A2Zzz

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AHI and OSA

Sleep Scoring Agreement

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SPECIAL FEATURE

A Technologist's Guide to Performing Sleep Studies

Designed as an introductory resource, the *Technologist's Guide to Performing Sleep Studies* provides step-by-step instructions for collecting sleep study data from patients. It includes sections that cover suggestions for putting the patient at ease, reviewing the patient's symptoms and medications, attaching the sensors, preparing to record, biological calibrations, artifact detection and correction, and documentation.

Purchase *A Technologist's Guide to Performing Sleep Studies* eBook in the AAST Learning Center

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AAST THANKS ITS PRESTIGE PARTNERS

2023 AAST Fellows

The AAST Fellow Program is a means of recognizing those who have made significant and sustained contributions to the field of sleep technology. Fellowship recipients must be credentialed in sleep technology by a nationally recognized organization for at least 15 years and have been a regular AAST member, in good standing, for the last 10 consecutive years.

AAST Fellows have also attained distinction through significant professional service to AAST and to the field of sleep technology; significant professional contributions to the field; or prominent leadership, influence and achievement in clinical practice, education or science.

The 2023 class of AAST Fellows include:

Joseph Castillo, RPSGT, RST, CCSH, RN, BSN, FAASM

Andrea Ramberg, MS, RPSGT

Christina Saulys, RST, RPSGT

Stephen Tarnoczy, BSRT, RRT/SDS, RPSGT, CCSH

2023 Award Winners

AAST Leadership Award

This award honors and recognizes an AAST member who has demonstrated exceptional leadership qualities through their commitment to AAST.

Winner: Sarah Brennecka, MBA, RPSGT, FAAST

AAST Service Award

This award honors and recognizes an AAST member who has made significant contributions to the growth and development of the sleep technology profession.

Winner: Joseph Castillo, RPSGT, RST, CCSH, RN, BSN, FAASM, FAAST

AAST Professional Development Service Award

This award honors and recognizes an AAST member who demonstrates exceptional commitment to advancing education in sleep technology.

Winner: Colton Wiggins, RRT-SDS, RPSGT

AAST Literary Award

This award honors an AAST member who has written an original article, paper or textbook chapter in the past year that has been accepted for publication.

Winner: Lisa Endee, MPH, RT, RRT-SDS, RPSGT

AAST AWARDS

President's Message

Advancing AAST Forward

By J. Emerson Kerr, III, MBA, RRT, FAAST

What an extraordinary year! I am so thankful for the amazing efforts of our volunteer members, committees, board members and management team, who faithfully work to deliver the best sleep technology education in the world. The work these teams have accomplished has brought new solutions to help promote our efforts to empower the global community of sleep technologists!

Before highlighting what's to come, I must reflect and thank those who have accomplished so much for our community. We continue to build on the efforts of the sleep care pioneers who laid our solid foundation. Most recently, my deep gratitude is extended to Laree Fordyce, MS, CCRP, RPSGT, RST, CCSH, FAAST, Julie DeWitt, RPSGT, RST, RCP, FAAST and Byron Jamerson, RPSGT, RST, CCSH, FAAST. These champions of our field have faithfully served for many years, participating in textbook writing and publication, guideline building, daily management and our incredibly successful educational series — especially the Certification in Clinical Sleep Health (CCSH) modules.

I am incredibly thankful for Laree's efforts — her leadership role began as the program committee chair in 2016, later serving as a board member starting in 2018 and finally taking on the mantle as our most recent president. This span of time saw many changes in AAST and sleep technology, and she volunteered while launching a very successful sleep diagnostics program serving both Canada and Columbia. On top of her significant volunteer role with AAST,

Laree also serves as the accreditation coordinator for the College of Physicians and Surgeons of Alberta. It has been a pleasure to serve by her side as president-elect! I thank her for her partnership as past president and many years of service to the global sleep community.

2023 saw some incredible AAST achievements. The following highlights our key efforts:

1. Launched a new website, learning management system and content hub (*The Sleep Scene*) — all designed to make the user experience across all its websites more accessible and streamlined;

2. Developed a simplified approach to claiming continuing education credits (CECs) for A_2Zzz;

3. Updated AAST Technical Guidelines to reflect split-night protocols for adult patients;

4. Hosted five community-wide webinars;

5. Launched an e-book, "The Fundamentals of Virtual Patient Monitoring;"

6. Hosted a very successful Sleep Technologists Appreciation Week to kick off our 45th anniversary celebration; and

7. Welcomed our newest board members, Kevin Adley, RPSGT, CCSH, Robin James, RPSGT and Robert Miller, CRT, RPSGT.

Thank you to everyone who made 2023 so successful!

2024 is shaping up to be exciting with new goals and plans that will continue advancing membership offerings, education initiatives and AAST's overall impact on the sleep industry — more updates to come in upcoming A_2Zzz publications!

The following is a broad summation of our plans for 2024:

1. Our 45th anniversary celebrations will be continuing throughout the year (members, watch your emails for anniversary-specific announcements);

2. We will be launching three new module series:
   a. The State of AI and Auto Scoring in Sleep Medicine
   b. A three-part adult scoring series
   c. A five-part Fundamentals of Home Sleep Apnea Testing (HSAT) series

3. Continued A_2Zzz publications and webinars; and

4. Strategic committees to drive membership, education and partnerships.

I am very excited about what both AAST and our field at large has to offer in the new year. We are in an extraordinary time for sleep technology, and by coming together as a community, we can continue to create the necessary resources to attract and retain skilled sleep care professionals across our field. Help us advance these goals by joining AAST or renewing your existing membership — the deadline is **Dec. 31, 2023**. For current members, renewals must be made by the deadline to ensure uninterrupted access to their member benefits, including the free CECs that can be earned from reading the magazine this very message is in.

If you have any questions regarding AAST membership in 2024, please reach out to AAST Headquarters at info@aastweb.org or 312-321-5191.

> *We continue to build on the efforts of the sleep care pioneers who laid our solid foundation.*

Instructions for Earning Credit

AAST members who read *A₂Zzz* and claim their credits online by the deadline can earn 2.00 AAST Continuing Education Credits (CECs) per issue, for up to 8.00 AAST CECs per year. AAST CECs are accepted by the Board of Registered Polysomnographic Technologists (BRPT) and the American Board of Sleep Medicine (ABSM).

To earn AAST CECs, carefully read the entirety of the Q3 issue of *A₂Zzz* and claim your credits online in the Learning Center. You must go online to claim your credits by the deadline of **March 31, 2024**. After the successful completion of the learning assessment, your certificate will be available in the My CEC Portal acknowledging the credits earned.

COST

The *A₂Zzz* continuing education credit offering is an exclusive learning opportunity for AAST members only and is a free benefit of membership.

STATEMENT OF APPROVAL

This activity has been planned and implemented by the AAST Board of Directors to meet the educational needs of sleep-care professionals. AAST CECs are accepted by the Board of Registered Polysomnographic Technologists (BRPT) and the American Board of Sleep Medicine (ABSM). Individuals should only claim credit for the issues they read in full and evaluate for this educational activity.
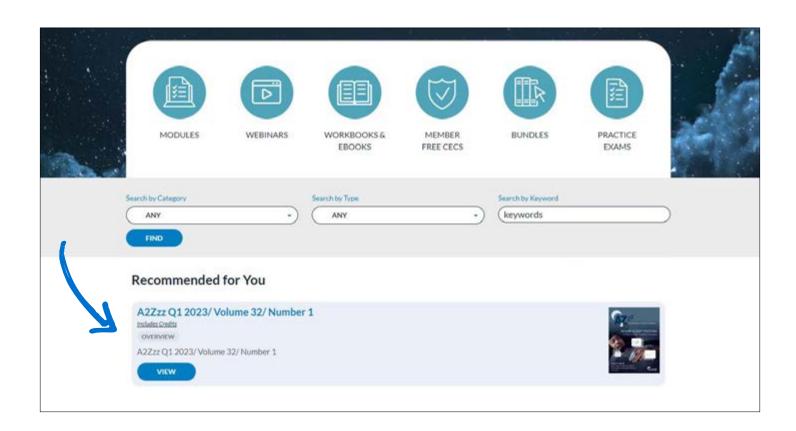
STATEMENT OF EDUCATIONAL PURPOSE & OVERALL EDUCATIONAL OBJECTIVES

A₂Zzz provides current sleep-related information that is relevant to sleep-care professionals. The magazine also informs readers about recent and upcoming activities of AAST. *A₂Zzz* should benefit readers in their practice of sleep or in their management and administration of a sleep disorders center.

READERS OF *A₂ZZZ* SHOULD BE ABLE TO DO THE FOLLOWING:

- Analyze articles for information that improves their understanding of sleep, sleep disorders, sleep studies and treatment options
- Interpret this information to determine how it relates to the practice of sleep care and medicine
- Decide how this information can improve the techniques and procedures that are used to evaluate sleep disorders patients and treatments
- Apply this knowledge in the practice of sleep care and medicine

You must go online to claim your CECs by the deadline of **March 31, 2024**.

The
INTERNET OF THINGS
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THE FUTURE OF SLEEP

By Regina Patrick, RPSGT, RST

In the 1980s, computer science students at Carnegie Mellon University (Pittsburgh, Pennsylvania), frustrated at going to the vending machine and finding it empty of Coke soft drinks (Coca-Cola Company, Atlanta, Georgia), had the idea of installing microswitches in the machine so they could track how many bottles were in it. The switches were hooked up to the main departmental computer[1] and the students wrote a server program that tracked the number of Coke bottles in the machine. Students could access the information from any computer through a web address on the internet. This was the first use of internet of things (IoT).

IoT now refers to the network of physical objects [i.e., "things"], which are embedded with sensors, processing abilities, software and other technologies, that connect and exchange data with other devices and systems over the internet or other types of communication network.[2] With these advancements, the use of IoT in the sleep field shows promise in improving the diagnosis and management of sleep disorders, primarily obstructive sleep apnea (OSA).

To discuss IoT requires first defining a few terms:

Big data: Extremely large and complex datasets that can be used to detect patterns, trends and associations, but are too large for traditional data processing software, which may be analyzed by computers to detect patterns, trends and associations. Examples of big data are e-mails, patients' records and transaction processing systems. [3,4]

Bluetooth technology: A wireless technology used to exchange data between fixed devices or mobile devices over short distances via radio waves. Examples of Bluetooth technology are wireless headsets used to talk on mobile phones and wireless computer keyboards.[5]

Cloud computing: The delivery over the internet (i.e., "the cloud") of computing services (e.g., server [a machine that computes, stores and manages data, devices and systems over a network], storage, databases, networking, software, analytics and intelligence). A provider (e.g., internet service provider) manages and provides cloud computing services to a client (e.g., consumers). Examples of cloud computing are social media, media-streaming, personal data storage, productivity software (e.g., Office 365 [Microsoft, Redmon, Washington] and Google Docs [Google, Mountain View, California], and online storage (e.g., Google Drive [Google]).[6,7]

Fog computing: A way to prevent network congestion, data is processed from devices without reducing said data's quantity. This is done by introducing a new processing unit between the cloud and the user to enhance reliability, energy efficiency and privacy maintenance and reduce latency.[8]

Internet: A global system of interconnected computer networks that uses a set of rules, called protocols (e.g., hypertext transfer protocol secure [HTTPS]) that allows a group of interconnected computing devices to exchange information with each other. Protocols may be processed by hardware (i.e., the physical part of a computer such as a central processing unit [CPU]), software or a combination of these. [9,10]

Patients often find the sensors uncomfortable and may struggle with going to sleep in a sleep center, which may impact a PSG recording.

IoT and Sleep

Polysomnography (PSG) is the gold standard for assessing people with suspected OSA. However, a PSG study involves applying several sensors on a person to record brainwaves, airflow, thoracic and abdominal movements, leg movements and blood oxygen saturation. Patients often find the sensors uncomfortable and may struggle with going to sleep in a sleep center, which may impact a PSG recording.

The ability to wirelessly record brainwaves, airflow, thoracic and abdominal movements, leg movements and blood oxygen saturation throughout a study and relay the information to the cloud so that sleep physicians can access it would be ideal for countering the drawbacks of PSG that patients experience. However, a fully wireless PSG study that records all of this information is not available at this time.

Wireless technology used in home PSG studies is more suited to screening for OSA than screening for other sleep disorders such as restless legs syndrome (RLS). A home PSG study involves attaching various sensors (e.g., thoracic belt, abdominal belt, sleep position sensor, oximeter) into a device, which is attached to a patient. Signals from the sensors are relayed from the device to a smart phone or computer via radio waves (i.e., Bluetooth technology) for processing, and from there they are relayed to the internet. A sleep physician can then access the data to determine whether a person has OSA.

Benefits of Increased IoT in the Sleep Field

IoT could make long-term ambulatory monitoring possible. Surrel et al.[11] recently developed a wearable system that can be used to monitor a patient for OSA over several days. The system contained a wearable electrocardiogram device (INYU sensor) that detects and predicts cardiovascular pathologies via monitoring electrocardiogram signals in real time.[12] Surrel designed an online algorithm (i.e., a specialized mathematical formula) that can be used to process changes in heart rate frequency to predict OSA. The

system had a classification accuracy of 83.2% (i.e., the number of correct predictions divided by the total number of input samples), when compared with manual scoring, and the algorithm had low utilization of the device's battery resources, which equated to the battery being able to provide 46 days of continuous OSA monitoring. The wearable device uploads its analysis to an online web service for continuous monitoring, thereby allowing tracking of the evolution of OSA over time.

IoT could make possible home-based monitoring of sleep disorders and treatment outcomes, especially for patients for whom visiting a sleep center would be difficult (e.g. elderly patients). To this end, Yacchirema-Vargas[13] developed a system that combines fog and cloud computing, IoT and big data analysis and storage. This combination allows data to be seen in real time, thereby overcoming the delay from data collection until a diagnosis. At the fog level, a smart IoT gateway device acts as a router by transmitting (i.e., routing) data between IoT devices and the cloud and preprocesses IoT data to detect events in real-time. Once the data is transmitted to the cloud, it is managed, stored and injected into a big data analyzer for further processing and analyzing. Yacchirema-Vargas believes that,

> *With quicker access to data, health professionals could improve their decision-making when monitoring and guiding sleep apnea treatment.*

with quicker access to data, health professionals could improve their decision-making when monitoring and guiding sleep apnea treatment.

Finally, IoT could be used to improve a person's sleep quality and sleep behavior. Takeuchi et al.[14] developed a cloud-based health care IoT (HIT) system that continuously acquires health-related information via activity monitors on participant's non-dominant wrists such as momentary symptoms, biological signals and surrounding environmental information. The HIT system consists of a cloud server and a smartphone app that is set up to collect data on a person's daily thoughts and behavior in their normal environment at or close to the time of the behavior. Additionally, the HIT app can connect with various IoT devices via Bluetooth technology to allow data to be transferred from the IoT devices to the HIT server, which can then store, integrate and manage data uploaded from the app and send personalized messages (i.e., push-type feedback messages) to app users.

In the feedback messages, a person is given information to improve their performance. In the Takeuchi study, participants were assigned to a feedback group or non-feedback group (i.e., control). Personalized sleep feedback messages were sent to participants in the feedback group, based on the sleep data. A sample message was, "You accumulated X minutes of sleep debt yesterday. Your current overall debt is X minutes. Sleep debt has adverse effects on physical and mental health. Adjust your daytime behavior to cancel your debt."

Questionnaires were then used to ask the participants, who were office workers, to indicate their current mood (e.g., depressed, anxious, stressed) and physical symptoms (e.g., sleepiness, fatigue and neck and shoulder stiffness) five times a day via a smartphone app.

Takeuchi found that compared to the control group, the feedback group had more stable sleep timing and less sleepiness, fatigue and neck and shoulder stiffness. Thus, the push feedback messages seem to promote sleep self-management and help individuals to address sleep behavior problems.

Limitations of IoT

Despite such encouraging findings, IoT has some limitations. The first is that although big data can be encrypted, large volumes of data are highly vulnerable to security threats, data breaches and cyberattacks. Thus, patients' health information and sensitive data can be misappropriated by cybercriminals.

A second limitation of the increased use of IoT is total reliance on the technology. If any part of a IoT system (e.g., a fog device or the Internet) were to crash, no backup alternatives exist to prevent a disruption in the collection, analysis and transmission of sleep data. A third limitation is that implementing IoT and keeping the software needed for IoT updates is expensive.

Nevertheless, scientists continue to work to determine how best to incorporate IoT into the sleep field to improve the diagnosis and treatment of sleep disorders to a greater extent than is possible with current technology. 🌙

REGINA PATRICK, RPSGT, RST, *has been in the sleep field for more than 30 years. She is also a freelance writer/editor.*

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AAST

Revenge Bedtime Procrastination

By Susan Hoefs, RPSGT, CCSH

Revenge bedtime procrastination (BP)[1] is defined as going to bed later than intended despite the absence of external reasons. It can be described as the decision to sacrifice sleep to stay up late and engage in free time activities in spite of the risk of being overly tired in the morning.

Procrastination is nothing new. For generations, human beings have put off starting or completing tasks, whether it is schoolwork, cleaning, paying bills or working out. BP is a newer phenomenon and appears to be on the rise, being seen as a way of getting "revenge" on daytime hours with little or no free time. The English term "revenge bedtime procrastination" emerged as a translation of an expression in Chinese reflecting frustration tied to long, stressful work hours that left little time for personal enjoyment. Social media has allowed the idea to spread globally and has finally given a name to a practice that many were already engaging in.

Those working in sleep medicine should be aware of BP as it affects many patients — and the nature of working long and stressful night shifts means many sleep-care professionals regularly engage in BP themselves.

Possible Causes of Bedtime Procrastination

Why is revenge BP increasing? It can be partially accredited to the overscheduled lifestyles many people lead. Working hard all day, trekking children to various activities and participating in regularly scheduled social activities leads to a loss of feeling in control. Often, someone's day is controlled more by work or school schedules, meetings and appointments rather than the person themself. This leads individuals to attempt to regain some personal time by making the decision to delay sleep to engage in unstructured activities such as reading, surfing the internet and social media, watching television or even just chatting with others in the household who are still awake.

BP is still an emerging concept in sleep science and there are debates going on about the psychology behind it. One explanation[2] is a failure in self-regulation or self-control. By the end of a busy and overscheduled day, the capacity for self-control is already at a lower point — which may facilitate sleep procrastination. However, not everyone agrees with this explanation; some argue it places too much emphasis on self-control. Instead, sleep procrastination may result from people who have an evening chronotype (night owls) and are forced to try to adapt to schedules designed for the nine to five work schedule common in the United States. Sacrificing sleep for leisure time may also be seen as an attempt to find recovery time in response to stress rather than failure of self-control.

Revenge BP also appears to be tied to significant daytime stress. For many, sleep procrastination may be a response to extended work hours that, if combined with a full night's sleep, leave virtually no time for entertainment or relaxation.[3]

Further research is needed to better understand BP, which most likely is the result of interacting factors. Naming the practice was an important step in moving forward with research and treatment for it.

People who engage in BP know they are doing it and generally want to receive enough sleep but fail to do so. This is known as an intention-behavior gap. Their intention may be to go to bed earlier, but subsequent behavior doesn't reflect that.

Understanding Bedtime Procrastination

Factors

Understanding BP can help sleep-care professionals realize when they are engaging in it. Clinical sleep educators should be knowledgeable about BP as many of their patients who are tired despite being treated for sleep disorders may be delaying their sleep. Knowing the symptoms, possible causes and consequences are vital to recognize when patients are delaying bedtimes.

Three factors are required for a late sleep time to be considered BP:

1. A delay in going to sleep that reduces one's total sleep time.

Their intention may be to go to bed earlier, but subsequent behavior doesn't reflect that.

Having set routines can help make behaviors feel almost automatic.

2. The absence of a valid reason for staying up later than intended, such as an external event or an underlying illness.

3. An awareness that delaying one's bedtime could lead to negative consequences.

Forms

BP can also take different forms. The first involves delaying the act of getting into bed, which is what revenge BP is. Another is delaying the time of trying to fall asleep once in bed, a problem that has been associated with rising rates of electronic device use. A person may engage in one or both forms of procrastination, each of which can reduce nightly sleep. According to a study done in 2020,[4] men have a higher occurrence of in-bed BP while another study[5] showed that women have a higher rate of BP while not in bed. This study also showed that students had higher rates of BP than non-students.

Outcomes

Like other poor sleep hygiene practices, BP can result in poor outcomes, including the increased risk of accidents due to inattentiveness or falling asleep while driving or operating machinery and health risks like worsening hypertension, heart disease, respiratory illness, obesity and more. Without proper rest, the immune system may become compromised. Lack of exercise due to tiredness or fatigue leads to worsening of health issues and can be stressful.[3]

Revenge BP may also be on the rise because of the COVID-19 pandemic, which increased stress due to stay-at-home orders so not as many enjoyable activities could be participated in outside the home. Part of BP is trying to reclaim the time at night that was missed out during the day. While outside the home social activities have returned to normal, the BP engaged in during the pandemic hasn't returned to normal. Working remotely has increased[6] since the pandemic and projections show it will continue to increase which further reduces social interaction in the workplace or following work.[7]

How to Prevent Bedtime Procrastination

The initial remedy for BP is healthy sleep hygiene,[8-9] which involves creating good sleep habits and an environment conducive to sleep. Having set routines can help make behaviors feel almost automatic. For this reason, a nighttime routine can reduce the impulse to stay up later.

Improving sleep hygiene is unlikely to fully resolve BP, but cognitive behavioral therapy for insomnia (CBT-I) and working with a clinical sleep educator (i.e., a sleep coach) on a regular basis may help. While research specifically for treating revenge BP is not available yet, CBT-I has been shown to be effective on the long-lasting effects of insomnia and some of the same tenets may apply to addressing BP.[8]

Revenge BP is on the rise and more research needs to be done to determine how best to treat it. People's mental energy resources are depleted by the end of the day, making it challenging to engage in healthier behaviors. Citing good sleep hygiene practices to patients hasn't been shown to be effective on its own — most patients know they are engaging in a poor bedtime practice. Understanding potential causes of BP and professional help may help change this harmful behavior. 🌙
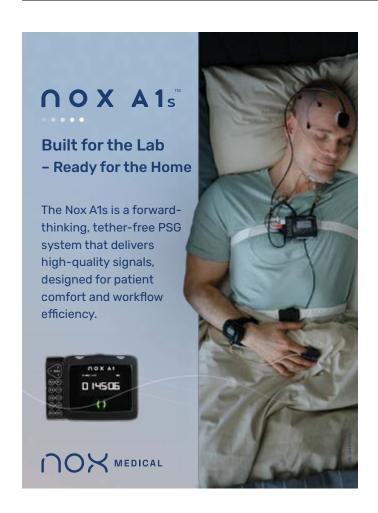
SUSAN HOEFS, RPSGT, CCSH, *has worked in the field of sleep medicine for nearly 30 years. She has experience in all aspects of polysomnography and currently volunteers as a clinical sleep educator at Lake Area Free Clinic in Oconomowoc, Wisconsin.*

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Advanced Sleep Titration eWorkbook

Designed as a complimentary resource to the AAST Advanced Sleep Titration e-Learning Course, the eWorkbook covers the same five topical areas as the online course:

- Anatomy and Physiology
- CPAP and BPAP Titration Guidelines
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SPONSORED: Is the Apnea-hypopnea Index the Best Metric for Evaluating Obstructive Sleep Apnea?

By Snorri Helgason

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Sleep apnea has been identified as a serious health issue for most countries. It exerts a substantial influence on individuals' physical and mental health, impairing daily function and overall quality of life if left untreated. Moreover, sleep apnea imposes a substantial burden on society, leading to extensive health care costs, absenteeism, presenteeism, reduced productivity, heightened personnel risks and an increased likelihood of motor vehicle accidents and injuries.

Since sleep apnea was defined in the 1970s as a disease, the definition of the disease and how to measure its severity has been categorized through the application of the apnea index, then later the apnea-hypopnea index (AHI).[1] Over the years, sleep medicine has established its diagnostic approach for sleep apnea predominantly using the AHI.[1,2] This metric holds significant influence as regulatory bodies, payors and providers rely on it to make crucial patient diagnostic decisions. The AHI plays a pivotal role in categorizing patients according to the severity of their condition and determining whether they receive treatment for obstructive sleep apnea (OSA).

However, throughout the years, a question has been raised by many in the field: Is the AHI truly the optimal metric for these purposes?

Understanding the AHI

Per the American Academy of Sleep Medicine (AASM) scoring manual, obstructive apneas involve complete upper airway collapse with a 90% or more drop in airflow for at least 10 seconds, accompanied by continued respiratory effort. Central apneas lack respiratory effort throughout the event, while mixed apneas start with no respiratory effort but resume

> *The severity of sleep apnea is defined by the AHI, a ratio of the sum of all respiratory events divided by the total hours of sleep.*

despite absent airflow. The AASM recommends that hypopneas be identified using a definition that is based on a ≥30% decrease in airflow associated with a ≥3% reduction in the oxygen saturation or an arousal (H3A) for diagnosis of OSA in adults.[3]

The severity of sleep apnea is defined by the AHI, a ratio of the sum of all respiratory events divided by the total hours of sleep. Currently, AHI is the sole indicator of OSA severity recognized by scientific societies. By this convention, an AHI of five to 15 events per hour defines mild sleep apnea, an AHI of 15 to 30 events per hour is moderate sleep apnea and an AHI of 30 or more events per hour is severe sleep apnea.[4,5] Historically, the

AHI has been favored for its simplicity in calculation and objective measurement of events like apnea and hypopnea,[6] helping physicians to classify the severity of the disease.

Limitations of the AHI

The correlation between the AHI and clinical outcomes has been found to be inadequate.[1,2,6,7] Since the AHI threshold is based on population averages, it fails to account for the unique characteristics of individual patients. This means that symptomatic patients may exhibit a low AHI, while asymptomatic individuals may be diagnosed with a high AHI. In such cases, health care providers face a challenge in determining the appropriate course of action.

Furthermore, the usefulness of the AHI as a metric in clinical settings is called into question when it is not strongly linked to symptoms or the risk of developing comorbid chronic diseases, such as cardiovascular disease, and does not provide information on the severity of the single events as they occur,[8] presence of significant oxygen desaturation, electrocardiogram (ECG) abnormalities or sympathetic activation, that may imply more significant pathology than the AHI alone.[6,7]

Over time, there have been changes in the definition of the AHI, including notable modifications in how oxygen saturation and breathing cessation are defined, as well as the inclusion of arousals with hypopnea events.

The AHI alone cannot help evaluate symptoms like cognitive impairment, daytime sleepiness or cardiovascular complications. Additionally, the methods employed in deriving the AHI can vary significantly in clinical practice. The measurement and scoring techniques used to calculate the AHI differ among sleep

laboratories and devices, resulting in potential inconsistencies and inter-laboratory variability. These variations can compromise the accuracy and reliability of the AHI as a metric, making it challenging to draw direct comparisons between studies and treatment outcomes.[8,9]

Alternative Metrics

To truly understand individual risks and predict treatment outcomes, it is crucial to delve deeper into the intricacies of this condition. Achieving a comprehensive understanding of the complexity of OSA is imperative for advancing precision medicine and personalized care within this field.[7, 10-14]

As a response to this enlightened understanding, new, advanced polysomnographic metrics are starting to be developed, like hypoxic burden (HB),[14] pulse wave amplitude drop (PWAD),[15] adjusted AHI[16] and others, to characterize the full impact of the disease.

The HB aims to capture the total amount of respiratory event-related hypoxemia over the sleep period. It is defined as the total area under the respiratory event-related desaturation curve,[15] and has a better association with cardiovascular disease than the AHI.[16]

PWADs are typically observed concomitantly with cortical arousals, which occur spontaneously or after nocturnal events such as sleep apneas/hypopneas and leg movements. The PWAD events reflect transient vasoconstriction followed by vasodilation that occurs in response to surges in sympathetic activity. This is then followed by a compensatory parasympathetic response.[17] PWA drops associated with respiratory events were correlated to cortical activity, suggesting that PWA drops could be used to indicate the brain's response to respiratory events.[18,19]

Utilizing these newly derived metrics... will significantly bolster our ability to identify various OSA subtypes

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The a-AHI adds an obstruction severity parameter that includes durations of each individual apnea and hypopnea and areas of related desaturation normalized for total time analyzed. It also provides valuable information to the AHI, potentially enhancing the identification of patients with OSA who are at the greatest risk of mortality or cardiovascular complications.[20]

Utilizing these newly derived metrics, extracted from extensive information obtained through polysomnography (PSG), will significantly bolster our ability to identify various OSA subtypes. Additionally, these metrics will facilitate the exploration of the underlying mechanisms of the disease in relation to specific comorbidities, leading to the discovery of improved treatments for OSA.

To comprehensively address the patient journey of individuals with sleep apnea and enhance their outcomes, it is imperative to identify more effective tools for personalizing the treatment pathway. It is crucial to reevaluate the approach of condensing an entire night's sleep into a single numerical value, particularly when this value, such as the AHI, exhibits weak correlations with symptoms and clinical outcomes.

While the sleep field has made significant strides in making sleep diagnostic studies more accessible, relying solely on the AHI and even employing various approaches to calculate the AHI raises valid concerns (e.g., using derived, indirect signals that correlate with AHI but do not measure airflow or effort directly[21]). In some cases, the ease and accessibility offered by simplified or oversimplified tests may come at the expense of more detailed and thorough diagnostic assessments.[9]

Though these tests can provide initial screening or basic insights into sleep disorders, they may not capture the intricacies needed for accurate diagnosis and personalized treatment planning. A broader perspective is needed to ensure that sleep apnea care and diagnosis are approached holistically, considering a range of factors beyond a single metric to achieve better patient outcomes. 🌙

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Sleep Scoring Among Different Types of Scorers: Thoughts on Getting to 100% Agreement

By Joseph Castillo, RPSGT, RST, CCSH, RN, BSN, FAASM, FAAST

Editor's Note: The thoughts expressed by the author in this article are not reflective of AAST.

From Hans Berger's first recording of human electroencephalogram (EEG) in 1924[1] until the mid-1990s, sleep records were recorded on paper. Scoring sleep stages throughout time was based on the Rechtschaffen and Kales manuscript published in 1968 that standardized the process (commonly referred to as R&K).[2]

In the late 1980s, however, sleep scoring began to change with the introduction of computers. With this, paper recordings became obsolete as sleep studies were able to be done digitally. This was followed by the implementation of rule-based auto scoring in the early 1990s, which was adopted by the sleep labs in the U.S.[3-5] Additionally, in 2007, the American Academy of Sleep Medicine (AASM) published its scoring manual in 2007, which became the defining reference for sleep scoring.[6]

Flash forward to today, machine learning auto scoring (artificial intelligence [AI]) is now pertinent on the sleep scene since Ensodata was cleared by the U.S. Food and Drug Administration (FDA) in 2017 for a software-only medical device, used under the supervision of clinicians, to analyze physiological signals and automatically score sleep study results.[7] The device challenged rule-based auto scoring and "augment[ed] the expert evaluation of sleep data including human scoring process."[8-9] Another example is the "WatchPAT, which significantly improves workflow by automatically rendering a fully scored report from a unique set of signals, most notably the Peripheral Arterial Tone (PAT®) signal, which is used to stage sleep without requiring any sensors on the face or head to record EEG."[10] With this, multiple companies, vendors and manufacturers

have now become the scorers during sleep studies — or rather their sleep products and digital systems — versus individual sleep technologists. While this change has streamlined processes, the different AI scoring tools require sleep-care professionals to learn how to use and understand different platforms and software. And while some of these tools go as far as to offer their own certifications as "master scorers," which might be awarded with some bias, is this enough to get everyone and everything (human and machine) to be in total agreement on scoring sleep studies?

I was lucky to learn how to read EEG in the early 1990s when I was living and becoming a medical doctor general practitioner (MD) in El Salvador, back when EEG was printed in squares on paper. The amplitude of various waveforms depended on the electrode sensitivity used during the recording, and the different sizes and measurements of sleep activity was easy to visualize (e.g., identify 0.5 sec or 75 µV peak to peak).

When I immigrated to the U.S.in the mid-2000s, I learned and adapted to score sleep studies on computers in a private sleep laboratory. The sleep studies were scored by two experienced registered polysomnographic technologists (RPSGTs). But despite being experts at scoring, they were never 100% in agreement with each other and often had to defer to the AASM scoring manual and R&K rules for final calls.

I share this tidbit from my training days 16 years later, as despite becoming an experienced scorer myself, I have not seen any two sleep scoring masters, seniors, experts, professionals or newbies be in 100% agreement with each other. But with all the scoring advancements, will the sleep community now become 100% in agreement on scoring? Will we be able to determine what is the best and most accurate way to assess sleep stages, as well as who (human or machine) and what should be referred to as the master rule and gold standard?

To answer these questions, we need to collectively review sleep studies of patients from many backgrounds (e.g., ages, genders,[11] special populations, different geographic global locations, diseases and medications[12]) to gather more information about the complexity of human brain activity overall. Additionally, we need to better define various muscle artifacts, such as the transient muscle artifact found from new, hypoglossal nerve stimulators in overnight titration studies, because upper airway stimulation (UAS) — like Inspire — has become a viable treatment alternative for well-selected patients with obstructive sleep apnea (OSA).[13] In doing this, we can collectively strengthen the industry's knowledge of sleep stages and in turn be more in agreement across all types of scorers on what should be considered standard.[14-23]

At the time of this publication, rule-based auto scoring and AI scoring are about 85% in agreement to the K&R rules and professional sleep scorers.[14-23] Is 85% good enough for a standard base autoscoring? Will the machines ever reach 100%? Is 100% agreement among machines utopia compared to an average agreement among human scorers?

Only time will tell. For now, it's about adaptation. The sleep industry needs to adapt to the scoring rules of the present — both human and AI — and should adapt to and integrate with the new technologies that are coming and evolving to be more in alignment with one another and achieve a sleep scoring agreement of 100%. 🌙

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