results: Patients with high anxiety (STAI-State ≥45) required significantly higher propofol induction doses (2.34 ± 0.42 mg/kg vs. 1.92 ± 0.38 mg/kg, $p < 0.001$) and greater intraoperative fentanyl consumption (4.82 ± 1.24 μg/kg/hr vs. 3.68 ± 1.08 μg/kg/hr, $p < 0.001$) compared to low-anxiety patients. STAI-State scores demonstrated the strongest correlation with total anesthetic requirements ($r = 0.64$, $p < 0.001$). APAIS anxiety subscale scores ≥13 predicted increased anesthetic consumption with 78.4% sensitivity and 72.6% specificity.

Conclusion: Preoperative anxiety scales, particularly STAI-State and APAIS, demonstrate significant predictive value for anesthetic requirements. Routine preoperative anxiety assessment may facilitate individualized anesthetic planning and optimize drug administration.

Keywords: Preoperative anxiety; STAI; APAIS; Anesthetic requirements; BIS monitoring; Propofol; Fentanyl.

Introduction

Preoperative anxiety represents one of the most common psychological responses experienced by patients awaiting surgical intervention, affecting an estimated 60-80% of the surgical population [1]. This emotional state encompasses a complex constellation of fears including concerns about anesthesia, surgical outcomes, pain, and loss of control [2]. Beyond its impact on psychological well-being, preoperative anxiety has been associated with numerous adverse perioperative outcomes including increased postoperative pain, prolonged recovery, and higher analgesic requirements [3].

The relationship between psychological states and anesthetic sensitivity has garnered considerable research attention over recent decades. Maranets and Kain demonstrated that anxious patients exhibit altered responses to anesthetic agents, potentially requiring modified dosing strategies [4]. This phenomenon has been attributed to complex neurobiological mechanisms involving the hypothalamic-pituitary-adrenal axis, autonomic nervous system activation, and alterations in neurotransmitter systems [5].

Several validated instruments have been developed for quantifying preoperative anxiety. The State-Trait Anxiety Inventory (STAI), developed by Spielberger, remains the gold standard for measuring situational and dispositional anxiety [6]. The Amsterdam Preoperative Anxiety and Information Scale (APAIS), introduced by Moerman and colleagues, was specifically designed for the surgical setting and offers a more concise assessment tool [7]. Additionally, the Visual Analog Scale for Anxiety (VAS-A) provides a rapid, single-item measure suitable for busy clinical environments [8]. Contemporary anesthetic practice increasingly emphasizes individualized drug administration guided by objective monitoring. Bispectral index (BIS) monitoring enables standardized titration of anesthetic depth, allowing more accurate assessment of inter-individual variability in drug requirements [9]. Despite this technological advancement, preoperative identification of patients likely to require higher anesthetic doses remains challenging. Recent investigations have explored the predictive utility of anxiety assessment for anesthetic consumption. Caumo et al. reported significant correlations between preoperative psychological variables and analgesic requirements [10]. Similarly, Kain and colleagues demonstrated associations between anxiety levels and postoperative opioid consumption in various surgical populations [11]. However, studies examining the predictive value of multiple anxiety instruments for intraoperative anesthetic requirements using standardized BIS-guided protocols are limited [12].

Furthermore, existing literature has not adequately addressed which anxiety assessment tool offers superior predictive accuracy for anesthetic requirements, nor has it established clinically useful cut-off values for identifying high-risk patients [13]. This knowledge gap impedes the translation of anxiety assessment into practical clinical decision-making.

The aim of this study was to evaluate the predictive value of three commonly used preoperative anxiety scales (STAI, APAIS, and VAS-A) for anesthetic requirements during BIS-guided general anesthesia, and to determine optimal cut-off scores for predicting increased anesthetic consumption.

Materials and Methods

Study Design and Setting: This prospective observational cohort study was conducted at the tertiary care hospital.

Sample Size Calculation: Based on preliminary data suggesting a correlation coefficient of 0.30 between anxiety scores and anesthetic requirements, a minimum sample size of 138 patients was required to achieve 90% power at a significance level of 0.05 using two-tailed testing. To account for potential dropouts and incomplete data, we planned to enroll 160 patients.

Participant Selection: Inclusion criteria comprised: age 18-70 years, ASA physical status I-III, scheduled for elective surgery under general anesthesia with anticipated duration of 60-180 minutes, and ability to comprehend and complete questionnaires. Exclusion criteria included: emergency surgery, chronic psychiatric disorders or current psychotropic medication use, cognitive impairment, chronic opioid or benzodiazepine use, known substance abuse, pregnancy, severe hepatic or renal dysfunction, and anticipated difficult airway requiring awake intubation techniques.

Preoperative Anxiety Assessment: Anxiety assessments were conducted in a quiet preoperative holding area approximately 60-90 minutes before scheduled surgery. Three validated instruments were administered by trained research personnel:

State-Trait Anxiety Inventory (STAI): This 40-item self-report questionnaire comprises two subscales measuring state anxiety (STAI-S, 20 items) and trait anxiety (STAI-T, 20 items). Each item is rated on a 4-point Likert scale, with subscale scores ranging from 20-80. Higher scores indicate greater anxiety.

Amsterdam Preoperative Anxiety and Information Scale (APAIS): This 6-item questionnaire includes an anxiety subscale (4 items, range 4-20) and an information desire subscale (2 items, range 2-10). Scores ≥13 on the anxiety subscale indicate clinically significant anxiety.

Visual Analog Scale for Anxiety (VAS-A): Participants marked their current anxiety level on a 100-mm horizontal line anchored by "no anxiety" (0) and "extreme anxiety" (100).

Anesthetic Protocol: No anxiolytic premedication was administered. Upon arrival in the operating room, standard monitoring was established including electrocardiography, non-invasive blood pressure measurement, pulse oximetry, and BIS monitoring (BIS Vista, Medtronic, and Dublin, Ireland). An intravenous line was secured and Ringer's lactate solution initiated. Anesthesia was induced with fentanyl 1.5 μg/kg followed by propofol administered at 30 mg every 10 seconds until loss of consciousness (defined as loss of verbal response and eyelash reflex). The total propofol induction dose was recorded. Rocuronium 0.6 mg/kg facilitated tracheal intubation.

Anesthesia was maintained with sevoflurane in oxygen-air mixture (FiO2 0.5) and supplemental fentanyl boluses. Sevoflurane concentration was titrated to maintain BIS values between 40-60. Additional fentanyl 25-50 μg was administered when heart rate or blood pressure increased >20% above baseline despite adequate BIS values. All anesthetic drug doses were recorded and adjusted for body weight and duration.

Outcome Measures: Primary outcomes included propofol induction dose (mg/kg), total intraoperative fentanyl consumption (μg/kg/hr), and mean end-tidal sevoflurane concentration (%). Secondary outcomes included time to loss of consciousness, recovery parameters (time to eye opening, extubation time), and postoperative opioid requirements in the first 24 hours.

Statistical Analysis: Statistical analyses were performed using SPSS version 27.0 (IBM Corporation, Armonk, NY) and MedCalc version 20.0. Continuous variables were assessed for normality using the Shapiro-Wilk test and expressed as mean ± standard deviation (SD) or median with interquartile range as appropriate. Categorical variables were expressed as frequencies and percentages.

Pearson or Spearman correlation coefficients were calculated to assess relationships between anxiety scores and anesthetic requirements. Multiple linear regression analysis was performed to identify independent predictors of anesthetic consumption. Patients were dichotomized into low-anxiety and high-anxiety groups based on established cut-offs, and group comparisons were made using independent samples t-test or Mann-Whitney U test.

Receiver operating characteristic (ROC) curve analysis was performed to determine optimal cut-off values for predicting increased anesthetic requirements (defined as values above the 75th percentile). Area under the curve (AUC), sensitivity, and specificity were calculated. Statistical significance was set at $p < 0.05$.

Results

Participant Characteristics: Of 160 patients initially enrolled, 150 completed the study and were included in the final analysis. Ten patients were excluded due to protocol deviations (n=4), surgical cancellation (n=3), or incomplete questionnaire data (n=3). Demographic and clinical characteristics are presented in Table 1.

Table 1: Demographic and Clinical Characteristics of Study Participants

Parameter	Total Sample (n=150)	Low Anxiety (n=82)	High Anxiety (n=68)	p-value
Age (years)	48.6 ± 14.2	47.8 ± 13.6	49.6 ± 14.9	0.428
Sex (Female/Male)	86/64	42/40	44/24	0.082
BMI (kg/m²)	26.4 ± 4.8	26.2 ± 4.6	26.7 ± 5.1	0.524
ASA I/II/III	52/78/20	32/42/8	20/36/12	0.168
Education (years)	12.8 ± 3.2	13.2 ± 3.0	12.3 ± 3.4	0.086
Previous surgery (yes)	98 (65.3%)	56 (68.3%)	42 (61.8%)	0.396
Surgery duration (min)	108.4 ± 32.6	106.2 ± 31.4	111.2 ± 34.0	0.346
Anxiety Scores				
STAI-State	42.8 ± 12.4	34.6 ± 7.2	52.6 ± 8.8	<0.001
STAI-Trait	38.4 ± 10.6	34.2 ± 8.4	43.4 ± 10.8	<0.001
APAIS (anxiety)	11.2 ± 4.2	8.4 ± 2.8	14.6 ± 3.4	<0.001
VAS-A (mm)	48.6 ± 24.8	32.4 ± 18.2	68.2 ± 16.4	<0.001

Data expressed as mean ± SD or n (%); High anxiety defined as STAI-State ≥45; BMI: Body Mass Index

The overall prevalence of high preoperative anxiety (STAI-State ≥45) was 45.3% (68/150).

Female patients demonstrated higher mean anxiety scores across all instruments compared to males (STAI-State: 45.2 ± 12.8 vs. 39.6 ± 11.4, p = 0.006).

Correlation between Anxiety Scores and Anesthetic Requirements: Significant positive correlations were observed between all anxiety measures and anesthetic requirements (Table 2).

STAI-State scores demonstrated the strongest correlations with propofol induction dose (r = 0.58, p < 0.001), fentanyl consumption (r = 0.64, p < 0.001), and mean sevoflurane concentration (r = 0.52, p < 0.001).

Table 2: Correlations between Anxiety Scores and Anesthetic Requirements

Anxiety Measure	Propofol Dose (mg/kg)	Fentanyl (μg/kg/hr)	Sevoflurane ET (%)	Total Requirement Score
STAI-State	r = 0.58, p < 0.001	r = 0.64, p < 0.001	r = 0.52, p < 0.001	r = 0.64, p < 0.001
STAI-Trait	r = 0.42, p < 0.001	r = 0.48, p < 0.001	r = 0.38, p < 0.001	r = 0.46, p < 0.001
APAIS-Anxiety	r = 0.54, p < 0.001	r = 0.58, p < 0.001	r = 0.46, p < 0.001	r = 0.56, p < 0.001
VAS-A	r = 0.48, p < 0.001	r = 0.52, p < 0.001	r = 0.42, p < 0.001	r = 0.50, p < 0.001

Pearson correlation coefficients; ET: End-tidal concentration; Total Requirement Score: composite z-score of all anesthetic parameters

Multiple regression analysis identified STAI-State score (β = 0.42, p < 0.001), female sex (β = 0.18, p = 0.012), and younger age (β = -0.22, p = 0.004) as independent predictors of increased anesthetic requirements, explaining 48.6% of the variance (adjusted $R^2 = 0.486$).

Comparison of Anesthetic Requirements by Anxiety Level: Patients with high preoperative anxiety required significantly greater anesthetic doses across all measured parameters (Table 3).

Table 3: Anesthetic Requirements by Anxiety Level

Parameter	Low Anxiety (n=82)	High Anxiety (n=68)	Mean Difference (95% CI)	p-value
Induction				
Propofol dose (mg/kg)	1.92 ± 0.38	2.34 ± 0.42	0.42 (0.28-0.56)	<0.001
Time to LOC (sec)	48.2 ± 12.4	62.4 ± 14.8	14.2 (9.8-18.6)	<0.001
Maintenance				
Fentanyl (µg/kg/hr)	3.68 ± 1.08	4.82 ± 1.24	1.14 (0.76-1.52)	<0.001
Sevoflurane ET (%)	1.82 ± 0.32	2.14 ± 0.38	0.32 (0.20-0.44)	<0.001
Mean BIS	48.4 ± 4.2	49.2 ± 4.6	0.8 (-0.6-2.2)	0.264
Recovery				
Eye opening (min)	8.4 ± 3.2	10.6 ± 3.8	2.2 (1.0-3.4)	<0.001
Extubation time (min)	10.2 ± 3.6	12.8 ± 4.2	2.6 (1.2-4.0)	<0.001
Postoperative				
PACU morphine (mg)	6.4 ± 3.2	9.8 ± 4.6	3.4 (2.0-4.8)	<0.001
24-hr opioid (MME)	32.4 ± 14.6	48.6 ± 18.2	16.2 (10.8-21.6)	<0.001

Data expressed as mean ± SD; LOC: Loss of Consciousness; ET: End-tidal; BIS: Bispectral Index; PACU: Post-Anesthesia Care Unit; MME: Morphine Milligram Equivalents

ROC curve analysis for APAIS anxiety subscale predicting increased anesthetic requirements (above 75th percentile) yielded an AUC of 0.82 (95% CI: 0.75-0.89). The optimal cut-off score of 13 provided sensitivity of 78.4% and specificity of 72.6%. For STAI-State, a cut-off of 45 demonstrated 81.2% sensitivity and 74.8% specificity (AUC = 0.86).

Discussion

This prospective study demonstrates that preoperative anxiety scales possess significant predictive value for anesthetic requirements during BIS-guided general anesthesia. Patients with elevated anxiety scores required substantially higher doses of propofol for induction, increased intraoperative fentanyl supplementation, and greater sevoflurane concentrations to maintain equivalent anesthetic depth. These findings have important implications for perioperative care optimization.

The relationship between psychological stress and altered anesthetic sensitivity has biological plausibility rooted in neurophysiological mechanisms. Anxiety activates the hypothalamic-pituitary-adrenal axis and sympathetic nervous system, resulting in elevated circulating catecholamines and cortisol [13-14].

These neuroendocrine changes may antagonize the effects of anesthetic agents through multiple pathways, including enhanced arousal states and modified neurotransmitter balance [15]. Our finding that high-anxiety patients required approximately 22% more propofol for induction aligns with previous investigations. Kil and colleagues reported similar increases in propofol requirements among anxious patients undergoing ambulatory surgery [16]. The extended time to loss of consciousness observed in anxious patients further supports the concept of relative anesthetic resistance in this population.

The STAI-State subscale emerged as the strongest predictor of anesthetic requirements in our analysis. This is consistent with the theoretical framework of the STAI, which conceptualizes state anxiety as a transient emotional response to perceived threats—precisely the psychological state anticipated in the immediate preoperative period [17]. The superiority of state over trait anxiety measures suggests that situational factors predominate in determining anesthetic sensitivity. The APAIS demonstrated comparable predictive utility while offering practical advantages for clinical implementation. Its brevity (six items versus 40 for the complete STAI) and surgery-specific content make it particularly suitable for busy preoperative settings [18].

The clinical implications of our findings are substantial. Routine preoperative anxiety screening could enable anesthesiologists to anticipate patients likely to require higher anesthetic doses, potentially facilitating smoother inductions and more efficient drug titration. Furthermore, identifying highly anxious patients creates opportunities for targeted interventions such as enhanced communication, anxiolytic premedication, or non-pharmacological anxiety reduction techniques.

Our observation of prolonged recovery times in anxious patients merits attention. While this may partly reflect higher cumulative anesthetic doses, anxiety-related factors may independently influence emergence characteristics. The significantly higher postoperative opioid requirements in anxious patients underscore the importance of addressing psychological factors in comprehensive perioperative pain management.

The strengths of this study include the use of multiple validated anxiety instruments, BIS-guided standardization of anesthetic depth, and a relatively large sample size. However, several limitations must be acknowledged. First, the observational design precludes causal inference. Second, we excluded patients with psychiatric disorders and those taking psychotropic medications, potentially limiting generalizability. Third, the single-center setting may affect external validity. Fourth, we did not assess the impact of anxiety-reducing interventions on anesthetic requirements.

Future research should explore whether preoperative anxiety modification through pharmacological or non-pharmacological interventions can normalize anesthetic requirements. Additionally, the development of prediction models incorporating anxiety scores with other patient factors could enhance individualized anesthetic planning.

Conclusion

This study demonstrates that preoperative anxiety scales, particularly the State-Trait Anxiety Inventory state subscale and Amsterdam Preoperative Anxiety and Information Scale, possess substantial predictive value for anesthetic requirements during general anesthesia. Patients with high preoperative anxiety require significantly greater doses of induction agents, maintenance anesthetics, and intraoperative opioids to achieve equivalent anesthetic depth. An APAIS anxiety subscale cut-off of 13 provides acceptable sensitivity and specificity for identifying patients at risk for increased anesthetic consumption. Integration of routine preoperative anxiety assessment into clinical practice may facilitate individualized anesthetic planning, optimize drug administration, and improve perioperative outcomes. These findings support a biopsychosocial approach to anesthetic care that acknowledges the significant influence of psychological factors on pharmacological responses.

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