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Research Article

STOP-Bang Criteria as a Difficult Airway Predictor in Surgical Patients at a Primary Referral Hospital in North Sumatra

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ABSTRACT

Introduction: Obstructive sleep apnea (OSA) is a sleep disorder associated with snoring, morning drowsiness, and hypoxemia, leading to an increased risk of difficult airway management. Polysomnography (PSG) is the gold standard for diagnosing OSA, but its high cost and limited accessibility necessitate alternative screening methods, such as the STOP-BANG questionnaire. **Objective:** This study aimed to evaluate the relationship between STOP-BANG scores and difficult airway conditions in surgical patients. **Methods:** A cross-sectional study was conducted at H. Adam Malik Hospital involving 110 surgical patients. Demographic and clinical data, including body mass index (BMI) and neck circumference, were collected. STOP-Bang scores were assessed preoperatively, and difficult airway conditions were documented. **Results:** The average BMI of the participants was 25.03 ± 2.62 kg/m², and the mean neck circumference was 27.83 ± 3.91 cm. A total of 81 patients reported a history of hypertension, a comorbidity frequently associated with OSA. Statistical analysis indicated that higher STOP-BANG scores were significantly correlated with a greater incidence of difficult airway conditions ($p = 0.015$). **Conclusions:** This study demonstrates that the STOP-BANG questionnaire has potential as a practical and accessible predictive tool for identifying patients at risk of difficult airway management related to OSA.

Keywords: airway difficulty, hypertension, sleep apnea

1. Introduction

The conditions wherein a physician, deemed proficient in airway management, encounters challenges while addressing airway management (ventilation, intubation, or both) in a particular condition or patient are referred to as a difficult airway event [1]. Difficulty in intubation occurs in 1-6.2% of patients undergoing general anaesthesia [2]. Several studies describe more than 90% of difficult airway events being unanticipated and dangerous events, such as CICV (cannot intubate and cannot ventilate), which is estimated at 0.01% - 0.07% of the total difficult airway events [3]. The phrase "CICV," also commonly referred to as "CICO" (Cannot Intubate, Cannot Oxygenate), characterizes a clinical scenario in which attempts to perform tracheal intubation, utilize a facemask, or employ a supraglottic airway device (SAD) are unsuccessful [4]. This condition causes the patient to use oxygen faster than the amount of oxygen obtained, and results in increased risk of hypoxia and brain injury, cardiac arrest, and even death. The CICO scenario is infrequent but carries a significant risk of morbidity and mortality, particularly when there is a delay in identifying it and/or administering appropriate interventions such as cricothyroidectomy [5].

A meta-analysis study reveals that the risk of airway difficulty is three to four times higher in patients with obstructive sleep apnea (OSA) [6]. OSA is the most common sleep-disordered breathing condition encountered in patients, with up to 60% of surgical patients remaining undetected for this condition. Patients previously undiagnosed with OSA are found to exhibit moderate to severe levels of OSA during preoperative assessments [7]. Polysomnography (PSG) is considered the gold standard for identifying OSA [8]. A limitation of PSG is the "first night effect," wherein individuals who typically sleep normally may experience insomnia or some degree of sleep disturbance when initially sleeping in an unfamiliar laboratory environment. Another drawback is the considerable expense and time involved in PSG [9].

Due to the high cost and limited accessibility of PSG examinations, alternative screening methods have been developed to aid in the diagnosis of OSA, such as the use of questionnaires. One of the most commonly used is the STOP-BANG questionnaire [8]. Researchers have also investigated the STOP-BANG questionnaire, drawing from multiple studies indicating a correlation between the degree of OSA risk as assessed by the STOP-BANG questionnaire and difficulties encountered during intubation [10]. Pivetta et al. have also conducted research on this questionnaire, examining its effectiveness across diverse patient demographics and demonstrating statistically significant sensitivity [11]. Additional research findings support the notion that the STOP-BANG questionnaire can effectively predict the likelihood of difficult mask-valve (DMV) scenarios [12]. Some studies have identified a correlation between STOP-BANG scores and prolonged stays in the Post Anaesthesia Care Unit (PACU), particularly in comparison to patients with either no or low STOP-BANG scores [13].

Given the simplicity of administration, the straightforwardness of the tools required, and the demonstrated sensitivity in previous research, the researcher is intrigued by the prospect of evaluating the efficacy of the STOP-BANG criteria as a predictor of difficult airway in surgical patients at H. Adam Malik General Hospital in Medan.

2. Methods

This research is an analytical study with a cross-sectional design using a questionnaire approach to determine the relationship between the use of the STOP-BANG criteria in diagnosing OSA in surgical patients and being a predictor of difficult airway conditions. The study was conducted in accordance with the 2013 revised Declaration of Helsinki guidelines. The research was carried out after the issuance of an ethical clearance from the Faculty of Medicine, University of North Sumatra, with the issued number 1073. The research was conducted in H. Adam Malik General Hospital, Medan. Informed consent was obtained from all study participants.

All eligible participants were male patients aged 18–65 years with an American Society of Anesthesiologists (ASA) physical status classification of I–III and scheduled to undergo surgery under general anesthesia with endotracheal tube intubation (GA-ETT). This restriction was applied because OSA and difficult airway conditions are more prevalent in men, and the STOP-BANG questionnaire was originally validated predominantly in male populations. Additionally, sex-related anatomical and hormonal differences could introduce confounding factors in airway assessment. Limiting the sample to male patients, therefore, enhanced internal validity and ensured a more homogeneous study cohort. Patients scheduled for ear, nose, and throat (ENT) surgeries or interventions related to the airway, never diagnosed with OSA, exposed to different anaesthesia protocols, and those whose surgeries were canceled, were not included in the study group.

The STOP-BANG criteria are a screening tool used to assess the likelihood of OSA in individuals. It consists of eight questions, with each letter representing a specific aspect of OSA risk: snoring, tiredness, observed apneas, pressure, body mass index (BMI), age, neck circumference, and male gender. Each question is scored with either 0 or 1 point, and the total score ranges from 0 to 8. Higher scores indicate a higher likelihood of having OSA.[11] Difficult ventilation is defined as inadequate ventilation delivery (confirmed by end-tidal carbon dioxide detection) due to the following issues: inadequate mask seal, gas leakage, or airway collapse [14]. Difficult ventilation was assessed by “mask seal, obesity, age, no teeth, and stiffness (MOANS)” criteria [15]. Meanwhile, difficult intubation was defined according to the American Society of Anesthesiologists (ASA) Difficult Airway Guidelines as failure to achieve successful tracheal intubation with direct or video laryngoscopy after multiple attempts by an experienced provider, necessitating alternative airway techniques [16].

The sample size of 110 was determined using the formula for calculating sample size for correlation tests, with a significance level (alpha) set at 0.05. After obtaining consent, interviews and data collection from patients were conducted by a standardized research team, including standardized protocol measurements of height, weight, and neck circumference to complete the STOP-BANG questionnaire. When the patient was undergoing ETT insertion, the scoring and ETT placement were assessed by the researcher according to the prepared questionnaire, and the procedure was performed by the research team. Incidence of difficulty in ventilation and intubation was then recorded.

Once the data collection was complete, a thorough check was conducted to ensure its integrity. Normally distributed numerical data were presented as mean ± standard deviation (SD), while non-normally distributed numerical data were represented by median values (range). Categorical data will be expressed as frequencies (percentages). Diagnostic tests, including sensitivity, specificity, likelihood ratios, and predictive values, were used to evaluate the STOP-BANG criteria and the occurrence of difficult airway events. The STOP-BANG cut-off score was predefined as ≥3, consistent with established recommendations in the literature. Hypothesis testing, specifically chi-square analysis, was conducted to examine the association between STOP-BANG values and difficult airway occurrences. Statistical analysis was performed utilizing SPSS, with statistical significance considered when the p-value was less than 0.05.

3. Results

Comparative analysis of the STOP-BANG questionnaire for assessing difficult ventilation

Table 1. Comparison of the STOP-BANG questionnaire for assessing difficult ventilation

STOP-BANG OSA Risk	Difficult Intubation		*P Value*	*Odds Ratio*	*Likelihood Ratio*
	Difficult	Not hard			
Risk of Moderate-Severe OSA	11(10%)	21(19,1%)	0,015	3,56	6,33
Mild OSA Risk	10(9,1%)	68(61,8%)			

OSA- obstructive sleep apnea

In Table 1, a study examined the relationship between OSA risk factors and the STOP-BANG assessment by analyzing their association with ventilation difficulties through a chi-square test in a cross-sectional analysis. The chi-square test yielded a p-value of 0.015, signifying a statistically significant association between the STOP-BANG questionnaire assessment and the occurrence of ventilation challenges. Additionally, an odds ratio (OR) of 3.56 was calculated, indicating that subjects with a moderate to severe rating on the STOP-BANG questionnaire were 3.56 times more likely to experience ventilation difficulty. Furthermore, the likelihood ratio was determined to be 6.33 in this analysis.

Table 2. Diagnostic Test Values of the STOP-BANG Questionnaire on Difficult Intubation

%	Sensitivity	Specificity	Accuracy	PPV	NPV
STOP-BANG OSA Risk	52,3%	76,4%	71,8%	34,3%	87,1%

OSA- obstructive sleep apnea, PPV- positive predictive value, NPV- negative predictive value

Table 2 elucidates the predictive efficacy of the STOP-BANG questionnaire in assessing the likelihood of ventilation difficulties. The study revealed that at H. Adam Malik General Hospital, Medan, the STOP-BANG questionnaire demonstrated a sensitivity of 52.3%, specificity of 76.4%, and accuracy of 71.8% in forecasting the occurrence of ventilation challenges among surgical patients. The positive predictive value was determined to be 34.3%, while the negative predictive value stood at 87.1%.

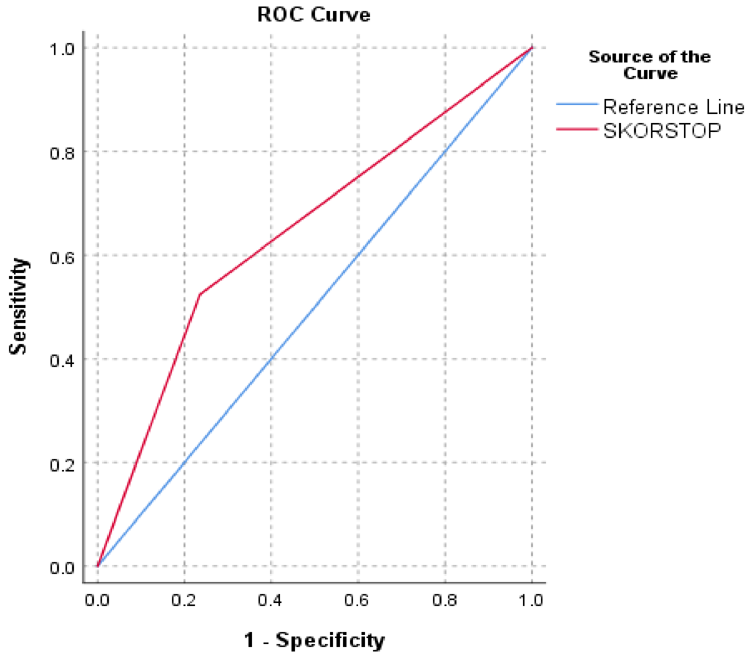

Figure 1. ROC curve for STOP-BANG questionnaire assessment of difficult airway

In Figure 1, a comparison is made between sensitivity and 1-specificity to assess the predictive value of the STOP-BANG questionnaire for predicting the incidence of difficult ventilation. Based on this graph, the STOP-BANG questionnaire has an area under the receiver operating characteristic (AUROC) value = 0.644 with a 95% confidence interval (Table 3).

Table 3. Area under the receiver operating characteristic STOP-BANG questionnaire

Variable	Area	*P Value*	Confidence Interval 95%	
			Lower	Upper
STOP-BANG questionnaire	0,644	0,041	0,506	0,782

4. Discussion

In this research, it was observed that 110 participants had an average body mass index (BMI) of 25.03 ± 2.62 kg/m^2. In a separate investigation by Siregar et al., it was noted that the mean BMI of male patients aged 50 with hypertension at Haji Adam Malik Hospital in Medan was 25.2 kg/m^2 [17]. Soitong et al. conducted a study in Thailand involving 435 male participants. Among these men, the average BMI was recorded as 23.8 ± 3.9 kg/m^2. Interestingly, when considering individuals with hypertension within this population, the average BMI rose to 25.3 ± 4.4 kg/m^2 [18]. Manjavong et al. similarly found comparable results, indicating an average BMI of 27.5 ± 2.5 kg/m^2 among patients diagnosed with metabolic disorders [19]. This study revealed that 81 patients (72.3% of the sample) were diagnosed with hypertension; these findings are particularly pertinent to several previous studies, notably Siregar et al.'s investigation involving patients treated at Haji Adam Malik General Hospital, Medan. In this study, not only were similar BMI values observed, but also consistent sample size conditions. However, it was noted that respondents in this study exhibited a BMI <30 kg/m^2. This observation is attributed to the characteristic lower BMI typically observed in the Asian population, diverging by 2-3 kg/m^2 compared to Caucasians, as referenced in the STOP-BANG questionnaire. While a BMI of 25 kg/m^2 falls within the normal range for Caucasians, it is considered overweight for Asians, consequently elevating the risk of diseases, including cardiovascular ailments [20]. Tham et al., in their study within the Southeast Asian context, including Indonesia, suggested employing distinct BMI thresholds for categorization: < 23.0 kg/m^2 for normal weight, 23.0 kg/m^2 for overweight, and > 25.0 kg/m^2 for obesity [21]. Xia et al.'s study in China supports this notion, indicating that adjusting the BMI cutoff on the STOP-BANG questionnaire to 28 kg/m2 could yield improved outcomes [22]. Researchers had determined that the assessment of BMI points on the STOP-BANG questionnaire might pose a concern in the Asian population, particularly in Southeast Asian countries like Indonesia. It was advised to utilize the relevant BMI values accordingly.

In this investigation, patients exhibited an average neck circumference of 27.83 ± 3.91 cm. Discrepancies in neck circumference values within this study are attributed to variations in patient characteristics. Typically, individuals with higher BMI tend to have larger neck circumferences, while those with lower BMI tend to have smaller ones [18,19]. In a study conducted by Soitong et al. in Thailand, it was observed that among 435 male participants, the mean neck circumference was recorded at 34.3 ± 2.4 cm. Additionally, the average neck circumference value rose to 35.2 ± 3.2 cm in individuals diagnosed with hypertension [18]. Mou et al. discovered that male patients with a larger neck circumference were more significantly impacted by OSA [23]. Loh and Toh's research in Singapore determined that among 435 male subjects, the mean neck circumference was 38.7 ± 2.6 cm. In cases where the diagnosis of OSA was confirmed, the average neck circumference increased to 41.0 ± 4.3 cm [24].

In this investigation, subjects with a mean age of 41.56 ± 14.30 years were identified. A study focusing on the Indonesian population indicated that within the age bracket of 30 to 69 years, there were approximately 114 million individuals. Among them, 18.4% or 21 million people were diagnosed with an apnea-hypopnea index (AHI) assessment of less than 5 times, while 6.9% or nearly 8 million people had an AHI of more than 15 times [25]. This assertion stems from the resemblance in characteristics between the two studies. Nonetheless, when considering research conducted in other nations such as China, a study investigating challenging airways, which comprised 1080 samples, revealed that individuals aged between 60 and 80 years constituted the most frequently represented age group in the study, accounting for 46.2% (455 out of 985) [26]. Saoraya et al stated that patients aged 55 years or more had difficulty with ventilation/bag-mask ventilation [27]. Slowik et al. and Gottlieb et al. both found that the occurrence of difficult airways escalated notably in individuals aged 50 years and above [28,29].

This study included 81 patients with a background who exhibited an OSA score exceeding 2. There exists substantial literature associating the prevalence of hypertension in adult males with OSA [30,31]. Soitong et al.'s research also identified a correlation between the prevalence of hypertension and physical examination indicators like neck circumference [18]. In the study, it was observed that 11 (10%) patients encountered ventilation challenges according to the moderate-severe OSA risk questionnaire, while 10 (9.1%) patients faced ventilation difficulties based on the mild OSA risk questionnaire. Singh et al.'s investigation indicated that 29 (58%) patients experienced moderate ventilation difficulties, with 10 patients experiencing difficult ventilation challenges [10]. In this study, findings revealed that 10 (9.1%) patients encountered intubation challenges as indicated by the OSA risk score, with a moderate-severe categorization. Additionally, 9 (8.2%) patients were identified as experiencing difficult intubation based on the mild OSA risk score. In Dai et al.'s investigation, out of 1080 patients, 44 (8.2%) encountered difficulties with mask ventilation, while 21 (2.1%) faced challenges with intubation. The study reported a sensitivity value of 0.71 (95% CI: 0.47–0.89) and a specificity of 0.79 (95% CI: 0.76–0.81) for intubation difficulty [26].

In a systematic review conducted by Detsky et al., which encompassed 33,559 patients, it was found that approximately 10% of the sampled patients encountered challenges with intubation [32]. In this study, it was discovered that an escalation in the STOP-BANG score was linked to a rise in the incidence of difficult airways, with a p-value of 0.015 and an odds ratio of 3.56. Higher STOP-BANG scores were associated with 3.56-fold higher odds of difficult ventilation compared to mild scores, indicating an increased predicted risk but not a causal relationship.

Higher STOP-BANG scores were associated with 3.56-fold higher odds of difficult ventilation compared to mild scores, indicating an increased predicted risk but not a causal relationship. Additionally, the risk of moderate-severe OSA based on the STOP-BANG score was 3.48 times higher than the risk of facing difficult intubation compared to the mild STOP-BANG score. These findings align with previous theories and research indicating a relationship between the STOP-BANG score and difficult airway events. For instance, Singh et al. found that a STOP-BANG score ≥ 3 was associated with difficult ventilation, while moderate and high STOP-BANG scores were linked to difficult intubation [10]. Similarly, Seet et al. reported odds ratios for difficult intubation corresponding to STOP-BANG scores of 3-4 and 5-8 as 3.0 and 4.4 times, respectively [33]. Mathangi et al.'s research suggested that the STOP-BANG score could serve as the sole predictor for ventilation challenges, with an odds ratio of 3.15 [34]. Nagappa et al. discovered that individuals with OSA were 3.46 times more likely to experience difficult intubation and 3.39 times more likely to encounter ventilation challenges [6].

In this study, the AUC value for predicting the occurrence of difficult ventilation and intubation was 0.64, with sensitivity values of 52.3% and 52.6%, and specificities of 76.4% and 75.8%, respectively. Dosman et al.'s study, conducted in 2022, revealed that utilizing the STOP-BANG questionnaire with a cutoff score of ≥ 3 (indicative of mild OSA) yielded a moderate AUC of 0.61 for detecting OSA within the general population [35]. Mou et al. observed AUC values of 0.75, 0.70, and 0.71 in their study, which were associated with the prevalence of patients diagnosed with mild, moderate, and severe obstructive sleep apnea (OSA), respectively [23]. Herschmann et al. achieved an AUC of 0.7 for the STOP-BANG questionnaire, while Pivetta et al. reported an AUC value of 0.76 in their respective studies. This study had a sensitivity of 52.3%, specificity of 76.4%, and accuracy of 71.8% [11,36].

Amra et al.'s research conducted in Iran revealed that the STOP-BANG questionnaire displayed notable sensitivity and specificity when compared to the Berlin and ESS questionnaires. Specifically, the sensitivity values for the Berlin, STOP-BANG, and ESS questionnaires were 86.42%, 81.46%, and 59%, respectively, while the specificity values were 52.94%, 82.35%, and 76.47%, respectively [8]. In Mou et al.'s study, it was discovered that individuals with a STOP-BANG score of ≥ 3 demonstrated a lower specificity value, which gradually rose as the STOP-BANG score increased to ≥ 5 (from 11.9% to 61.9%). The sensitivity for the same score was recorded as 66.7%.[23] Pivetta et al.'s study conducted in a Southeast Asian population revealed that when employing the STOP-BANG questionnaire, the results yielded a sensitivity of 81% and a specificity of 60% [11]. Furthermore, various other researchers in their independent studies have also concluded that the STOP-BANG questionnaire can serve as an effective screening tool for predicting difficult airway scenarios, including difficult ventilation, intubation, or both [8,10,11]. The STOP-BANG questionnaire was originally designed and developed as a tool to aid in the diagnosis of OSA, particularly in settings where patients have limited access to facilities such as polysomnography [37]. Although polysomnography is considered the gold standard examination for diagnosing OSA, it also has limitations. One such limitation is the "first night effect," where patients may experience altered sleep patterns or reduced sleep quality during the initial night of testing, leading to potentially inaccurate results [29].

This study acknowledges certain limitations. The subjective nature of difficult ventilation and intubation incidence poses challenges, particularly if the individual performing intubation lacks adequate skills or experience. However, this concern was mitigated by recruiting volunteers assessed as competent and ensuring the availability of appropriate difficult airway equipment to address potential challenges during ventilation or intubation. Additionally, difficulties with ventilation and intubation primarily occurred in patients with a STOP-BANG score of ≥ 3, along with elevated BMI and/or neck circumference. While researchers anticipated these challenges, volunteers may not have been aware of them beforehand. Another limitation is the absence of polysomnography or similar facilities, which could serve as a control for patients with a STOP-BANG score of ≥ 3.

While several studies have suggested that the STOP-BANG questionnaire can serve as a useful alternative when polysomnography is unavailable, a combined approach utilizing both the STOP-BANG questionnaire and polysomnography is advocated for optimal screening and diagnostic accuracy. Researchers have suggested that the integration of STOP-BANG and polysomnography could offer a robust screening and diagnostic tool for OSA, particularly in predicting difficult airways.

5. Conclusion

A relationship exists between the STOP-BANG score and difficult airway occurrences. Among the patients, 32 (28.6%) were identified as at risk for moderate to severe obstructive sleep apnea (OSA) based on the STOP-BANG criteria. The sensitivity of the STOP-BANG score in predicting difficult ventilation was 52.3% and in predicting difficult intubation was 52.6%. Correspondingly, the specificity of the STOP-BANG score in predicting difficult ventilation was 76.4% and in predicting difficult intubation was 75.8%. The positive predictive value of the STOP-BANG score in predicting difficult ventilation was 34.3% and in predicting difficult intubation was 31.2%. Conversely, the negative predictive value of the STOP-BANG score in predicting difficult ventilation was 87.1% and in predicting difficult intubation was 88.4%.

6. Data Availability Statement

The datasets generated and analyzed during the current study are not publicly available due to privacy and ethical considerations, but are available from the corresponding author upon reasonable request.

7. Ethical Statement

This study received ethical clearance from the Research Ethics Committee of the Faculty of Medicine, Universitas Sumatera Utara. With ethical clearance number 1073/KEPK/USU/2023, issued on October 27^{th,} 2023

8. Author Contributions

Ikrar Rananta Simanjuntak, Andriamuri P. Lubis, Ade Winata, and Arlinda Sari Wahyuni were involved in the conceptualization and methodology of this research. Ikrar Rananta Simanjuntak and Andriamuri P. Lubis contributed to data curation and the preparation of the original draft. Ade Winata and Arlinda Sari Wahyuni were responsible for visualization and investigation. Ikrar Rananta Simanjuntak provided supervision throughout the project. Andriamuri P. Lubis, Ade Winata, and Arlinda Sari Wahyuni contributed to software development and validation. Ikrar Rananta Simanjuntak was responsible for writing, reviewing, and editing the manuscript. All authors read and approved the final version of the manuscript.

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11. Conflict of Interest

The authors declare no conflict of interest in the writing of this article.

References

[1] Apfelbaum JL, Hagberg CA, Connis RT, Abdelmalak BB, Agarkar M, Dutton RP, Fiadjoe JE, Greif R, Klock PA, Mercier D, Myatra SN, O'Sullivan EP, Rosenblatt WH, Sorbello M, Tung A. 2022 American Society of Anesthesiologists Practice Guidelines for Management of the Difficult Airway. Anesthesiology. 2022 Jan 1;136(1):31–81.

[2] Endlich Y, Lee J, Culwick MD. Difficult and failed intubation in the first 4000 incidents reported on webAIRS. Anaesth Intensive Care. 2020 Nov 1;48(6):477–87.

[3] Xu Z, Ma W, Hester DL, Jiang Y. Anticipated and unanticipated difficult airway management. Curr Opin Anaesthesiol. 2018 Feb;31(1):96–103.

[4] Pearce W, Barr J, Ziai K, Goyal N. "Cannot Intubate, Cannot Oxygenate" (CICO) rescue by emergency Front of Neck Airway (eFONA). Operative Techniques in Otolaryngology-Head and Neck Surgery. 2020 Jun 1;31(2):96–104.

[5] Kelly FE, Duggan LV. Preparing for, and more importantly, preventing, "cannot intubate, cannot oxygenate" events. Anaesthesia. Wiley; 2020 Jun;75(6):707–10.

[6] Nagappa M, Wong DT, Cozowicz C, Ramachandran SK, Memtsoudis SG, Chung F. Is obstructive sleep apnea associated with difficult airway? Evidence from a systematic review and meta-analysis of prospective and retrospective cohort studies. PLoS One. 2018 Oct 4;13(10):e0204904.

[7] Bae E. Preoperative risk evaluation and perioperative management of patients with obstructive sleep apnea: a narrative review. J Dent Anesth Pain Med. 2023 Aug;23(4):179–92.

[8] Amra B, Javani M, Soltaninejad F, Penzel T, Fietze I, Schoebel C, Farajzadegan Z. Comparison of Berlin Questionnaire, STOP-Bang, and Epworth Sleepiness Scale for Diagnosing Obstructive Sleep Apnea in Persian Patients. Int J Prev Med. 2018 Mar 9;9:28.

[9] Frase L, Nissen C, Spiegelhalder K, Feige B. The importance and limitations of polysomnography in insomnia disorder-a critical appraisal. J Sleep Res. 2023 Dec;32(6):e14036.

[10] Singh T, Singh A, Khader A, Singh A, Kour A. To Evaluate Usefulness of Stop-Bang Questionnaire in Predicting Difficult Bag Mask Ventilation and Difficult Intubation in Adult Patients for Elective Surgery: Important Guide for Obstructive Sleep Apnea Patients. Apollo Medicine. 2023;20(3):215.

[11] Pivetta B, Chen L, Nagappa M, Saripella A, Waseem R, Englesakis M, Chung F. Use and Performance of the STOP-Bang Questionnaire for Obstructive Sleep Apnea Screening Across Geographic Regions: A Systematic Review and Meta-Analysis. JAMA Netw Open. 2021 Mar 1;4(3):e211009.

[12] Khan MN, Ahmed A. Accuracy of STOP-Bang Questionnaire in Predicting Difficult Mask Ventilation: An Observational Study. Cureus. 2021 Jun;13(6):e15955.

[13] Chudeau N, Raveau T, Carlier L, Leblanc D, Bouhours G, Gagnadoux F, Rineau E, Lasocki S. The STOP-BANG questionnaire and the risk of perioperative respiratory complications in urgent surgery patients: A prospective, observational study. Anaesthesia Critical Care & Pain Medicine. 2016 Oct 1;35(5):347–53.
[14] Shah PN, Sundaram V. Incidence and predictors of difficult mask ventilation and intubation. J Anaesthesiol Clin Pharmacol. 2012 Oct;28(4):451–5.
[15] Parthasarathy S, Bag SK, Krishnaveni N. Assessment of airway the MOUTH concept. J Anaesthesiol Clin Pharmacol. 2012 Oct;28(4):539.
[16] Traylor BA, McCutchan A. Unanticipated Difficult Intubation in an Adult Patient. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2023.
[17] (PDF) Carotid Intima Media Thickness as a Predictor for the .. Available from: https://www.academia.edu/116610722/Carotid_Intima_Media_Thickness_as_a_Predictor_for_the_Severity_of_Coronary_Artery_Disease
[18] Soitong P, Jangjaicharoen S, Kaewsanit A, Mali P, Viriyakhaikul Y, Boonnumma S, Tipmabutr S, Chalermchuang P, Maneechot W, Numnoi C, Phungmali K, Meksong T, Ponpadermyod B, Jirachairattanasin W, Sakboonyarat B, Rangsin R, Mungthin M, Piyaraj P. Association of neck circumference and hypertension among adults in a rural community Thailand: A cross-sectional study. PLoS One. 2021 Aug 20;16(8):e0256260.
[19] Manjavong M, Limpawattana P, Rattanachaiwong S, Mairiang P, Reungjui S. Utility of body mass index and neck circumference to screen for metabolic syndrome in Thai people. Asian Biomed. 2017 Feb 1;11(1):55–63.
[20] Caleyachetty R, Barber TM, Mohammed NI, Cappuccio FP, Hardy R, Mathur R, Banerjee A, Gill P. Ethnicity-specific BMI cutoffs for obesity based on type 2 diabetes risk in England: a population-based cohort study. Lancet Diabetes Endocrinol. 2021 Jul;9(7):419–26.
[21] Tham KW, Abdul Ghani R, Cua SC, Deerochanawong C, Fojas M, Hocking S, Lee J, Nam TQ, Pathan F, Saboo B, Soegondo S, Somasundaram N, Yong AML, Ashkenas J, Webster N, Oldfield B. Obesity in South and Southeast Asia-A new consensus on care and management. Obes Rev. 2023 Feb;24(2):e13520.
[22] Xia M, Liu S, Ji N, Xu J, Zhou Z, Tong J, Zhang Y. BMI 35 kg/m2 does not fit everyone: a modified STOP-Bang questionnaire for sleep apnea screening in the Chinese population. Sleep Breath. 2018 Dec;22(4):1075–82.
[23] Mou J, Pflugeisen BM, Crick BA, Amoroso PJ, Harmon KT, Tarnoczy SF, Shirley Ho S, Mebust KA. The discriminative power of STOP-Bang as a screening tool for suspected obstructive sleep apnea in clinically referred patients: considering gender differences. Sleep Breath. 2019 Mar;23(1):65–75.
[24] Loh JMR, Toh ST. Rethinking neck circumference in STOP-BANG for Asian OSA. Proc Singap Health. 2019 Jun;28(2):105–9.
[25] Benjafield AV, Ayas NT, Eastwood PR, Heinzer R, Ip MSM, Morrell MJ, Nunez CM, Patel SR, Penzel T, Pépin JL, Peppard PE, Sinha S, Tufik S, Valentine K, Malhotra A. Estimation of the global prevalence and burden of obstructive sleep apnoea: a literature-based analysis. Lancet Respir Med. 2019 Aug;7(8):687–98.
[26] Dai Y, Walline JH, Wu Y, Zhu H, Xu J, Yu X. Incidence and diagnostic validity of difficult airway in emergency departments in China: a cross-sectional survey. J Thorac Dis. 2023 Feb 28;15(2):434–41.
[27] Saoraya J, Vongkulbhisal K, Kijpaisalratana N, Lumlertgul S, Musikatavorn K, Komindr A. Difficult airway predictors were associated with decreased use of neuromuscular blocking agents in emergency airway management: a retrospective cohort study in Thailand. BMC Emerg Med. 2021 Mar 25;21(1):37.
[28] Slowik JM, Sankari A, Collen JF. Obstructive Sleep Apnea. StatPearls Publishing; 2024.
[29] Gottlieb DJ, Punjabi NM. Diagnosis and Management of Obstructive Sleep Apnea: A Review. JAMA. 2020 Apr 14;323(14):1389–400.
[30] Bangash A, Wajid F, Poolacherla R, Mim FK, Rutkofsky IH. Obstructive Sleep Apnea and Hypertension: A Review of the Relationship and Pathogenic Association. Cureus. 2020 May 22;12(5):e8241.
[31] Parise BK, Santos RB, Mesas AE, Silva WA, Giatti S, Aielo AN, Cunha LF, Souza SP, Bortolotto LA, Griep RH, Lotufo PA, Bensenor IM, Drager LF. Sleep irregularity and the association with hypertension and blood pressure levels: the ELSA-Brasil study. J Hypertens. 2023 Apr 1;41(4):670–7.

[32] Detsky ME, Jivraj N, Adhikari NK, Friedrich JO, Pinto R, Simel DL, Wijeysundera DN, Scales DC. Will This Patient Be Difficult to Intubate?: The Rational Clinical Examination Systematic Review. JAMA. 2019 Feb 5;321(5):493–503.
[33] Seet E, Chung F, Wang CY, Tam S, Kumar CM, Ubeynarayana CU, Yim CC, Chew EFF, Lam CKM, Cheng BCP, Chan MTV. Association of Obstructive Sleep Apnea With Difficult Intubation: Prospective Multicenter Observational Cohort Study. Anesth Analg. 2021 Jul 1;133(1):196–204.
[34] Mathangi K, Mathews J, Mathangi CD. Assessment of perioperative difficult airway among undiagnosed obstructive sleep apnoea patients undergoing elective surgery: A prospective cohort study. Indian J Anaesth. 2018 Jul;62(7):538–44.
[35] Dosman JA, Karunanayake CP, Fenton M, Ramsden VR, Seeseequasis J, Mike D, Seesequasis W, Neubuhr M, Skomro R, Kirychuk S, Rennie DC, McMullin K, Russell BP, Koehncke N, Abonyi S, King M, Pahwa P. STOP-Bang Score and Prediction of Severity of Obstructive Sleep Apnea in a First Nation Community in Saskatchewan, Canada. Clocks Sleep. 2022 Oct 12;4(4):535–48.
[36] Herschmann S, Berger M, Haba-Rubio J, Heinzer R. Comparison of NoSAS score with Berlin and STOP-BANG scores for sleep apnea detection in a clinical sample. Sleep Med. 2021 Mar;79:113–6.
[37] Oshita H, Ito N, Senoo M, Funaishi K, Mitama Y, Okusaki K. The STOP-Bang Test Is Useful for Predicting the Severity of Obstructive Sleep Apnea. JMA J. 2020 Oct 15;3(4):347–52.