



Prevalence of risk of obstructive sleep apnea in hospitalized internal medicine patients in a rural academic medical center

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Abstract

Purpose: This study aims to determine the prevalence of obstructive sleep apnea risk within hospitalized patients utilizing the STOPBANG questionnaire, evaluate patient interest in follow-up testing and determine the factors that influence their interest in follow-up. **Methods:** A researcher approached eligible patients hospitalized at a tertiary hospital, explained the study, and acquired verbal consent. They administered the STOPBANG questionnaire, discussed participants' risk, and provided information about follow-up polysomnography. **Results:** Of 335 patients approached, 121 patients were excluded and 60 (17.9%) were already diagnosed with obstructive sleep apnea. Of the 154 participants screened, 42.2%, 35.7% and 22.1% were at low, intermediate and high risk of obstructive sleep apnea, respectively. Of those at intermediate to high risk, 44 expressed interest in following up with polysomnography and 32 were not interested. Older patients were less likely to express interest in follow-up (OR 0.098 95% CI: 0.012-0.893) and patients that reported snoring were more likely to express interest in follow-up (OR 3.15 CI: 1.14-8.75). **Conclusions:** There is a high prevalence of intermediate to high obstructive sleep apnea risk (57.8%) in undiagnosed patients in a rural tertiary care center. Younger patients were 10 times more likely to consider polysomnography (PSG), which supports arguments for early screening for obstructive sleep apnea. Snorers were 3 times more likely to consider PSG, which may reflect the narrow focus of public awareness of obstructive sleep apnea.

Introduction

Obstructive sleep apnea (OSA) is a sleep disorder characterized by pauses in breathing of 10 seconds or more causing unrestful sleep and often accompanied by loud or abnormal snoring, daytime sleepiness, irritability, and depression. According to the National Sleep Foundation, more than 18 million Americans have OSA, 80% of whom are undiagnosed¹. Undiagnosed OSA is associated with higher healthcare expenditures costing the United States an estimated 149.6 billion dollars in 2015 alone. Further, it accounts for the 4th highest percentage of healthcare expenses, trailing only cancer, diabetes and heart disease². In addition to the financial costs, OSA increases morbidity and mortality of cardiovascular and cerebrovascular events³. Health systems and patients would benefit from timely diagnosis and treatment of OSA.

The STOPBANG survey was originally developed for use in perioperative patients to screen for OSA and stratify risk of complications from anesthesia.⁴ Since then, it has been utilized and validated in tertiary care centers to screen many diverse populations of patients for OSA^{5,6}. However, much

of the literature is limited to specific subpopulations such as obese patients⁷ and patients over 50,⁸ and thus may not be as generalizable. Further, there is limited published data identifying patient characteristics that may impact interest in pursuing follow-up polysomnography (PSG). This study aims to utilize the STOPBANG questionnaire to identify the prevalence of risk of undiagnosed OSA on an inpatient medicine ward, evaluate the interest of patients to undergo further testing and determine patient characteristics that may impact interest in pursuing follow-up PSG.

Methods

We conducted a single-center, descriptive study on adult patients at a tertiary care medical center by administering the STOPBANG survey to randomly selected patients on the Internal Medicine Service. The quick STOPBANG questionnaire is a validated tool for identifying high risk features of OSA.⁵ It is composed of 8 questions that ask about core symptoms and risk factors for OSA including snoring, excessive daytime sleepiness (EDS), choking during sleep, hypertension, body mass index (BMI), age, neck size and gender (**Figure 1**).



Figure 1. STOPBANG Questionnaire used during patient recruitment. Reprinted with permission from Dr. Chung and colleagues at STOPBANG.ca.

1. **SNORING?** Do you Snore Loudly (loud enough to be heard through closed doors or your bed-partner elbows you for snoring at night)? Yes/No
2. **TIRED?** Do you often feel Tired, Fatigued, or Sleepy during the daytime (such as falling asleep during driving or talking to someone)? Yes/No
3. **OBSERVED?** Has anyone Observed you Stop Breathing or Choking/Gasping during your sleep? Yes/No
4. **PRESSURE?** Do you have or are being treated for High Blood Pressure? Yes/No
5. **BODY MASS INDEX** more than 35 kg/m²?
6. **AGE** older than 50? Yes/No
7. **NECK SIZE** large? (Measured around Adam's apple)
For male, is your shirt collar 17 inches / 43cm or larger?
For female, is your shirt collar 16 inches / 41cm or larger?
8. **GENDER** = Male? Yes/No

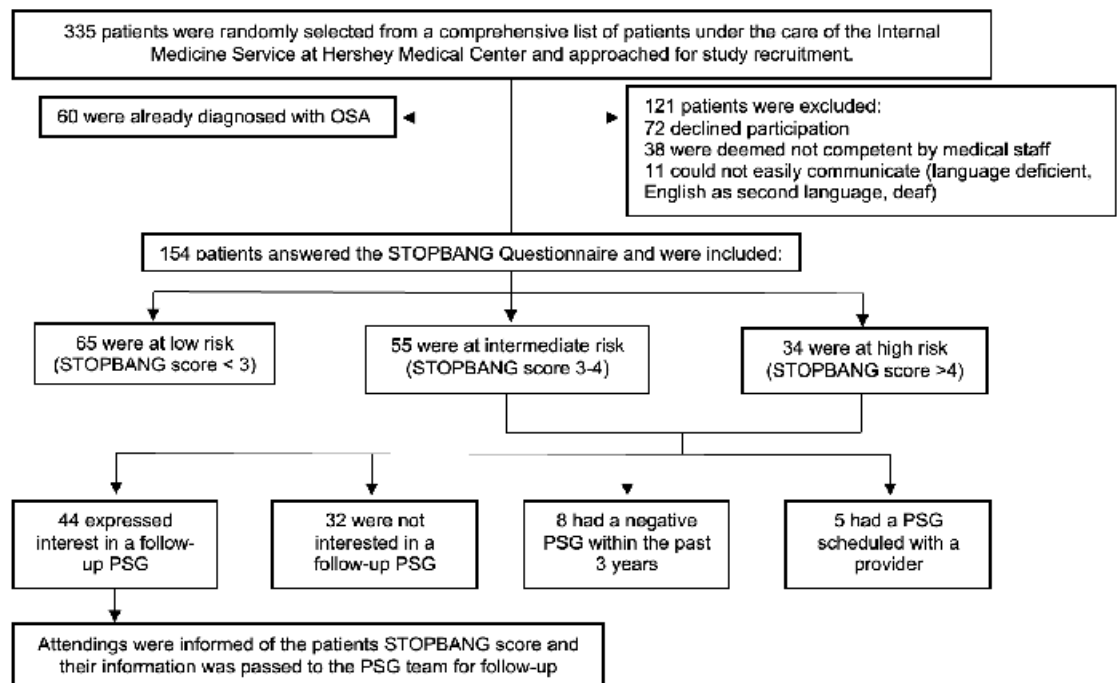
From August 6th to December 2nd 2019, an interviewer approached randomly selected patients on the Internal Medicine Service in their rooms and guided them through the consent form. Patients were excluded upon if they were under the age of 18, lacked capacity to consent, had significant language barriers, declined to participate or were currently diagnosed with OSA. After giving verbal consent, patients were administered the STOPBANG Questionnaire. If patients could not self-report neck size at the time of the interview, the interviewer measured it with paper measuring tape. If patients were uncertain of the answers to STOPBANG questions, such as treatment for or diagnosis of hypertension, the electronic medical record

was utilized for verification. Each patient's STOPBANG score was tabulated on site, and they were informed of their result and its implications for their risk of OSA. Patient's with a score of 3-4 or >4 (indicating intermediate or high-risk) were recommended an outpatient PSG and asked if their contact information could be shared with the Sleep Medicine Program. The Human Subjects Protection Office determined this work did not require formal IRB review because the research met the criteria for exempt research according to institutional policies and federal regulations.

All variables were summarized prior to analysis by checking the distributions of continuous variables with histograms and normal probability plots. Statistical significance was set at p<0.05. Patients with a STOPBANG score of >2 and interest in undergoing PSG for definitive diagnosis were compared to subjects without interest in undergoing a PSG using a Chi-square test for categorical variables. For continuous variables, a two-sample t-test was used for normally distributed variables (age) and a Wilcoxon Rank Sum test was used for skewed variables (BMI). This analysis was extended to a multivariable logistic regression model that included the most significant factors of age, snoring, and neck size. Prior to fitting the multivariable model, the predictors were checked for multicollinearity using variance inflation factor (VIF) statistics. The fit of the model was assessed using Pearson, Deviance, and Hosmer & Lemeshow goodness-of-fit tests. Odds ratios were used to quantify the magnitude and direction of variables significantly associated with the willingness to pursue an OSA work-up in the multivariable model. All analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC).

Figure 2. Flowchart of study design and patient recruitment.

Patients that met inclusion criteria were administered a STOPBANG survey and had their necks measured. Patients with STOPBANG score indicating intermediate-high risk were asked to pursue follow-up PSG, and their responses were recorded. For patients interested in following up at Hershey Medical Center, the PSG team was notified of their STOPBANG score.



Results

Three hundred thirty five patients were approached, while 121 patients were excluded because 38 were not competent to participate, 11 had language barriers and 72 declined to participate. 60 (17.9%) were already diagnosed with OSA and were excluded. Of the 154 patients interviewed, the average age was 60.7 and BMI was 28.7 kg/m². Forty-one (26.6%) endorsed snoring, 44 (28.6%) endorsed EDS, 36 (23.4%) had been observed to stop breathing, 81 (52.6%) had diagnosed hypertension, 33 (21.4%) had a BMI over 35.0 kg/m², 112 (72.7%) were over 50 years in age, 55 (36.2%) had a large neck size (>17 cm if male, >16 cm if female) and 72 (46.8%) of participants were male. 65 (42.2%), 55 (35.7%) and 34 (22.1%) participants were at low, intermediate and high risk of OSA, respectively (**Table 1**).

Of the 89 patients at intermediate to high risk, 44 (49.4%) expressed interest in following up with a PSG, 32 (36.0%) were not interested, 8 (9.0%) had a recent negative PSG, and 5 (5.6%) had recently scheduled a PSG (**Figure 2**). For patients that expressed interest, their attendings were informed of their STOPBANG score and their information was passed to the PSG team for follow-up.

In post-hoc analysis, we found that reported snoring on

the STOPBANG questionnaire was significantly associated with interest in following up p=0.037. Younger patients were also more likely to express interest in following up p=0.004. All other answers to the STOPBANG questionnaire were not significantly associated with interest in pursuing PSG (**Table 2**), although those with a larger neck size tended toward a significant association with interest (p=0.084). The association between age and interest was confirmed through a two-sample t-test (p=0.001). The mean age of patients interested in undergoing PSG was 59.0 (95% CI 55.2-62.9) while the mean of patients not interested was 69.6 (95% CI 64.3-74.8) p=0.001.

To further explore these associations, we generated a logistical regression using age, endorsement of snoring and neck size. The model passed multicollinearity testing and showed good fit on Deviance, Pearson and Homer-Lemeshow goodness-of-fit testing. Age and snoring remained significant at p=0.031 and p=0.027, respectively, while neck size remained insignificant at p=0.170. Older patients had 10 times lower odds to be interested in follow-up (OR 0.098 95% CI: 0.012-0.893) and patients that endorsed snoring had 3 times higher odds to express interest in follow-up (OR 3.15 CI: 1.14-8.75).

Variable	Total (n=154)	STOPBANG ≤2 (n=65)	STOPBANG >2 (n=89)	Percent Difference
Loud snoring				47.6%
No	113 (73.4%)	62 (54.9%)	51 (45.1%)	
Yes	41 (26.6%)	3 (7.3%)	38 (92.7%)	
Daytime sleepiness				30.5%
No	110 (71.4%)	56 (50.9%)	54 (49.1%)	
Yes	44 (28.6%)	9 (20.5%)	35 (79.6%)	
Observed choking or apnea				36.9%
No	118 (76.6%)	60 (50.9%)	58 (49.2%)	
Yes	36 (23.4%)	5 (13.9%)	31 (86.1%)	
High blood pressure				50.0%
No	73 (47.4%)	50 (68.5%)	23 (31.5%)	
Yes	81 (52.6%)	15 (18.5%)	66 (81.5%)	
BMI				42.1%
≤35 kg/m ²	121 (78.6%)	62 (51.2%)	59 (48.8%)	
>35 kg/m ²	33 (21.4%)	3 (9.1%)	30 (90.9%)	
Age				23.8%
≤50 years	42 (27.3%)	25 (59.5%)	17 (40.5%)	
>50 years	112 (72.7%)	40 (35.7%)	72 (64.3%)	
Large neck size				52.8%
No	97 (63.8%)	60 (61.9%)	37 (38.1%)	
Yes	55 (36.2%)	5 (9.1%)	50 (90.9%)	
Gender				42.8%
Female	82 (53.3%)	51 (62.2%)	31 (37.8%)	
Male	72 (46.7%)	14 (19.4%)	58 (80.6%)	

Table 1. Relationship between risk factors and positive STOPBANG score.

Relationship between risk factors and STOPBANG score > 2 among hospitalized internal medicine patients. Percent difference between patients with STOPBANG score > 2 with each risk factor and without each risk factor depicted on the left.

Table 2.
Risk factors compared to interest in undergoing PSG.

Risk factors of patients with a STOPBANG score >2 compared to their interest in undergoing PSG. Patients that had a previously reported PSG in the past 3 years or that were in the process of scheduling one prior to participation in the study were considered "interested".

*Chi-square test.

Variable	Total (n=89)	No Interest (n=32)	Interested (n=57)	Percent Difference	P-value*
Loud snoring				47.6%	0.037
No	51 (57.3%)	23 (45.1%)	28 (54.9%)		
Yes	38 (42.7%)	9 (23.7%)	29 (76.3%)		
Daytime sleepiness				30.5%	0.243
No	54 (60.7%)	22 (40.7%)	32 (59.3%)		
Yes	35 (39.3%)	10 (28.6%)	25 (71.4%)		
Observed choking or apnea				36.9%	0.145
No	58 (65.2%)	24 (41.4%)	34 (58.6%)		
Yes	31 (34.8%)	8 (25.8%)	23 (74.2%)		
High blood pressure				50.0%	0.712
No	23 (25.8%)	9 (39.1%)	14 (60.9%)		
Yes	66 (74.2%)	23 (34.9%)	43 (65.2%)		
BMI				42.1%	0.713
≤35 kg/m ²	59 (66.3%)	22 (37.3%)	37 (62.7%)		
>35 kg/m ²	30 (33.7%)	10 (33.3%)	20 (66.7%)		
Age				23.8%	0.004
≤50 years	17 (19.1%)	1 (5.9%)	16 (94.1%)		
>50 years	72 (80.9%)	31 (43.1%)	41 (56.9%)		
Large neck size				52.8%	0.084
No	37 (42.5%)	17 (46.0%)	20 (54.0%)		
Yes	50 (57.5%)	14 (28.0%)	36 (72.0%)		
Gender				42.8%	0.320
Female	31 (34.8%)	9 (29.0%)	22 (71.0%)		
Male	58 (65.2%)	23 (39.7%)	35 (60.3%)		

Discussion

The primary finding of this study is a prevalence of intermediate to high risk of OSA (STOPBANG score >2) in 57.8% of a randomly sampled inpatient population on the hospitalist service at tertiary academic medical center. These results are lower than previous work by Kumar et al which found high risk on STOPBANG in 76.8% of patients⁶. This difference may be partially explained by differences in patient populations; Kumar's study was conducted at an urban tertiary care center whereas our center serves a primarily suburban/rural catchment area. Finally, we found that 17.9% of our patients interviewed were already diagnosed with OSA, similar to the 15.9% that Kumar identified. Another study by Finkel et al. found the prevalence of high risk of OSA in undiagnosed patients undergoing surgery was 23.7% when screened with the apnea risk evaluation system⁹. The vast differences between our prevalence values and Finkel's is likely due to differences in questionnaire stratification; the apnea risk evaluation system stratifies risk by no, low, moderate, and high. Thus, many patients fitting into moderate risk may have fit into the intermediate risk group on the STOPBANG survey. Furthermore, the patient population they surveyed

was composed of peri-operative patients, whereas ours were on the internal medicine service.

Other work on inpatient populations has been limited to subpopulations. Sharma found that the prevalence of high OSA risk to be 84.4% and later 76.2% in patients with a BMI >30, which is lower than our rate of 90.9% in patients with a higher threshold for BMI of >35^{7,10}. Notably, Sharma opted to use the simplified STOP survey so that patients could self-administer the survey by omitting the additional four questions about BMI, age, neck size and gender. Shear et al found the prevalence of OSA in patients older than 50 to be 39.5% with the Berlin survey, which is lower than our value of 64.5% in patients over 50⁸. Notably, recent evidence suggests that the STOPBANG survey has higher sensitivity and diagnostic odds ratios than both the Berlin and STOP surveys, and recommends its use in the absence of available PSG¹¹. These differences may also be explained by differences in catchment area: our catchment area is largely rural whereas above studies catchment areas are primarily urban.

Previous studies have shown that of hospitalized patients with positive STOPBANG screenings, approximately 2/3 will have a form of sleep-disordered breathing¹².

The identification, prompt diagnosis and treatment of individuals at risk for OSA could greatly benefit patients and healthcare systems alike. A significant barrier to increasing identification and treatment is awareness, as undiagnosed individuals are more likely to have lower functional health literacy and less knowledge of OSA's symptoms and complications^{13,14}. Further, previous work has shown that educational programs can improve CPAP adherence after diagnosis by 52%,¹⁵ though evidence that educational programs impact on pursuit of follow-up PSG has not been investigated.

This study finds that patients who snore and are younger may be more likely to consider undergoing PSG to rule in or out OSA. One explanation for this finding may relate to patients' health literacy. For example, if patients' preexisting conception of risk factors for OSA centers around snoring, then they may be more likely to endorse follow up if they report snoring. Snoring has been shown to be the most readily identified symptom of OSA compared to apnea and EDS (6.5%, 4.7% and 1.2%, respectively) in a randomly selected population in Singapore¹³. Additionally, previous work comparing patients that self-reported OSA and newly diagnosed patients from a random screening found an inverse association between snoring and previous diagnosis of OSA – indicating that those previously diagnosed were more likely to be snorers¹⁴. Our finding that patients that report snoring are more willing to consider follow-up testing may in part explain this phenomenon. Thus, while it is important to promote continued awareness of snoring as a symptom of OSA, raising awareness of the other risk factors such as choking and EDS may increase willingness to undergo screening. Further work should clarify what symptoms patient's perceive are associated with OSA in order to identify areas for targeted interventions.

A similar idea could explain the differences in age and interest in follow-up that we observed. It is possible that as health literacy continues to improve and the younger population gains better access to information through increased reliance on the internet, knowledge around the impacts of OSA on QOL may be rising. However, other evidence suggests that older populations tend to be more knowledgeable about OSA, and would argue against this hypothesis¹³. An alternative explanation may relate to the state of health of the patients on our wards. In general, younger patients on the floors are less complex and have longer life expectancies and may see treating OSA as more impactful on their long-term health.

Limitations

Our findings must be interpreted with the following limitations. Firstly, this study is limited by the methodology of the STOPBANG survey. Because much of the survey is reliant on patient-reported data, patients with language

barriers and those lacking capacity were unable to participate. Further, the STOPBANG survey is by no means diagnostic; follow-up PSG is the standard for diagnosis of OSA. While this study investigated the relationship between demographic factors and patient interest in completing a PSG, we have no data confirming OSA via PSG or home respiratory polygraphy. Additionally, our sample size of 154 patients is notably smaller than other studies by more than an order of magnitude^{9,12}. Secondly, as this study was conducted at a tertiary care center that serves a large rural catchment area, the patients surveyed may differ from patients in community hospitals or non-referral centers. In contrast, the major strength of this study is the investigation of all patients regardless of perceived risk, which enables us to extrapolate the prevalence of OSA risk in inpatient settings without limiting to subsets of patients.

Conclusion

Taken together, our results confirm the high prevalence of diagnosed OSA (17.9%) and patients with high OSA risk (57.8%) in inpatient populations. The finding that younger patients are 10 times more likely to consider PSG support arguments for early screening for OSA. Additionally, the finding that snorers are 3 times more likely to consider PSG may reflect the narrow focus of public awareness of OSA. Emphasizing early screening and awareness of the various symptoms associated with OSA may be strategies to alleviate the financial and QOL burden that undiagnosed OSA places on health systems and patients.

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