Home sleep apnea testing failure rate and its causes at Vanderbilt sleep disorders center

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BACKGROUND

According to a clinical practice guideline published in March 2017 by the American Academy of Sleep Medicine (AASM), polysomnography (PSG) is the standard diagnostic test for diagnosing obstructive sleep apnea (OSA) in adult patients who have a concern for OSA based on a comprehensive sleep evaluation.[1] However, a home sleep apnea test (HSAT) with a technically adequate device can be used for the diagnosis of OSA in uncomplicated adult patients presenting with signs and symptoms that indicate an increased risk of moderate to severe OSA. The STOP-BANG questionnaire is one of the most widely accepted screening tools for OSA; however, it is not well-validated in the obstetrical population (see table below).

Home sleep apnea tests are primarily designed to test for sleep apnea and may not be suitable for every patient or type of sleep disorder. For example, HSATs are not recommended for people with congestive heart failure or chronic obstructive pulmonary disease. Currently, HSAT is an easy, cost-effective way to diagnose obstructive sleep apnea in adults without significant co-morbidity.

A HSAT may fail for several reasons. A self-administered device may become loose during the night, especially pulse-oximetry, leading to inaccurate signals and artifacts. Equipment error is one of the reasons for HSAT failure; many home sleep test devices alarm when a sensor becomes detached or there is an issue with the equipment. This alarm can wake the patient, causing sleep interruptions and inaccurate readings.

Moreover, HSAT commonly underestimates the number of obstructive respiratory events per hour compared to a polysomnogram, leading to inconclusive results in some cases. The HSAT failure necessitates repeated HSAT or in-lab polysomnography. If an HSAT fails, the test can be repeated from the beginning the next night. However, if the results are inconclusive, the patient may need to have a sleep study done in a sleep center or hospital.

To improve the time and cost effectiveness of our sleep labs, our project aims to investigate the HSAT failure rate and its causes over one month, thereby enhancing the success rate of HSAT in diagnosing sleep apnea.

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METHOD

Home Sleep Apnea Test data were obtained from Polysmith. Data were obtained without patient identifiers. Any patient lists were shredded at the end of each day. All electronic data were kept secure in accordance with VUMC Health Insurance Portability and Accountability Act (HIPAA) Policies.

Every HSAT recorded within a one-month duration in January 2024 was reviewed to determine the number of HSATs that were able to diagnose or rule out sleep apnea successfully. If not, the potential causes of the HSAT failure were identified. Adequacy of HSAT in our study is defined as the HSAT providing sufficient data, to confidently diagnose or rule out obstructive sleep apnea, allowing for timely and effective treatment. The number of repeated HSATs or in-lab polysomnography after the failure of HSAT was also determined. After investigating the probable causes of HSAT failure, we will address the issue with our sleep lab staff and sleep providers to improve the HSAT failure rate in our sleep labs.

RESULTS

There were 145 HSATs completed in January 2024. The demographic data of patients included in

Table 1. Demographic Data

Parameters	Value
Male	64 (44.14%)
Female	81 (55.86%)
Average age	47.12 years
Average BMI	33.56 kg/m^2
Medicare coverage	12 (8.28%)
Average STOP-BANG score	3.99
Average Epworth sleepiness scale score	9.53
Chief Complaints	
Snoring	107 (73.79%)
Excessive daytime sleepiness	71 (48.97%)
Known case OSA	16 (11.03%)
Headache/migraine	4 (2.76%)
Fatigue	2 (1.38%)
Memory loss	2 (1.38%)
Insomnia	1 (0.69%)
Morning inertia	1 (0.69%)

Table 2. Technical Data from HSATs

Parameters	Value
Average total recording time (TRT)	415.48 minutes
Adequate study	145 (100%)
Cluster of events, suggestive of REM-related respiratory events	79 (54.48%)
Poor SpO_2 signals > 50% of TRT	2 (1.38%)
Poor SpO_2 signals < 50% of TRT	18 (12.41%)
Nasal Pressure/Thermistor signal	
Good	95 (65.52%)
Adequate	45 (31.03%)
Poor	5 (3.45%)
Average SpO_2 nadir	82.79%
Average REI per AASM	20.3 events/hour
Average REI per Medicare	13.72 event/ hours
OSA Diagnosis by AASM	116 (78.91%)
OSA Diagnosis by AASM, but not Medicare	30 (25.86%)
OSA Diagnosis by Medicare	86 (58.5%)
Polysomnogram done after HSAT	7 (4.83%)

the study are shown in Table 1. Eighty-one (55.86%) were female; sixty-four (44.14%) were male. The average age was 47.12 years. The average body mass index (BMI) was 33.56 kg/m^2. Twelve patients (8.28%) had Medicare coverage. Sixteen patients (11.03%) were known to have OSA diagnosis. The average STOP-BANG score was 3.99. The average Epworth sleepiness scale score was 9.53. Most patients, 107 (73.7%), complained of snoring, 71 (48.97%) experienced excessive daytime sleepiness, and 16 (11.03%) had a diagnosis of OSA. Other complaints included fatigue, memory loss, insomnia, and morning inertia.

Technical data gathered from HSATs were shown in Table 2. The average total recording time (TRT) was 415.48 minutes. All HSATs were adequate, even though 20 (13.79%) studies showed poor oxygen saturation signals. Two of these studies (1.38%) showed poor oxygen saturation (SpO_2) signals for more than 50% of TRT and while eighteen studies (12.41%) showed poor oxygen saturation signals for less than 50% of TRT. Ninety-five studies (65.52%) and forty-five studies (31.03%) showed good and adequate nasal pressure/thermistor signals, respectively. While five studies (3.45%) showed poor nasal pressure or thermistor signals. Seventy-nine studies (54.48%) showed cluster of respiratory events, suggestive of REM-related events. The average SpO_2 nadir was 82.79%. The average respiratory event index (REI) was 20.3, and 13.72 events/hour according to AASM and Medicare criteria, respectively. Twenty-nine patients (20%) did not meet criteria for OSA diagnosis (average STOP-BANG was 2.41). One-hundred and sixteen patients (81.37%) met AASM criteria for OSA diagnosis (average STOP-BANG was 4.25). Thirty of these 116 patients (25.86%) did not meet Medicare criteria for OSA diagnosis (average STOP-BANG 3.63) while the remaining eighty-six patients (59.31%) met Medicare criteria for OSA diagnosis (average STOP-BANG was 4.48). Eight patients were referred for a polysomnogram after HSAT was completed. Four of these patients did not meet the AASM diagnostic criteria for OSA by HSAT (all of them had a STOP-BANG score of 2); mild OSA was diagnosed in three of these patients by polysomnography. One patient did not meet AASM diagnostic criteria for OSA in either HSAT or polysomnogram. Of the remaining 4 patients who were referred

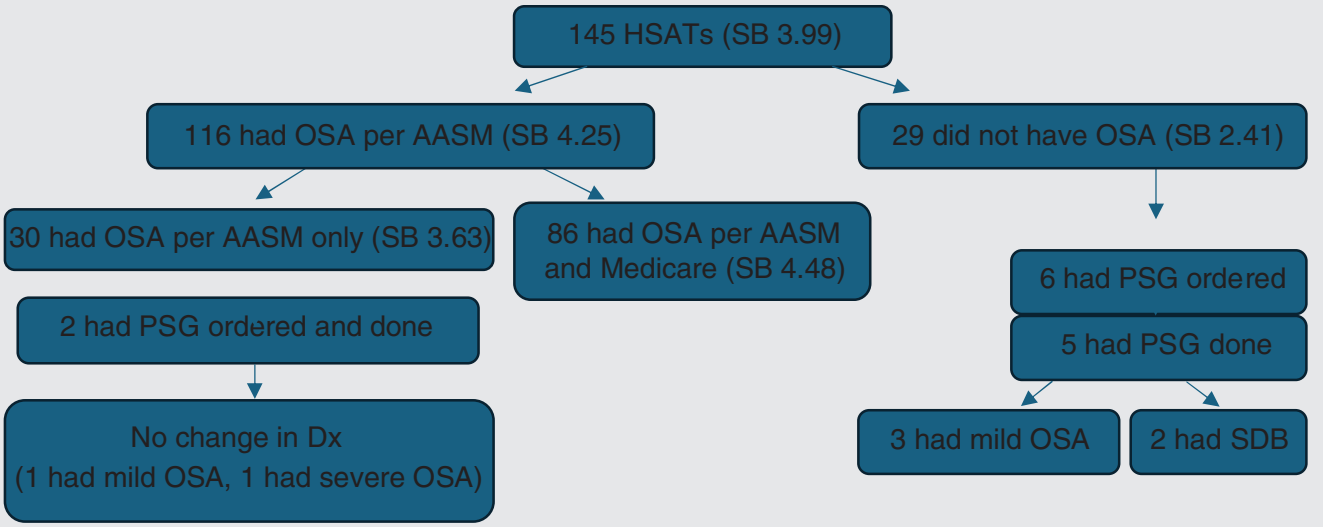

Figure 1. OSA diagnosis by HSAT and subsequent PSG.
SB = average STOP-BANG score, OSA = obstructive sleep apnea, SDB = sleep-disordered breathing.

for polysomnography, two patients had Medicare insurance. These two patients did not meet the Medicare diagnostic criteria for OSA on either the HSAT or polysomnogram. One patient did not complete a polysomnogram after not meeting the AASM diagnostic criteria for OSA in the HSAT. Another patient with severe OSA (total AHI 48.5 events/hour) and an elevated central apnea index (CAI 20.5 events/hour) in the HSAT had a polysomnogram that showed similar findings (total AHI 53.5 events/hour with CAI of 23 events/hour).

Discussion

The polysomnogram is the gold standard diagnostic method for OSA diagnosis; however, cost and access limitations are significant issues. Home sleep apnea testing is an alternative method to diagnose OSA in adults and may be less costly, more convenient, and more efficient in an appropriate group of patients. From our study, all HSAT data were adequate, despite poor SpO_2 signals were observed in 20 studies (13.79%), and poor nasal pressure/thermistor signals were detected in 5 studies (3.45%). There were no repeated HSAT orders, this is likely due to our policy to automatically repeat the study when critical signals (e.g., pulse oximetry) are absent or severely compromised.

The home sleep apnea test is a reliable test to diagnose OSA when patients are at high risk for OSA (STOP-BANG score is equal to or higher than 3). Two patients in the high-risk group required a polysomnogram after HSAT. One had a STOP-BANG score of 3 and did not complete a polysomnogram. The other patient whose STOP-BANG score was 6 had OSA by AASM but not Medicare criteria in both HSAT and polysomnogram. Three of 4 patients in the low-risk group (all with STOP-BANG score of 2) and negative HSAT results, met AASM criteria for OSA by polysomnogram. One patient did not have a STOP-BANG score in the chart, and did not meet the diagnostic criteria for OSA by polysomnogram. One patient required a polysomnogram to further investigate co-occurrence of obstructive and central sleep apnea.

Our study suggested that polysomnography was not superior to HSAT for the diagnosis of OSA when Medicare criteria are applied, as two patients did not meet the OSA per Medicare diagnostic criteria in both HSAT and in subsequent polysomnography. This is likely due to Medicare criteria's reliance on 4% oxygen desaturations without consideration of respiratory event related arousals measured by EEG on polysomnograms. This implies that the degree of oxygen desaturation detected by HSAT are comparable to by polysomnogram, at least in our study.

STOP-Bang questionnaire

Please answer the following questions by checking "yes" or "no" for each one.

	Yes	No
Snoring (Do you snore loudly?)	❑	❑
Tiredness (Do you often feel tired, fatigued, or sleepy during the daytime?)	❑	❑
Observed Apnea (Has anyone observed that you stop breathing, or choke or gasp during your sleep?)	❑	❑
High Blood **P**ressure (Do you have or are you being treated for high blood pressure?)	❑	❑
BMI (Is your body mass index more than 35 kg per m^2?)	❑	❑
Age (Are you older than 50 years?)	❑	❑
Neck Circumference (Is your neck circumference greater than 40 cm [15.75 inches]?)	❑	❑
Gender (Are you male?)	❑	❑

Score 1 point for each positive response.

Scoring interpretation: 0 to 2 = low risk, 3 or 4 = intermediate risk, ≥5 = high risk.

Source: University Health Network, Toronto, Ontario, Canada (www.stopbang.ca/osa/screening/php). Used with permission from Sauk Prairie Healthcare.

Conclusion

The home sleep apnea test is a reliable and accurate test to diagnose obstructive sleep apnea in patients who are at high risk for OSA (STOP-BANG score is higher than 3). For time- and cost-effectiveness, patients with a low risk of OSA (STOP-BANG score of 0 to 2) should undergo a polysomnogram directly if OSA is suspected or needed to be ruled out. In our study, using a polysomnogram does not increase the number of patients diagnosed with OSA under Medicare criteria compared to a home sleep apnea test (HSAT).

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Reference

1. Kapur VK, Auckley DH, Chowdhuri S, et al. Clinical practice guideline for diagnostic testing for adult obstructive sleep apnea: an American Academy of Sleep Medicine clinical practice guideline. *J Clin Sleep Med* 2017;13(3):479–504.