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SPECIAL ARTICLES

## Polysomnography for Obstructive Sleep Apnea Should Include Arousal-Based Scoring: An American Academy of Sleep Medicine Position Statement

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The diagnostic criteria for obstructive sleep apnea (OSA) in adults, as defined in the International Classification of Sleep Disorders, Third Edition, requires an increased frequency of obstructive respiratory events demonstrated by in-laboratory, attended polysomnography (PSG) or a home sleep apnea test (HSAT). However, there are currently two hypopnea scoring criteria in The AASM Manual for the Scoring of Sleep and Associated Events: Rules, Terminology and Technical Specifications (AASM Scoring Manual). This dichotomy results in differences among laboratory reports, patient treatments and payer policies. Confusion occurs regarding recognizing and scoring “arousal-based respiratory events” during OSA testing. “Arousal-based scoring” recognizes hypopneas associated with electroencephalography-based arousals, with or without significant oxygen desaturation, when calculating an apnea-hypopnea index (AHI), or it includes respiratory effort-related arousals (RERAs), in addition to hypopneas and apneas, when calculating a respiratory disturbance index (RDI). Respiratory events associated with arousals, even without oxygen desaturation, cause significant, and potentially dangerous, sleep apnea symptoms. During PSG, arousal-based respiratory scoring should be performed in the clinical evaluation of patients with suspected OSA, especially in those patients with symptoms of excessive daytime sleepiness, fatigue, insomnia, or other neurocognitive symptoms. Therefore, it is the position of the AASM that the **RECOMMENDED** AASM Scoring Manual scoring criteria for hypopneas, which includes diminished airflow accompanied by either an arousal or  $\geq 3\%$  oxygen desaturation, should be used to calculate the AHI. If the **ACCEPTABLE** AASM Scoring Manual criteria for scoring hypopneas, which includes only diminished airflow plus  $\geq 4\%$  oxygen desaturation (and does not allow for arousal-based scoring alone), must be utilized due to payer policy requirements, then hypopneas as defined by the **RECOMMENDED** AASM Scoring Manual criteria should also be scored. Alternatively, the AASM Scoring Manual includes an option to report an RDI which also provides an assessment of the sleep-disordered breathing that results in arousal from sleep. Furthermore, given the inability of most HSAT devices to capture arousals, a PSG should be performed in any patient with an increased risk for OSA whose HSAT is negative. If the PSG yields an AHI of 5 or more events/h, or if the RDI is greater than or equal to 5 events/h, then treatment of symptomatic patients is recommended to improve quality of life, limit neurocognitive symptoms, and reduce accident risk.

**Keywords:** arousal-based scoring, obstructive sleep apnea, polysomnography

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### INTRODUCTION

The American Academy of Sleep Medicine (AASM) is the leading professional society dedicated to promotion of sleep health. The AASM improves sleep health and fosters high-quality, patient-centered care through advocacy, education, strategic research, and practice standards. The AASM endeavors to advance sleep health policy that improves the health and well-being of the general public.

Obstructive sleep apnea (OSA) is characterized by repetitive episodes of complete (apnea) or partial (hypopnea) upper airway obstruction during sleep. Per the AASM International Classification of Sleep Disorders (ICSD-3), diagnostic criteria

for adults include either having (1) five or more predominantly obstructive respiratory events (obstructive and mixed apneas, hypopneas, or respiratory effort-related arousals [RERAs]) per hour of sleep during polysomnography (PSG) or per hour of monitoring time during a home sleep apnea test (HSAT) with symptoms or comorbidities or (2) fifteen or more predominantly obstructive respiratory events per hour of sleep during PSG or per hour of monitoring time during an HSAT.<sup>1</sup> Patients who exclusively have RERAs were previously designated as having upper airway resistance syndrome, but this diagnosis is now subsumed under the heading of OSA in the ICSD-3 given the shared pathophysiology and response to treatment. Sleep apnea testing results are calculated as an

apnea-hypopnea index (AHI) or respiratory disturbance index (RDI) for PSG or a respiratory event index (REI) for an HSAT, which is based on monitoring time since total sleep time based on electroencephalography (EEG) is often not recorded when using an HSAT.

However, there exists confusion among some clinicians and payers regarding the recognition and scoring of “arousal-based respiratory events” during sleep apnea testing. “Arousal-based scoring” recognizes hypopneas associated with EEG-based arousals, with or without significant oxygen desaturation, when calculating an AHI, and includes RERAs, in addition to hypopneas and apneas, when calculating RDI [ $RDI = (\# \text{ apneas} + \# \text{ hypopneas} + \# \text{ RERAs}) \times 60 / \text{total sleep time in minutes}$ ].

The definition of respiratory events, particularly hypopneas, has evolved over time as advancing technology has allowed for improved detection of reduced airflow. The *RECOMMENDED* hypopnea definition in the current version of The AASM Manual for the Scoring of Sleep and Associated Events: Rules, Terminology and Technical Specifications (AASM Scoring Manual) asserts the importance of recognizing respiratory events leading to arousal. The current *RECOMMENDED* scoring criteria for a hypopnea are as follows<sup>2</sup>:

Score a respiratory event as a hypopnea if ALL of the following criteria are met:

- a. The peak signal excursions drop by  $\geq 30\%$  of pre-event baseline using nasal pressure (diagnostic study), positive airway pressure (PAP) device flow (titration study), or an alternative hypopnea sensor (diagnostic study).
- b. The duration of the  $\geq 30\%$  drop in signal excursion is  $\geq 10$  seconds.
- c. There is a  $\geq 3\%$  oxygen desaturation from pre-event baseline or the event is associated with an arousal.

The current scoring criteria for an RERA in the AASM Scoring Manual are as follows<sup>2</sup>:

If electing to score respiratory effort-related arousals, score a respiratory event as a respiratory effort-related arousal (RERA) if there is a sequence of breaths lasting  $\geq 10$  seconds characterized by increasing respiratory effort or by flattening of the inspiratory portion of the nasal pressure (diagnostic study) or PAP device flow (titration study) waveform leading to arousal from sleep when the sequence of breaths does not meet criteria for an apnea or hypopnea.

As new research increasingly uncovers the many negative outcomes associated with OSA,<sup>3</sup> it is crucial to accurately score all respiratory events, including those with arousal, in order to effectively diagnose and treat all patients with OSA.

## POSITION

For scoring respiratory events, it is the position of the AASM that:

1. The *RECOMMENDED* AASM Scoring Manual criteria for hypopneas should be utilized in the clinical evaluation of patients with suspected OSA. By accounting for both oxygen desaturations and arousals, the *RECOMMENDED* AASM Scoring Manual criteria helps more definitively rule out the presence of OSA in patients with symptoms of excessive daytime sleepiness, fatigue, insomnia or other neurocognitive symptoms.
2. Even if a sleep center must use the *ACCEPTABLE* AASM Scoring Manual criteria for hypopneas (the criteria currently used by the Centers for Medicare and Medicaid Services) due to payer policy requirements, respiratory events that include arousals should be captured either by scoring hypopneas using the *RECOMMENDED* AASM Scoring Manual criteria or optionally by reporting an RDI. Reporting either would still allow the interpreting physician to diagnose OSA based upon ICSD-3 criteria. If the PSG yields an AHI (using the *RECOMMENDED* definition) of 5 or more events/h, or if the RDI is greater than or equal to 5 events/h, then treatment of symptomatic patients is recommended to improve quality of life, limit neurocognitive symptoms, and reduce accident risk.
3. An in-laboratory PSG should be performed<sup>4</sup> when the results of an HSAT are negative in a patient with increased risk for OSA. Because identification of arousal-based respiratory events is challenging when using most HSAT devices, given the absence of EEG data, the *RECOMMENDED* AASM Scoring Manual criteria requiring arousal cannot be applied.

## DISCUSSION

Using different criteria for scoring hypopneas can alter determinations made about diagnoses when evaluating patients with suspected OSA.<sup>5</sup> A patient presenting with classic OSA symptoms such as snoring, witnessed apneas, and daytime sleepiness may fail to be diagnosed with OSA if arousal-based scoring is not utilized when interpreting their PSG. Studies have shown that not utilizing arousal-based scoring may lead to a missed diagnosis in up to 30% to 40% of patients with OSA, especially in patients who are younger and non-obese.<sup>6</sup> There may be instances in which a sleep center must use the *ACCEPTABLE* AASM Scoring Manual criteria for hypopneas due to requirements in payer policies. In these situations, either hypopneas using the *RECOMMENDED* AASM Scoring Manual criteria should also be scored or optionally an RDI reported.

Not including arousal-based respiratory events of any form when scoring a PSG may lead to either lack of proper diagnosis of OSA, misclassification of OSA severity, or misidentification of another sleep disorder or medical disorder (eg, idiopathic hypersomnia, chronic fatigue syndrome). These patients may remain improperly treated, leading to persistent sleep symptoms, worsened work performance, decreased neurocognitive function, and poor clinical outcomes.<sup>7</sup>

Evidence demonstrates that arousals, and not hypoxemia, better predict hypersomnia in patients with OSA.<sup>8–10</sup> Eliminating sleep fragmentation, even with persistent hypoxemia, improved sleepiness compared with baseline.<sup>11</sup> Existing data also support inclusion of RERAs in order to fully define sleep-disordered breathing.<sup>12</sup> Consequently, there is insufficient evidence to support the use of hypoxemia as a singular, disease-defining trait for OSA, and some of the cardinal features of OSA, such as daytime sleepiness, cannot be explained by hypoxemia alone.<sup>11</sup>

## CONCLUSIONS

The definition of OSA has evolved over time as research has continued to improve our understanding of the pathophysiology and significance of sleep-related breathing disorders. Current evidence emphasizes the importance of using arousal-based scoring of respiratory events when evaluating patients suspected of having OSA.

## REFERENCES

1. American Academy of Sleep Medicine. *International Classification of Sleep Disorders*. 3rd ed. Darien, IL: American Academy of Sleep Medicine; 2014.
2. Berry RB, Albertario CL, Harding SM, et al.; for the American Academy of Sleep Medicine. *The AASM Manual for the Scoring of Sleep and Associated Events: Rules, Terminology and Technical Specifications*. Version 2.5. Darien, IL: American Academy of Sleep Medicine; 2018.
3. Farrell PC, Richards G. Recognition and treatment of sleep-disordered breathing: an important component of chronic disease management. *J Transl Med*. 2017;15(1):114.
4. 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.
5. Ruehland WR, Rochford PD, O'Donoghue FJ, Pierce RJ, Thornton AT. The new AASM criteria for scoring hypopneas: impact on the apnea hypopnea index. *Sleep*. 2009;32(2):150–157.

6. Guilleminault C, Hagen CC, Huynh NT. Comparison of hypopnea definitions in lean patients with known obstructive sleep apnea hypopnea syndrome (OSAHS). *Sleep Breath*. 2009;13(4):341–347.
7. Kristo DA, Lettieri CJ, Andrada T, Taylor Y, Eliasson AH. Silent upper airway resistance syndrome: prevalence in a mixed military population. *Chest*. 2005;127(5):1654–1657.
8. Koch H, Schneider LD, Finn LA, et al. Breathing disturbances without hypoxia are associated with objective sleepiness in sleep apnea. *Sleep*. 2017;40(11).
9. Roehrs T, Zorick F, Wittig R, Conway W, Roth T. Predictors of objective level of daytime sleepiness in patients with sleep-related breathing disorders. *Chest*. 1989;95(6):1202–1206.
10. Stepanski EJ. The effect of sleep fragmentation on daytime function. *Sleep*. 2002;25(3):268–276.
11. Colt HG, Haas H, Rich GB. Hypoxemia vs sleep fragmentation as cause of excessive daytime sleepiness in obstructive sleep apnea. *Chest*. 1991;100(6):1542–1548.
12. Redline S, Budhiraja R, Kapur V, et al. The scoring of respiratory events in sleep: reliability and validity. *J Clin Sleep Med*. 2007;3(2):169–200.

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## DISCLOSURE STATEMENT

The authors are members of the 2017–2018 board of directors of the American Academy of Sleep Medicine. This position statement was developed by the board of directors of the AASM to improve the diagnosis of OSA. It is published by the AASM as an advisory that is to be used for educational and informational purposes only.