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The Anxious Airway: Correlation Between Preoperative Anxiety Scores and Hemodynamic Instability During Endotracheal Intubation

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ABSTRACT

Background: Laryngoscopy and endotracheal intubation elicit a reflex sympathetic response mediated by glossopharyngeal and vagus nerve afferents, resulting in transient hypertension and tachycardia. While preoperative anxiety elevates baseline catecholamines, whether anxiety intensity reliably predicts the magnitude of hemodynamic instability during airway manipulation remains unclear.
Objectives: This prospective observational study assessed the relationship between preoperative anxiety scores and hemodynamic responses during the induction of general anesthesia and endotracheal intubation.
Methods: One hundred adults (ASA physical status I–III) were consecutively enrolled and underwent elective surgery under general anesthesia. Preoperative anxiety was assessed using the Hamilton Anxiety Rating Scale (HAM-A). Patients were categorized as having mild (<17), mild-to-moderate (18–24), or moderate-to-severe (25–30) anxiety. Hemodynamic parameters—heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP)—were recorded at baseline, post-sedation, 1 minute post-intubation, and 3 minutes post-intubation. Pearson's correlation and multivariable linear regression analyses were performed.
Results: Patients with moderate-to-severe anxiety exhibited significantly greater increases in HR and MAP compared with those with mild anxiety. Pearson's correlation demonstrated strong positive associations between HAM-A scores and peak hemodynamic changes (HR: $r = 0.736$; MAP: $r = 0.745$; $p < 0.001$). Multivariable regression analysis showed that each 1-point increase in HAM-A score independently predicted a 0.98 mmHg rise in MAP ($p < 0.001$), after adjustment for age and sex.
Conclusion: Preoperative anxiety, as measured by HAM-A, is a significant independent predictor of hemodynamic instability during endotracheal intubation. Routine anxiety assessment may help identify patients at risk for exaggerated pressor responses.

***Keywords**: Preoperative Anxiety; Endotracheal Intubation; Hemodynamic Response; HAM-A; General Anesthesia.*

INTRODUCTION

Endotracheal intubation represents one of the most noxious stimuli encountered during general anesthesia. Direct laryngoscopy stimulates the glossopharyngeal and vagus nerves, provoking a reflex sympathoadrenal discharge that causes a transient but significant rise in blood pressure and heart rate (Kovac, 1996; Lakhe et al., 2021). In patients with hypertension or cardiovascular disease, these responses may precipitate pulmonary edema, myocardial ischemia, or intracranial hemorrhage (Kovac, 1996), emphasizing the need to mitigate this stress response.

Various pharmacologic strategies—including opioids, lidocaine, β-blockers, and novel agents like pregabalin—have been used to attenuate intubation-induced hypertension (Reddy & Murari, 2019). However, while these agents blunt physiological reflexes, patient-related psychological factors may also modulate the pressor response. Preoperative anxiety is highly prevalent, affecting 60–80% of adults undergoing surgery (H. J. Kim et al., 2023; W. S. Kim et al., 2010). Anxiety elevates plasma catecholamines and cortisol (Wetsch et al., 2009) and has been linked to increased anesthetic requirements, prolonged recovery, and postoperative delirium (Shebl et al., 2025).

Despite its prevalence, preoperative anxiety is often under-recognized and infrequently assessed in routine practice (Apfelbaum et al., 2003). Furthermore, data linking anxiety severity specifically to hemodynamic responses during airway manipulation remains conflicting. For instance, W. S. Kim et al. (2010) found significant correlations between anxiety and blood pressure changes only in patients aged ≥45 years, whereas Ahmetovic-Djug et al. (2017) reported no significant correlation during induction. Thus, whether the severity of preoperative anxiety, quantified using a validated clinician-rated scale, reliably predicts the cardiovascular response to endotracheal intubation in adults undergoing elective surgery remains uncertain.

Given the physiological plausibility that psychological stress primes the sympathetic nervous system, we hypothesized that patients with higher preoperative anxiety would exhibit greater hemodynamic instability during intubation. To test this, we prospectively assessed Hamilton Anxiety Rating Scale (HAM-A) scores in adults undergoing elective surgery and correlated anxiety severity with heart rate and blood pressure responses at key periintubation time points.

MATERIALS AND METHODS

Study Design and Participants This single-center, prospective observational study was conducted after obtaining approval from the institutional ethics committee and written informed consent from all participants. Adults aged 18–65 years scheduled for elective surgical procedures under general anesthesia requiring endotracheal intubation were screened. Inclusion criteria were American Society of Anesthesiologists (ASA) physical status I–III and the ability to comprehend the anxiety assessment. Exclusion criteria included anticipated difficult airway, cardiovascular disease (hypertension, arrhythmias, coronary artery disease), chronic use of anxiolytics or β-blockers, pregnancy, psychiatric disorders, and refusal to participate.

Sample Size

A formal sample size calculation was not performed. However, a sample size of 100 participants was considered adequate based on prior similar studies demonstrating moderate to strong correlations between anxiety scores and peri-intubation hemodynamic changes.

Preoperative Anxiety Assessment Participants underwent a preoperative visit on the evening before surgery. After explaining the study, an anesthesiologist trained in the Hamilton Anxiety Rating Scale administered the 14-item HAM-A. Each item is scored 0 (absent) to 4 (very severe) with total scores ranging from 0 to 56. Scores were classified as mild (<17), mild-to-moderate (18–24), or moderate-to-severe (25–30) anxiety (Hamilton, 1959). In the present cohort, HAM-A scores did not exceed 30; therefore, anxiety categories above the moderate-to-severe range were not represented. The assessor remained blinded to hemodynamic measurements.

Anesthesia Protocol Standard fasting guidelines were followed. No sedative premedication was given. On arrival in the operating room, a peripheral intravenous cannula was inserted, and standard monitors (ECG, non-invasive blood pressure, pulse oximetry) were attached. Baseline HR, SBP, DBP, and Mean Arterial Pressure (MAP) were recorded with the patient supine.

Anesthesia was induced with fentanyl 2 µg/kg and propofol 2 mg/kg, and atracurium 0.6 mg/kg facilitated neuromuscular blockade. Gentle mask ventilation with 100% oxygen was performed for three minutes before laryngoscopy. Direct laryngoscopy was performed with a Macintosh size 3 or 4 blade by an experienced anesthesiologist; endotracheal intubation was completed within 20 seconds. Anesthesia was maintained with sevoflurane (minimum alveolar concentration 1.0) in 50% oxygen and nitrous oxide.

Hemodynamic Measurements Hemodynamic parameters were recorded at four time points:

- **Baseline:** Immediately before induction.
- **T1 (Sedation):** After administration of propofol and fentanyl, just before laryngoscopy.
- **T2 (Peak):** One minute after successful endotracheal intubation.
- **T3 (Recovery):** Three minutes after intubation.

HR was recorded from the ECG monitor and SBP/DBP/MAP via automated non-invasive oscillometric cuff. All readings were averaged over two consecutive values. Any arrhythmias, hypotension (<20% decrease from baseline) or hypertension (>30% increase from baseline) were noted. The anesthesiologist performing laryngoscopy and endotracheal intubation was blinded to the patients' anxiety scores.

Statistical Analysis Data were analyzed using IBM SPSS V24. Continuous variables are presented as mean ± standard deviation (SD) and categorical variables as counts and percentages. Differences between anxiety categories were assessed using one-way analysis of variance (ANOVA) for continuous variables and the chi-square test for categorical variables. Pearson's correlation coefficients quantified the relationship between HAM-A scores and changes in HR, SBP, DBP, and MAP from sedation to peak response (T2 – T1). A multivariable linear regression model evaluated the independent association between HAM-A score and MAP change, adjusting for age and sex. A two-sided $p < 0.05$ was considered statistically significant. Assumptions of linearity, normality of residuals, and homoscedasticity were assessed and found to be acceptable.

RESULTS

Participant Characteristics One hundred participants were enrolled. Their demographic and baseline characteristics are summarized in Table 1. The cohort included 53 women and 47 men with a mean age of 40.9 ± 14.0 years. ASA physical status distribution was I (37%), II (38%), and III (25%). The mean baseline HR was 74.3 ± 9.8 beats per minute (bpm), mean SBP 121.2 ± 13.8 mmHg, DBP 79.5 ± 9.6 mmHg, and MAP 93.4 ± 7.7 mmHg. Forty patients (40%) had mild anxiety, 35 (35%) mild-to-moderate, and 25 (25%) moderate-to-severe anxiety.

Hemodynamic Changes Table 2 shows mean HR, SBP, DBP, and MAP at each periintubation time point stratified by anxiety severity. After induction (T1), all groups exhibited modest decreases from baseline. The greatest hemodynamic changes occurred at T2. The moderate-to-severe anxiety group showed the largest increases in HR (mean 112 ± 13 bpm) and MAP (115 ± 13 mmHg), whereas the mild group had smaller increases (HR 93 ± 12 bpm, MAP 100 ± 8 mmHg). At T3, values trended toward sedation levels but remained higher in the moderate-to-severe group.

Pearson's correlation demonstrated strong positive associations between HAM-A score and hemodynamic change from sedation to peak. Correlation coefficients were 0.736 (HR change), 0.713 (SBP change), 0.775 (DBP change), and 0.745 (MAP change), all with $p < 0.001$.

Multivariable linear regression (Table 3) showed that HAM-A score independently predicted MAP rise; each 1-point increase in HAM-A was associated with a 0.98 mmHg greater MAP increment (95% CI 0.80–1.15, $p < 0.001$) after adjusting for age and sex, while age and sex were not significant predictors ($p > 0.05$). The regression model explained 56% of the variance in MAP change ($R^2 = 0.56$).

Adverse Events No difficult airways occurred. Transient hypertension (>30% above baseline) was observed in 18% of patients and was more frequent in the moderate-to-severe anxiety group (28%) than the mild group (10%). No arrhythmias or myocardial ischemic changes were recorded.

Table 1: Demographic and baseline characteristics (n = 100)

Characteristic	Overall	Mild anxiety (n=40)	Mild-to-moderate (n=35)	Moderate-to-severe (n=25)	*p*-value
Age, years (mean ± SD)	40.9 ± 14.0	40.4 ± 13.7	40.2 ± 14.6	42.5 ± 13.8	NS
Sex (female/male)	53/47	20/20	20/15	13/12	NS
ASA physical status I/II/III	37/38/25	14/16/10	13/14/8	10/8/7	NS
HAM-A score (mean ± SD)	19.4 ± 7.4	11.3 ± 3.3	20.4 ± 2.0	27.3 ± 1.6	**p < 0.001**
Baseline HR (bpm)	74.3 ± 9.8	77.3 ± 9.0	73.0 ± 9.1	71.3 ± 10.9	NS
Baseline SBP (mmHg)	121.2 ± 13.8	123.6 ± 15.0	118.6 ± 13.9	121.0 ± 11.2	NS
Baseline DBP (mmHg)	79.5 ± 9.6	81.8 ± 10.3	78.5 ± 8.9	78.2 ± 9.7	NS
Baseline MAP (mmHg)	93.4 ± 7.7	95.1 ± 8.1	92.2 ± 7.3	92.8 ± 7.7	NS

Note: NS = Not Significant (p > 0.05).

Table 2: Hemodynamic changes stratified by anxiety severity category

Variable	Mild (n=40)	Mild-to-moderate (n=35)	Moderate-to-severe (n=25)	*p*-value
HR (bpm)				
Baseline	77.3 ± 9.0	73.0 ± 9.1	71.3 ± 10.9	NS
T1 (Sedation)	72.4 ± 8.8	68.0 ± 8.4	66.4 ± 10.7	NS
T2 (Peak)	93.0 ± 12.0	103.1 ± 12.9	112.3 ± 12.8	**p < 0.001**
T3 (Recovery)	85.8 ± 11.3	96.7 ± 12.1	104.5 ± 13.4	**p < 0.001**
SBP (mmHg)				
Baseline	123.6 ± 15.0	118.6 ± 13.9	121.0 ± 11.2	NS
T1 (Sedation)	117.0 ± 14.6	113.2 ± 13.4	116.2 ± 10.7	NS
T2 (Peak)	133.7 ± 13.9	142.7 ± 14.3	150.5 ± 15.1	**p < 0.001**
T3 (Recovery)	126.8 ± 12.6	136.6 ± 11.8	142.2 ± 15.6	**p < 0.001**
DBP (mmHg)				

Baseline	81.8 ± 10.3	78.5 ± 8.9	78.2 ± 9.7	NS
T1 (Sedation)	76.6 ± 9.3	73.0 ± 8.5	72.9 ± 9.0	NS
T2 (Peak)	83.8 ± 8.7	91.7 ± 9.2	99.7 ± 10.7	**p < 0.001**
T3 (Recovery)	79.2 ± 11.3	86.6 ± 9.6	89.7 ± 11.7	**p < 0.001**
MAP (mmHg)				
Baseline	95.1 ± 8.1	92.2 ± 7.3	92.8 ± 7.7	NS
T1 (Sedation)	90.3 ± 7.8	87.2 ± 6.7	87.1 ± 7.4	NS
T2 (Peak)	100.3 ± 7.8	109.5 ± 8.8	115.3 ± 13.2	**p < 0.001**
T3 (Recovery)	95.3 ± 8.5	100.7 ± 6.6	105.3 ± 9.7	**p < 0.001**

Note: NS = Not Significant (p > 0.05).

Table 3: Multivariable linear regression analysis predicting MAP rise

Predictor	**Unstandardized Coefficient (β)**	**95% Confidence Interval**	***p*-value**
HAM-A Score	0.98	0.80 to 1.15	**p < 0.001**
Age	0.06	−0.04 to 0.24	0.24
Sex	0.42	−1.10 to 1.94	0.58

Dependent Variable: Change in Mean Arterial Pressure (MAP) from sedation to peak. Model R² =0.56. NS = Not Significant.

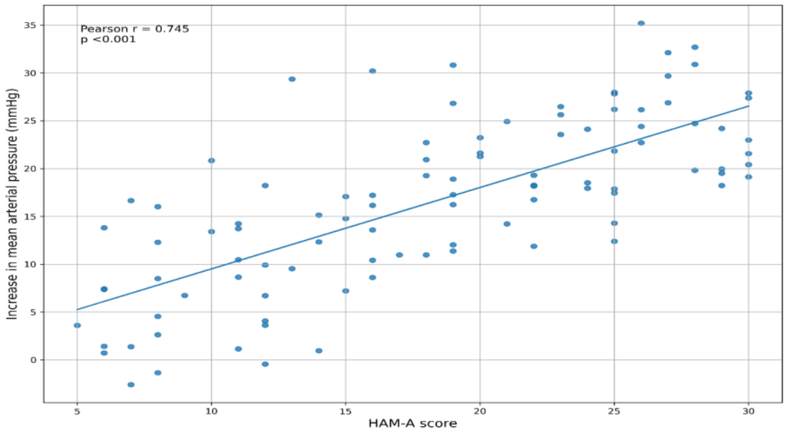

Figure 1: Relationship Between Preoperative Anxiety (HAM-A Score) and Rise in Mean Arterial Pressure After Endotracheal Intubation.

Scatter plot showing the positive correlation between HAM-A score and rise in mean arterial pressure following endotracheal intubation. Each point represents an individual participant (n = 100), and the line denotes the linear regression fit.

DISCUSSION

This prospective study suggests a significant association between preoperative anxiety and the hemodynamic response to endotracheal intubation. Higher HAM-A scores were strongly correlated with greater increases in Heart Rate (HR), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), and Mean Arterial Pressure (MAP). Multivariable regression confirmed that the anxiety score independently predicted the MAP rise after adjusting for age and sex, explaining over half of the variance. These findings support our hypothesis that psychological stress primes the sympathetic nervous system, augmenting the pressor response to airway manipulation.

Intubation-induced hemodynamic changes arise from the stimulation of nociceptive receptors in the oropharyngeal and laryngotracheal structures. Afferent impulses via cranial nerves IX and X excite the vasomotor center, producing a sympathetic surge, catecholamine release, and vagal inhibition (Kovac, 1996). Hypertensive patients exhibit exaggerated and unpredictable responses because of increased sympathetic activity and catecholamine sensitivity (Kovac, 1996). Preoperative anxiety itself elevates baseline catecholamines, cortisol, and cardiovascular parameters (Wetsch et al., 2009). Thus, in anxious individuals, the combined effect of psychological stress and laryngoscopic stimulation may potentiate tachycardia and hypertension. Our data showing strong correlations between HAM-A scores and hemodynamic surges support this synergistic effect.

The prevalence of moderate anxiety in our cohort aligns with earlier surveys reporting that 60–80% of surgical patients experience significant preoperative anxiety (H. J. Kim et al., 2023; W. S. Kim et al., 2010). Prior research on the relation between anxiety and intubation responses has yielded mixed results. A Korean study using the State-Trait Anxiety Inventory (STAI) found correlations between state anxiety and blood pressure changes only in patients over 45 years of age (W. S. Kim et al., 2010), whereas a prospective study of 80 adults reported no association between anxiety scores and hemodynamic variables but noted that patients with higher anxiety required lower doses of anesthetic to achieve hypnosis (Ahmetovic-Djug et al., 2017). Similarly, Hamdan et al. (2025) found no correlation between anxiety and hemodynamic changes during office-based laryngeal surgery, suggesting that the magnitude of surgical stimulus plays a role. Those studies included small samples or focused on trait anxiety. Our larger cohort used the HAM-A, a clinician-rated scale capturing both psychiatric and somatic components, and included patients across anxiety categories (Hamilton, 1959). The robust associations we observed suggest that the intensity of acute anxiety, rather than age, is the key determinant of cardiovascular lability.

Pharmacologic interventions can attenuate the pressor response to intubation. Benzodiazepines such as midazolam are widely used for anxiolysis; although a randomized controlled trial reported that midazolam did not reduce subjective anxiety, it attenuated intubation-induced increases in blood pressure, heart rate, and catecholamines and helped maintain hemodynamic stability during induction (Jeon et al., 2018). A comparative study found intramuscular midazolam superior to oral diazepam for preoperative sedation with excellent cardiovascular stability (Suri, 2000). Dexmedetomidine, a highly selective α2-adrenoceptor agonist, has also demonstrated superior efficacy in attenuating the hemodynamic stress response to tracheal intubation compared to other agents, while preserving respiratory function (Keniya et al., 2011). Furthermore, short-acting β-blockers such as esmolol effectively control tachycardia associated with intubation, though they may not provide the anxiolytic benefits of benzodiazepines or α2-agonists (Figueredo & Garcia-Fuentes, 2001). Pregabalin and gabapentin have also been shown to blunt the sympathetic response by binding to α2δ subunits of voltage-gated calcium channels, inhibiting neurotransmitter release; they provide analgesia and anxiolysis and reduce pressor responses (Reddy & Murari, 2019). Melatonin premedication has been reported to reduce heart rate and blood pressure elevations after intubation and decrease propofol requirements (Gupta et al., 2016). These observations underscore the interplay between anxiolysis and hemodynamic stability.

Our findings support the assertion that non-pharmacologic interventions may also be beneficial. Informational counseling, cognitive-behavioral therapy, music therapy, and aromatherapy have been shown to reduce anxiety and improve perioperative outcomes (Bello et al., 2025). Providing detailed procedural information via multimedia or video-based education has also been proven to significantly lower preoperative anxiety scores compared to standard verbal information (Jlala et al., 2010). A systematic review demonstrated that preoperative anxiety is associated with increased anesthetic and analgesic requirements and postoperative delirium (Shebl et al., 2025). Recognizing and addressing anxiety should therefore be part of holistic perioperative care.

Screening for anxiety using a validated instrument such as the HAM-A is simple and can be integrated into routine preoperative assessment. Patients identified with moderate-to-severe anxiety may benefit from targeted interventions—pharmacologic (benzodiazepines, pregabalin, dexmedetomidine) or non-pharmacologic—to attenuate sympathetic activation. Our data suggest that each point increase in the HAM-A score translates to nearly a 1 mmHg greater rise in MAP during intubation. While this increment may be clinically insignificant for healthy patients, it could be critical in those with limited cardiovascular reserve. In high-risk patients, using devices that minimize laryngeal stimulation (e.g., McCoy blade or video laryngoscopes) may further reduce hemodynamic stress (Lakhe et al., 2021).

Limitations This study also has limitations. First, the observational design precludes causal inference; unmeasured factors such as pain or previous anesthetic experiences may influence both anxiety and hemodynamic responses. Second, it was conducted in a single tertiary center with a relatively small sample, limiting generalizability. Third, anxiety assessment relied on a subjective clinician-rated scale and was performed only once; anxiety may fluctuate over time. Objective measures such as cortisol or catecholamine levels (Wetsch et al., 2009) and functional near-infrared spectroscopy (H. J. Kim et al., 2023) could complement psychometric scales in future research. Fourth, patients with cardiovascular disease were excluded; thus, the results may underestimate responses in high-risk populations. Inter-observer variability in HAM-A scoring was not assessed and may represent a potential source of measurement bias. Finally, we did not examine the effects of anxiolytic premedications or compare different laryngoscopic techniques.

CONCLUSION

In this prospective observational study, preoperative anxiety measured by the HAM-A showed a strong positive correlation with hemodynamic instability during endotracheal intubation. Patients with moderate-to-severe anxiety experienced significantly greater tachycardia and hypertension compared with those with mild anxiety. These findings highlight the importance of routine assessment of anxiety and incorporation of anxiolytic strategies into anesthetic practice to minimize sympathetic activation and improve cardiovascular stability during airway management.

Declaration:

Conflicts of interests: The authors declare no conflicts of interest.

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