

STOP-BANG and history of Obstructive Sleep Apnea: a new predictive model improves sensitivity

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Introduction

Obstructive Sleep Apnea (OSA) affects ~9-24% of the general population, a large number of subjects remain undiagnosed while the majority of them, undiagnosed, would be affected by moderate-to-severe OSA. These subjects are predisposed to an increased risk of complications, and for surgical patients, such risk is for perioperative cardiac, respiratory and airway complications. [1-2]

Methods

In the present work, we report the quality-assurance analysis of 9 months assessment in a preoperative clinic of a teaching hospital: our main objective was to evaluate the effectiveness (real world clinical efficacy) of a novel predictive model based on a STOP-BANG [3] modified [4] (SBm) in diagnosing OSA based on clinical history taking.

Data was collected from May 2013 to January 2014 as part of a Hospital clinical-quality monitoring program at the University of Texas Health-Memorial Hermann Hospital-Texas Medical Center at Houston, utilizing a dedicated sheet. Patients were prospectively screened based on STOP-BANG, Mallampati, thyromental distance (TMD). Five risk factors were defined HIGH weight (a priori) for the modified model (SNORING, APNEAS, NECK, BMI, Mall 3-4, Male/Female postmenop). Frequencies of primary variables were assessed. The sensitivity and specificity of STOP-BANG was based on a recognized cutoff of 4 and 5 risk factors [3] and a model analysis utilizing a novel strategy was then applied to improve sensitivity of the screening test. Different combination of 4-5 general risks factors and or 3 high risk factors were evaluated.

Results

A total of 1937 patients' questionnaires were collected during the review period. Based on distribution of OSA risk, twelve percent (N=236) were OSA known by history. The stratification in the different risk categories showed a linear correlation between the history of OSA and the associated risks factors. The standard model of stratification, based on 4 or 5 risks factors, showed respectively 0.67 Sens and 0.83 Spec, and 0.50 Sens and 0.92 Spec. Based on the new applied model though the sensitivity and specificity improved to 0.85 and 0.62 and 0.84 and 0.68 respectively, at 4 or 5 cut off.

Variables	All patients (N=1937)	OSA Risk			P-value
		<3	3<6	>6	
OSA hx	(N=1937)	(N=701)	(N=983)	(N=252)	<0.0001
Yes	236 (12.2)	14 (2.0)	104 (10.6)	117 (46.4)	
No	1701 (87.8)	687 (98.0)	879 (89.4)	135 (53.6)	
Management	(N=1925)	(N=700)	(N=976)	(N=248)	<0.0001
BIPAP	10 (0.5)	0 (0)	3 (0.3)	7 (2.8)	
CPAP	131 (6.8)	3 (0.4)	61 (6.3)	67 (27.0)	
NONE	76 (4.0)	9 (1.3)	29 (3.0)	37 (14.9)	
OTHER	7 (0.4)	1 (0.1)	4 (0.4)	2 (0.8)	
NA	1701 (88.4)	687 (98.1)	879 (90.1)	135 (54.4)	
Snoring	(N=1931)	(N=697)	(N=982)	(N=252)	<0.0001
Yes	936 (48.5)	139 (19.9)	559 (56.9)	238 (94.4)	
No	995 (51.5)	558 (80.1)	423 (43.1)	14 (5.6)	
Tiredness	(N=1920)	(N=700)	(N=971)	(N=249)	<0.0001
Yes	604 (31.5)	102 (14.6)	316 (32.5)	186 (74.7)	
No	1316 (68.5)	598 (85.4)	655 (67.5)	63 (25.3)	
Apneas	(N=1922)	(N=696)	(N=978)	(N=248)	<0.0001
Yes	312 (16.2)	11 (1.6)	126 (12.9)	175 (70.6)	
No	1610 (83.8)	685 (98.4)	852 (87.1)	73 (29.4)	
BP_Tx	(N=1924)	(N=696)	(N=977)	(N=251)	<0.0001
Yes	1011 (52.6)	98 (14.1)	679 (69.5)	234 (93.2)	
No	913 (47.5)	598 (85.9)	298 (30.5)	17 (6.8)	
Older than 50	(N=1935)	(N=701)	(N=982)	(N=252)	<0.0001
Yes	1186 (61.3)	190 (27.1)	770 (78.4)	226 (89.7)	
No	749 (38.7)	511 (72.9)	212 (21.6)	26 (10.3)	
Male	(N=1927)	(N=697)	(N=978)	(N=252)	<0.0001
Yes	782 (40.6)	187 (26.8)	471 (48.2)	124 (49.2)	
No	1145 (59.4)	510 (73.2)	507 (51.8)	128 (50.8)	
Female post menopausal	(N=1931)	(N=698)	(N=981)	(N=252)	<0.0001
Yes	646 (33.5)	125 (17.9)	401 (40.9)	120 (47.6)	
No	503 (26.1)	386 (55.3)	109 (11.1)	8 (3.2)	
Male	782 (40.5)	187 (26.8)	471 (48.0)	124 (49.2)	
Neck Size	(N=1905)	(N=692)	(N=963)	(N=250)	<0.0001
Yes	341 (17.9)	15 (2.2)	152 (15.8)	174 (69.6)	
No	1564 (82.1)	677 (97.8)	811 (84.2)	76 (30.4)	
BMI	(N=1873)	(N=675)	(N=951)	(N=247)	<0.0001
Yes	449 (24.0)	62 (9.2)	205 (21.6)	182 (73.7)	
No	1424 (76.0)	613 (90.8)	746 (78.4)	65 (26.3)	
Mallampati High (3-4)	(N=1644)	(N=600)	(N=840)	(N=204)	<0.0001
Yes	31 (1.9)	3 (0.5)	15 (1.8)	13 (6.4)	
No	1613 (98.1)	597 (99.5)	825 (98.2)	191 (93.6)	
Short_TD	(N=1420)	(N=527)	(N=712)	(N=181)	0.02
Yes	177 (12.5)	56 (10.6)	87 (12.2)	34 (18.8)	
No	1243 (87.5)	471 (89.4)	625 (87.8)	147 (81.2)	

Table 1. Demographical distribution of OSA history, STOP-BANG Risk Factors and stratification Risk Categories of OSA

# of general risk factors patient possessed	OSA		P-values
	YES (N=236)	No (N=1701)	
>4 (Positive)	TP: 157 (66.5%)	FP: 295 (17.3%)	<0.0001
<=4 (Negative)	FN: 79 (33.5%)	TN: 1406 (82.7%)	

Table 2A. Frequency table of OSA and Risk factors based on a cut off of 4. Sensitivity=TP/(TP+FN)=0.67; Specificity=TN/(TN+FP)=1561/(1561+140)=0.83 Diagnostic rule: Based on frequencies of risk factor distribution and history of OSA, we use 4 as a criteria to define TP (True Positive), FP (False Positive), TN (True Negative), FN (False Negative); TP: OSA+ and > 4 RF; FN: OSA+ and <= 4 RF; TN: OSA- and <= 4RF; FP: OSA- and > 4.

# of general risk factors patient possessed	OSA		P-values
	YES (N=236)	No (N=1701)	
>5 (Positive)	TP: 118 (50.0%)	FP: 140 (8.2%)	<0.0001
<=5 (Negative)	FN: 118 (50.0%)	TN: 1561 (91.8%)	

Table 2B. Frequency table of OSA and Risk factors based on a cut off of 5. Sensitivity=TP/(TP+FN)=0.5; Specificity=TN/(TN+FP)=1561/(1561+140)=0.92 Diagnostic rule: Based on frequencies of risk factor distribution and history of OSA, we use 5 as a criteria to define TP (True Positive), FP (False Positive), TN (True Negative), FN (False Negative); TP: OSA+ and > 5 RF; FN: OSA+ and <= 5 RF; TN: OSA- and <= 5RF; FP: OSA- and > 5.

Diagnostic rule	OSA		P-values
	YES (N=236)	No (N=1701)	
Positive	TP: 201 (85.2%)	FP: 648 (38.1%)	<0.0001
Negative	FN: 35 (14.8%)	TN: 1053 (61.9)	

Table 3A. Frequency table of OSA and Risk factors based on a cut off of 4 for generic STOP BANG risk factors and or 3 High Risk Factors. Sensitivity=TP/(TP+FN)=0.85; Specificity=TN/(TN+FP)=1053/(1053+648)=0.62 Diagnostic rule: Based on frequencies of risk factor distribution and history of OSA, we use 4 as a criteria to define TP (True Positive), FP (False Positive), TN (True Negative), FN (False Negative); TP: 1) OSA+ and > = 4 RF in general (the modified 9 RF based on stop-bang with higher sensitivity) and/or 2) OSA+ and at least 3 high RF, FN: OSA+ and <= 3 RF in general (Up to 3 RF of the modified 9 RF based on stop-bang) and < 3 high RF (up to 2), i.e., most of other OSA+ if they are not considered as TFPF: OSA- and >= 3 high RF and/or >= 4 general, TN: selected other OSA -

Diagnostic rule	OSA		P-values
	YES (N=224)	No (N=1701)	
Positive	TP: 189 (84.4%)	FP: 539 (31.7%)	<0.0001
Negative	FN: 35 (15.6%)	TN: 1162 (68.3%)	

Table 3B. Frequency table of OSA and Risk factors based on a cut off of 5 for generic STOP BANG risk factors and or 3 High Risk Factors. Sensitivity=TP/(TP+FN)=0.84; Specificity=TN/(TN+FP)=1162/(1162+539)=0.68 Diagnostic rule: Based on frequencies of risk factor distribution and history of OSA, we use 5 as a criteria to define TP (True Positive), FP (False Positive), TN (True Negative), FN (False Negative); TP: 1) OSA+ and > = 5 RF in general (the modified 9 RF based on stop-bang with higher sensitivity) and/or 2) OSA+ and at least 3 high RF, FN: OSA+ and <= 3 RF in general (Up to 3 RF of the modified 9 RF based on stop-bang) and < 3 high RF (up to 2), i.e., most of other OSA+ if they are not considered as TFPF: OSA- and >= 3 high RF and/or >= 5 general, TN: selected other OSA -

Discussion

OSA is a frequent clinical condition, and high risk patients are prevalently undiagnosed. Utilizing our modified version of STOP-BANG questionnaire with risk weighted frequency adjustment model, the Sensitivity (screening power) of SBm could be improved to 85%.

References

- [1] Kaw R, Chung F, Pasupuleti V, Mehta J, Gay PC, Hernandez AV. Meta-analysis of the association between obstructive sleep apnoea and postoperative outcome. Br J Anaesth. 2012 Dec;109(6):897-906.
- [2] Corso R, Petrini F, Buccioli M, Nanni O, Carretta E, Troilo A, De Nuzzo D, Pigna A, Di Giacinto I, Agnoletti V, Gambale G. Clinical utility of preoperative screening with STOP-Bang questionnaire in elective surgery. Minerva Anestesiol. 2014 Aug;80 (8):877-84.
- [3] Chung F, Subramanyam R, Liao P, Sasaki E, Shapiro C, Sun Y. High STOP-Bang score indicates a high probability of obstructive sleep apnoea. Br J Anaesth. 2012 May;108(5):768-75.
- [4] Cattano D., Mullaly A., Kainer L., Courtney S., Hagberg C.A. Risk Stratification, Prevalence and Risk Factors of Obstructive Sleep Apnea by Stop-Bang in an Adult Surgical Population Assessed in the Preoperative Anesthesia Clinic. Anesthesiology, 2014: A2036.