


A Retrospective Analysis on Patients at High-Risk for Obstructive Sleep Apnea Undergoing Ear, Nose, and Throat Surgeries

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Background: Obstructive sleep apnea (OSA) may be related to episodes of oxygen de-saturation, hypercapnia, cardiovascular dysfunction, cor-pulmonale, and pulmonary hypertension. STOP-BANG is an acronym for eight specific questions used to assess the likelihood of OSA. If the individual exhibits three or more of these indicators, he/she should be considered to be at high risk for OSA complications. Therefore, the decision of proceeding with inpatient versus outpatient ENT surgery still remains controversial. The primary objective of the study was to identify and correlate desaturation (SPO₂ <90%) episodes and risk factors.

Methods: We conducted a single-center retrospective study between October 1, 2011 and August 31, 2014 in order to identify postoperative complications during the first 24 hours that justify postoperative monitoring and hospital admission. A total of 292 subjects were included for data analysis. Patients were divided into two groups based on the number of OSA risk factors: group A with 3–4 risk factors (n = 166), and group B with ≥5 risk factors (n = 126). The following information was collected: demographics, ASA, preoperative STOP-BANG score, length of surgery, intraoperative complications, opioid consumption, post anesthesia care unit (PACU) and overall length of stay, supplemental oxygen requirement, oxygen desaturation, and postoperative opioid consumption.

Results: No statistically significant difference was found when comparing demographic variables between both groups. All STOP-BANG variables showed statistical significance. PACU and inpatient variables were similar among both groups, with the exception of length of hospital stay (longer stay in group B when compared to group A [$p = 0.003$]). Desaturation differences between both groups during PACU were statistically significant ($p = 0.008$). A post-hoc analysis showed a 0% incidence of overall desaturation in the group with three STOP-BANG indicators.

Conclusions: Our retrospective analysis concluded that patients diagnosed with three STOP-BANG risk factors did not experience postoperative complications and hospital admission was not justified.

Key Words: Obstructive sleep apnea, ENT surgeries, STOP-BANG questionnaire, PO complications, opioid consumption.

Level of Evidence: 4

INTRODUCTION

The American Society of Anesthesiologists (ASA) defines obstructive sleep apnea (OSA) as a partial/complete obstruction of the upper airway while the patient is asleep, causing arousal in order to restore airway patency.^{1,2} This may be related to episodes of oxygen desaturation, hypercapnia, or other serious complications, such as cardiovascular dysfunction, systemic

hypertension, cor pulmonale, and hypoxic pulmonary vasoconstriction with pulmonary hypertension.^{1,3,4}

According to the literature, the estimated prevalence of OSA in the United States varies between 1–24% in middle-aged men, and 2–9% in adult women.^{4,5} Various reported conditions that increase the susceptibility for OSA include age, obesity, menopause status, craniofacial irregularities, male gender, family history of OSA, smoking, and alcohol usage.⁶

Postoperative monitoring of OSA patients in the intensive care unit (ICU) was a standard procedure until a publication by Terris et al.,⁷ with follow-up studies by Mickelson and Gessler,^{8,9} concluded that only patients with severe OSA, marked morbid obesity, and other comorbidities could benefit from non-ICU floor monitoring. A recent study published by Spiegel et al.¹⁰ further suggested that patients undergoing uvulopalatopharyngoplasty (UPPP) may be discharged the day of surgery after 2–3 hours of observation in the post-anesthesia care unit (PACU).

Due to aforementioned complications, a comprehensive preoperative evaluation is mandatory for patients identified to be at high-risk for, or already diagnosed with OSA. Such an assessment should contain past

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medical history (including polysomnography test, if available), questions about morning headaches, daytime somnolence, frequent arousals during sleep, and a STOP-BANG questionnaire.¹¹

STOP-BANG is an acronym for specific questions used to assess the likelihood of OSA in a patient.^{12,13} The questionnaire contains eight distinct questions regarding different risk factors: (1) Snoring, (2) Tiredness, (3) Observed apneas, (4) history of high blood Pressure, (5) Body mass index (>35 kg/m²), (6) Age (>50 years), (7) Neck circumference (>40 cm), and (8) Gender (male).^{13,14} If patients exhibit three or more of the possible eight indicators, they should be included in the OSA high risk category.¹² Physical examination should include airway evaluation, nasopharyngeal characteristics, tonsil size, and tongue volume. According to ASA guidelines for perioperative management of patients with OSA, there is insufficient data to evaluate the efficacy of both interviews and physical/airway examination.¹⁵ The STOP-BANG questionnaire was created as an alternative tool to identify patients at risk for OSA when polysomnography is not available.¹⁶

The number of apnea and hypopnea episodes per hour during a polysomnographic test is reported as the apnea-hypoxemia index (AHI), considered to be the gold standard approach to diagnose OSA and assess the severity of sleep disordered breathing (SDB).^{12,17} The AHI definition classifies the threshold values of the estimated prevalence and severity distribution of OSA as normal (<5), mild (5 ≤ AHI < 15), moderate (15 ≤ AHI < 30) and severe (AHI > 30).^{12,18}

The optimization of patient's airway patency prior to surgery should include detailed preoperative instructions concerning the use of preoperative continuous positive airway pressure (CPAP) or, in more severe cases, noninvasive positive pressure ventilation (NIPPV), as well as nontechnical methods such as mandibular repositioning devices (MRDs) and weight loss.¹⁹

Intraoperative concerns, such as anesthesia technique, airway management, extubation while awake, and recovery in a lateral semi-upright position, should all be considered when deciding on the location of postoperative management: inpatient versus outpatient.¹²

It is the standard of care at our institution to admit high-risk OSA patients for 24-hour monitoring in order to avoid possible complications. Considering the existing limited body of evidence related to this topic, we conducted a retrospective chart review in order to identify postoperative complications during the first 24 hours that justified postoperative hospital admission and monitoring.

MATERIALS AND METHODS

We conducted a single-center retrospective review of selected medical records of subjects who underwent ENT surgeries at The Ohio State University Wexner Medical Center between October 1, 2011 and August 14, 2014. After obtaining the approval of the Institutional Review Board (Office of Responsible Research Practices), electronic medical records were accessed in order to retrieve patients' perioperative information. A total of 567 charts were reviewed.

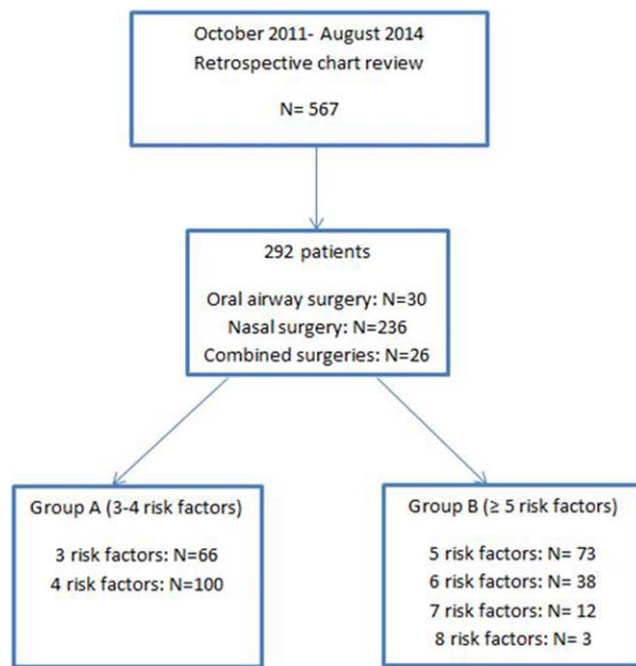


Fig. 1. Retrospective analysis flowchart of total number of subjects categorized by number of OSA risk factors. N=Number of patients

The subjects, aged ≥18 years, with a past medical history of OSA or determined to be at-risk by the STOP-BANG questionnaire, and undergoing ENT surgeries (endoscopic sinus surgery, inferior turbinate submucosal resection, concha bullosa resection, septoplasty, tonsillectomy, uvulectomy, and uvulopalatopharyngoplasty; individually or in combination) with overnight hospitalization between October 1, 2011 and August 14, 2014 at The Ohio State University Wexner Medical Center were included in the study. Subjects aged <18 years old, pregnant woman, and prisoners were excluded from the study.

A STOP-BANG questionnaire performed as standard of care during the preoperative evaluation was used to identify patients at high risk for OSA (three or more risk factors). In addition, the AHI recorded in the polysomnographic test was collected from the medical records, if available.

The following information was collected for analysis purposes: patient demographics (age, gender, race, weight, height, and body mass index [BMI]), predictors and perioperative variables (ASA, preoperative STOP-BANG score, length of surgery, intraoperative complications, opioid consumption, PACU length of stay, use of supplemental oxygen, and oxygen saturation). Considering the number of OSA risk factors, subjects were divided into two groups: group A having 3–4 risk factors, and group B having ≥5 risk factors (Fig. 1). In addition, the following inpatient care information was collected: length of hospital stay, postoperative complications, opioid consumption during the first 24 hours following surgery, use of supplemental oxygen, and oxygen saturation. Patients' charts were also reviewed for a period of 30 days after surgery in order to assess mortality and re-hospitalization incidence.

Postoperative complications were collected and divided into three different categories: oxygen desaturation episode (defined as oxygen saturation of 90% or less), hypertension (requiring treatment), and other (headaches, tape induced corneal

TABLE I.
Demographics, STOP-BANG Risk Factors and Perioperative Surgical Variables.

	OSA High-Risk ENT Population N = 292		P-value
	Group A N = 166	Group B N = 126	
Age, mean (SD), years	47.7 ± 15.5	51.7 ± 15.1	0.025
Weight, mean (SD), kg	99.2 ± 23.4	113.8 ± 28.4	<0.0001
Height, mean (SD), cm	171.0 ± 12.3	174.0 ± 10.6	0.023
BMI, mean (SD)	33.5 ± 7.3	37.6 ± 9.6	0.0002
Race—White, n (%)	126 (75.9%)	102 (80.9%)	0.352
ASA I/II/III/IV	3/69/93/1	0/30/88/8	0.0003
STOP-BANG risk factors			
Snoring, n (%)	129 (77.7)	113 (89.6)	0.007
Tired, n (%)	64 (38.5)	84 (66.6)	<0.0001
Observed apnea, n (%)	29 (17.4)	58 (46.0)	<0.0001
Hypertension, n (%)	89 (53.6)	97 (76.9)	<0.0001
BMI > 35, n (%)	65 (39.1)	68 (53.9)	0.011
Age > 50, n (%)	77 (46.4)	82 (65.0)	0.001
Neck > 40 cm, n (%)	66 (39.7)	99 (78.5)	<0.0001
Male, n (%)	79 (47.6)	100 (79.2)	<0.0001
Length of surgery, mean (SD), minutes	82.6 ± 49.2	78.2 ± 37.1	0.406
Length of PACU stay, mean (SD), minutes	111.1 ± 57.1	112.8 ± 57.1	0.796
Length of hospital stay, mean (SD) hours	11.4 ± 12.6	16.0 ± 14.0	0.003
Intraoperative opioid consumption, mean (SD), oral morphine, mg	25.9 ± 16.2	32.3 ± 24.7	0.085
Recovery opioid consumption, mean (SD), oral morphine, mg	24.6 ± 17.0	25.2 ± 15.5	0.782
Inpatient opioid consumption, mean (SD), oral morphine, mg	61.5 ± 43.4	52.2 ± 37.6	0.204
Oral airway surgery	17 (10.1%)	13 (10.4%)	0.937
Nasal surgery	135 (80.4%)	102 (81.6%)	0.789
Combined (oral and nasal surgeries)	16 (9.5%)	10 (8%)	0.650

Bold values indicate statistical significance.

ASA = American Society of Anesthesiologists; BMI = body mass index; ENT = ear, nose, and throat; OSA = obstructive sleep apnea; PACU = post-anesthesia care unit; SD = standard deviation; STOP-BANG = Snoring, Tiredness, Observed apneas, history of high blood Pressure, Body mass index, Age, Neck circumference, and Gender.

abrasions, postoperative nausea and vomiting, postoperative bleeding, and non-clinically significant electrocardiogram abnormalities).

STATISTICAL ANALYSIS

The data were analyzed using SAS, version 9.4 (SAS Institute Inc., Cary, NC, USA). Prior to analysis, the data were examined for outliers, and no extreme values were found. Normality of data was assessed after visually inspecting the data and Shapiro Wilk normality test. Patient demographics and clinical parameters were summarized by risk factor groups and reported as means (SD) for continuous variables and total number and percentage for categorical variables. Depending on the expected cell counts of the corresponding contingency tables, Chi-square or Fisher's exact test was used to explore the association between risk factor groups and other categorical variables. Continuous variables were compared between groups using Student's t test or

Wilcoxon rank sum tests; whichever was appropriate. Significance level was set $\alpha \leq 0.05$.

RESULTS

A total of 567 charts were reviewed based on inclusion and exclusion criteria, 292 (51.49%) subjects were considered for data analysis. All subjects included in data analysis were high risk for OSA (≥ 3 risk factors) according to STOP-BANG criteria. Considering the number of OSA risk factors, subjects were divided into 2 groups: group A having 3–4 risk factors ($n = 166$), and group B having ≥ 5 risk factors ($n = 126$) (Fig. 1).

Subjects' demographic variables such as age, BMI, and gender are listed in Table I. All demographic variables between both groups showed statistical significance except for race-white ($p = 0.352$).

Intergroup analysis of STOP-BANG variables showed the following results when considering groups A

TABLE II.
Postoperative Complications and Oxygen Delivery Devices Used.

	OSA High risk ENT population N = 292		P-value
	Group A N= 166	Group B N= 126	
PACU			
Desaturation	11 (16.1%)	32 (45.0%)	0.008
Hypertension	36 (52.9%)	32 (45.0%)	0.658
Other	21 (30.8%)	7 (9.8%)	0.011
Inpatient			
Desaturation	14 (56.0%)	21 (63.6%)	0.830
Hypertension	4 (16.0%)	6 (18.1%)	0.999
Other	7 (28.0%)	6 (18.1%)	0.547
PACU oxygen delivery devices used			
Nasal cannula	4 (57.1%)	25 (80.6%)	0.435
Facial mask	3 (42.8%)	5 (16.1%)	0.228
Venturi	0 (0.0%)	1 (3.2%)	0.821
Inpatient oxygen delivery devices used			
Nasal cannula	8 (72.7%)	12 (60.0%)	0.774
Facial mask	3 (27.2%)	5 (25.0%)	0.999
Venturi	0 (0.0%)	3 (15.0%)	0.535

ENT = ear, nose, and throat; OSA = obstructive sleep apnea; PACU = post-anesthesia care unit; SD = standard deviation.

and B: snoring (77.7% vs. 89.6%; $p = 0.007$), BMI >35 kg/m² (39.1% vs. 53.9%; $p = <0.011$), and age > 50 (46.4% vs. 65%; $p = 0.001$). Tiredness (38.5% vs. 66.6%; $p = <0.0001$), observed apnea (17.4% vs. 46.0%; $p = <0.0001$), hypertension (53.6% vs. 76.9%; $p = <0.0001$), neck circumference (39.7% vs. 78.5%; $p < 0.0001$), and male gender (47.6% vs. 79.2%; $p = <0.0001$) were found to be highly statistically significant ($p < 0.001$) (Table I).

Intra- and postoperative variables were also compared between group A and group B. Length of surgery (measured in minutes), opioid consumption (units of oral morphine use, mg), and length of PACU stay were similar in both groups. However, length of hospital stay was higher in group B when compared to group A ($p = 0.003$) (Table I).

Type of oxygen delivery devices and their incidence of use to treat desaturations showed no difference between both groups. Postoperative desaturation showed statistical significance in PACU ($p = 0.008$) between both groups (16.1% vs. 45%), but not during hospital stay (56% vs. 63.6%; $p = 0.830$) (Table II).

In order to analyze the differences between ENT patients with three and four risk factors, previously included in group A, a post-hoc analysis was made showing an incidence of overall desaturation of 0% (97.5% confidence interval [CI] 0; +0.0543) for the group with three risk factors. The groups with four and five risk factors revealed an incidence of overall desaturation of 25% (95% CI +0.1687; +0.3465), and 42% (95% CI +0.3332; +0.5118), respectively (Table III).

A subset analysis comparing AHI and STOP-BANG scores was performed for subjects with both assessments available (143 subjects, 48.97%), in order to assess the correlation with OSA severity (Table IV). The analysis indicated a significant correlation among subjects with severe AHI scores and ≥ 5 STOP-BANG risk factors ($p = 0.003$).

Additionally, another post-hoc analysis was performed in order to identify differences in the incidence of desaturation episodes when considering OSA severity according to AHI scores (Table V). The analysis did not show a significant difference in desaturation episodes

TABLE III.
Post-hoc Analysis of Postoperative Desaturation Variables.

	Group A N = 166		Group B N = 126	P-value
	3 risk factors (N = 66)	4 risk factors (N = 100)	≥ 5 risk factors (N = 126)	
Post-anesthesia care unit	0	11	32	<0.0001
Inpatient	0	14	21	<0.0001
Overall Postoperative Desaturation	0 (0.0%)	25 (25.0%)	53 (42.0%)	<0.0001

TABLE IV.
Apnea-Hypopnea Index and STOP-BANG Scores Correlation.

AHI score	STOP-BANG score			P-value
	GROUP A N = 71		GROUP B N = 72 ≥5 risk factors N = 72	
	3 risk factors N = 29	4 risk factors N = 42		
Normal (<5) N = 5	3 (10.3%)	1 (2.3%)	1 (1.3%)	0.076
Mild sleep apnea (≥5 - <15) N = 30	11 (37.9%)	8 (19.0%)	11 (15.2%)	0.038
Moderate sleep apnea (≥15 - <30) N = 36	6 (20.6%)	16 (38.0%)	14 (19.4%)	0.071
Severe sleep apnea (≥30) N = 72	9 (31.0%)	17 (40.4%)	46 (63.8%)	0.003

among normal, mild, moderate, and severe OSA groups. No 30 days readmission or respiratory complications were documented.

DISCUSSION

There is limited literature available on whether patients at high risk for OSA should be admitted or managed in an ambulatory setting after an ENT procedure. Therefore, the following assessments should be considered: anatomical abnormalities, type of procedure, type of anesthesia, opioid consumption, and facility capabilities.²⁰

Baugh et al. recently reviewed 452 OSA patients who underwent head and neck airway surgery. The analysis focused on emergency department (ED) visits and/or postoperative clinic visits. The authors found no substantial differences between patients receiving inpatient versus outpatient surgery, and concluded that it was not necessary to admit all OSA patients after surgery.²¹ Our data analysis showed that patients with three risk factors did not experience perioperative or post-discharge complications (no unplanned hospitalization or ED visit).

A review published by Bryson et al. assessed readmission within seven days after discharge on 77,809 patients diagnosed with OSA. A total of 1,547 unplanned readmissions were analyzed; the study concluded that OSA severity was not associated with an increased incidence of unplanned admissions.²² Our study population did not experience any readmissions within 30 days after surgery.

Vasu et al. reported that age >60 years, STOP-BANG score ≥3, obesity, and ASA ≥3 were independently associated with a higher risk of postoperative

complications in 135 patients undergoing elective surgery. Moreover, patients at high risk for OSA were associated with a longer length of hospital stay.²³ In our study, the length of hospital stay was significantly longer in group B when compared to group A ($p = 0.003$).

Legal implications of postoperative complications in OSA patients have also been recently discussed. Fouladpour et al. reviewed 24 lawsuits initiated as a result of postoperative complications in patients with known or suspected OSA. Among these patients, 96% were previously diagnosed with OSA and 37.5% underwent ENT procedures (seven UPPP, one septoplasty, and one tooth extraction). The authors described the outcomes of these cases considering demographics, type and location of complications, opioid consumption, type of surgery, and ultimate resolution of the case. Immediate postoperative complications were related to opioid consumption leading to hypoxic arrest (three deaths), anoxic brain injury due to unsuccessful reintubation (five cases), and pulmonary edema (one death). Perioperative opioid consumption for patients with ≥5 risk factors varied with no statistical significance when compared with patients to 3–4 risk factors.²⁴

Fouladpour's review invites anesthesiologists to reconsider alternatives to opioid medication when treating OSA surgical patients.²⁸ Our study indicated no differences in opioid consumption when comparing both groups. Moreover, our institutional pain management protocol implemented multimodal therapy within 24 hours post-surgery, hereby reducing side effects from opioid medications.

Currently, OSA is primarily identified by a standard polysomnography test, a procedure not routinely

TABLE V.
Post-hoc Analysis of Postoperative Desaturation Variables.

AHI Score	Normal (<5) N = 5	Mild Sleep Apnea (≥5 - <15) N = 30	Moderate Sleep Apnea (≥15 - <30) N = 36	Severe Sleep Apnea (≥30) N = 72	P-value
PACU	1 (20%)	4 (13.3%)	7 (19.4%)	14 (19.4%)	0.896
Inpatient	1 (20%)	4 (13.3%)	7 (19.4%)	14 (19.4%)	0.896
Overall	2 (40%)	8 (26.6%)	14 (38.8%)	28 (38.8%)	0.671

AHI = apnea-hypopnea index; PACU = post-anesthesia care unit

performed in all ENT patients. A novel retrospective study published by Asha'ari et al. in 2017 analyzed 95 patients with AHI >5 who underwent upper airway surgeries as part of their treatment for OSA.²⁵ A total of 48 patients (51%) developed at least one perioperative complication and according to a multivariable model, the incidence of complications increased with age and BMI, but was not associated with AHI severity.²⁵ Likewise, our retrospective study identified polysomnography test performed in 143 subjects (48.97%), showed no significant association between AHI severity and likelihood of perioperative desaturation.

A few limitations are worth mentioning. Considering that polysomnography is the most accurate method to diagnose OSA and assess its severity, only 48.97% of our OSA study patients were evaluated based on this test.

Due to the retrospective nature of the design, baseline oxygen saturation values were not captured, and there was a lack of consistency in capturing desaturation events by healthcare providers. The study did not consider data from subjects with <3 risk factors. A future prospective study should analyze data based on individual categories corresponding to the number of risk factors in order to better classify patients per groups.

Chung et al. published the preoperative screening and anesthesia guidelines for OSA patients undergoing surgery, intending to offer general recommendations considering local standard procedures, patient status, type and length of intervention, and available resources.²⁶

CONCLUSIONS

Our retrospective analysis suggested that patients diagnosed with three OSA risk factors based on the STOP-BANG questionnaire did not experience any postoperative complications and that hospital admission was not justified. The study also showed that patients with four risk factors should be assessed on a patient-by-patient basis in order to identify those individuals who require hospitalization and monitoring. In addition, multimodal pain therapy should be considered to reduce postoperative opioid use in patients at risk of respiratory depression. Well-designed prospective studies should identify patients at risk of perioperative complications using the STOP-BANG questionnaire. Early supplementary oxygen administration at admission associated with reduced perioperative opioid consumption and multimodal pain therapy management should be considered as well. Based on our data we concluded that a STOP-BANG score of three for patients undergoing ENT procedures might be considered a reliable indicator of uneventful perioperative outcomes and immediate patient discharge, reducing financial burden created by unnecessary hospitalizations. However, several factors along with STOP-BANG score should be considered when deciding to admit or not ENT patients.

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