

# A review of the major changes suggested by the new Manual of the American Academy of Sleep Medicine in the polysomnography routine

*Revisão sobre as principais mudanças sugeridas pelo novo manual da Academia Americana de Medicina do Sono na rotina da polissonografia*

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## ABSTRACT

After an extensive literature review of sleep recording practices, the American Academy of Sleep Medicine recently published a new manual for sleep scoring and the recording of associated events in the routine sleep laboratory. This article presents and discusses the major changes that are suggested by the new manual compared to the recommendations previously practiced by most clinical and experimental investigators of human sleep.

**Keywords:** Sleep stages; Sleep/physiology; Electroencephalography; Polysomnography; Sleep disorders; Reference values; Practice guidelines as topic

## RESUMO

Recentemente, após ampla revisão da literatura sobre as práticas de registro do sono, a *American Academy of Sleep Medicine* publicou um novo manual para estagiamento do sono e marcação de eventos associados à rotina do laboratório do sono. O presente artigo apresenta e discute as principais mudanças sugeridas pelo novo manual em comparação à recomendação anteriormente praticada pela maior parte das investigações clínicas e experimentais do sono humano.

**Descritores:** Fases do sono; Sono/fisiologia; Eletroencefalografia; Polissonografia; Transtornos do sono; Valores de referência; Guias de prática clínica como assunto

Nearly 40 years after the publication of standardized terminology and the techniques of sleep recording and sleep scoring in adults by Rechtschaffen and Kales (R & K), in 1968<sup>(1)</sup>, the American Academy of Sleep Medicine (AASM) has published a new manual for sleep scoring and the recording of associated events in the routine sleep lab<sup>(2)</sup>.

The first manual published by R & K had already suggested a later review of its contents, anticipating the scientific advancement in the field of sleep<sup>(1)</sup>. In addition, the previous manual involved only recording, scoring and char-

acterization of sleep in normal adults and was obviously based on the registration equipment available at the time. Abnormal sleep-related events, such as arousals<sup>(3)</sup>, periodic limb movements<sup>(4)</sup> and respiratory events<sup>(5)</sup>, that were not included in that standardization, were instead discussed in several later publications derived from task forces of the former American Sleep Disorders Association and the AASM. The advance of sleep evaluation technology and the amount of available scientific information provided an opportunity for progress in the reviewing process of the characterization and measurement of sleep-related events.

In 2003, the board of directors of the AASM approved a proposal to develop a new manual for sleep scoring. This process initiated in 2004 with the establishment of task forces that would act to develop reference material and to provide support to the new manual<sup>(6-13)</sup>.

Based on the evidence in the literature and expert consensus, the major suggested changes involve rules, terminology and technical specifications related to polysomnography (PSG) recording and scoring.

Important suggestions in the new manual concern the quality of the PSG recording equipment; the manual recommends a minimum digital resolution of 12 bits per sample and gives an expected minimum sampling frequency for each evaluated variable. In addition, it includes descriptions of the suggested characteristics of the digital equipment, the rules for the display/manipulation used to visualize recording channels and the rules for the digital analysis of PSG recordings. Therefore, a polygraph used in the sleep laboratory routine should meet these recommendations to ensure the quality of the signal acquisition.

Another important change involves recording of the electroencephalogram (EEG), which is necessary for sleep

scoring. Unlike the R & K manual, which suggested one central derivation (C3 or C4 using contralateral ear lobe or mastoid process referent), the new manual recommends placing the derivations at F4-M1 (M1 = left mastoid process), C4-M1 and O2-M1. The electrodes F3, C3, O1 and M2 (M2 = right mastoid process) should also be placed as reserves in case of recording artifacts from the recommended electrodes. Slow waves, which characterize deep sleep, and K-complexes should be observed in the frontal derivation, where they present high amplitude. In addition, based also on the locations of their maximum amplitudes, the vertex sharp waves and sleep spindles should be observed in the central derivation, whereas the alpha rhythm should be observed in the occipital area.

To record the electrooculogram, the manual recommends the placement of an electrode located 1 cm below the outer canthus of the left eye (E1) and another electrode placed 1 cm above the outer canthus of the right eye (E2), with both referenced to the right mastoid process (M2). To record the electromyogram of the chin, it recommends the placement of three electrodes: two for recording and the third as a reserve in case of recording artifacts from one of others.

The terminology used to define the sleep stages has also changed. The wakefulness is now called Stage W. Non-rapid eye movement (NREM) sleep stages are now called stages N1, N2 and N3 (the latter represents slow-wave sleep and replaces the R & K nomenclature of stages 3 and 4), and rapid eye movement (REM) sleep is now called stage R.

The main changes with regard to scoring relate to the stage N2. A new rule defines the beginning of a period of stage N2 as the point when at least one of the following events has occurred in the first half of the epoch or the second half of the previous epoch: 1) the presence of one or more K-complexes unassociated with an arousal and/or 2) the presence of one or more sleep spindles. After a period of stage N2 has begun, the period with mixed frequencies and low amplitude and without the presence of K-complexes or sleep spindles should continue to be staged as N2 (as long as it was preceded by an epoch presenting with a K-complex unassociated with arousal and/or a sleep spindle). The end of stage N2 is now defined as involving the occurrence of one of the following events: 1) a transition to another sleep stage or wakefulness or 2) an arousal (change to stage N1 until a K-complex unassociated with an arousal or a sleep spindle occur).

The new manual does not address the characterization of Movement Time, as defined by R & K, for the epochs that could not be staged as sleep or wakefulness due to the presence of muscle tension and/or artifacts associated with movement of the subject during more than 50% of the epoch. However, the presence of "major body movement" should be

considered and defined as the movement and muscle artifact obscuring the EEG for more than half of the epoch and that hinder the determination of the sleep stage. An epoch that presents major body movement should be scored according to the following rules: 1) if the alpha rhythm is present (even for less than 15 seconds), stage as wakefulness; 2) If no alpha rhythm is discernable, but an epoch scorable as stage W either precedes or follows the epoch with a major body movement, score as stage W and 3) if neither of these conditions has occurred, then there was not a change in sleep stage.

Regarding sleep-related events, one of the most important revisions relates to the hypopnea scoring recommendation. This event should be scored based on the airflow recording from the nasal pressure cannula. The rule defines hypopnea as when there is a decrease in airflow amplitude greater than or equal to 30% that lasts at least 10 seconds and is associated with a decrease in oxyhemoglobin saturation equal to or greater than 4%. However, the new manual also describes an alternative rule for scoring hypopnea that includes events that show a decrease in airflow amplitude greater than or equal to 50% that lasts at least 10 seconds and is associated with a decrease in oxyhemoglobin saturation greater than or equal to 3% and/or arousal.

According to the AASM, the latter should be used in epidemiological studies, whereas sleep specialists should opt for either the recommended or the alternative rule for clinical evaluations<sup>(14)</sup>.

Scoring standardization of the movements during sleep would better address the identification of, among others, PSG features of REM sleep behavior disorder and bruxism. The use of the recommended chin electromyogram placement can identify the bruxism if the placement of the electrodes for masseter muscles recording is not available.

The new manual also recommends the identification of changes in heart rate, which can be measured by an electrocardiographic derivation (modified electrocardiograph Lead II), in the description of the rules for recording each cardiac event, demonstrating the relevance of this evaluation to PSG routine.

Whereas the new manual does cover topics such as the minimum parameters to be described in a PSG report and in the analysis of the whole recording, sleep and sleep-related events in children, the criteria to be used for establishing some normal and abnormal reference values for each sleep parameter are not discussed. As an example, this is the case for sleep patterns, which may need to change the normal percentages parameters for each sleep stage used so far, since other derivations of the EEG are included to scoring sleep. Some authors that have comparatively evaluated sleep scoring according to the criteria of R & K and the new AASM manual showed that the resulting values for sleep latency,

REM sleep, total sleep time and sleep efficiency were similar between the two sets of criteria. However, there is an increase in stages N1 and N3 and a reduction in stage N2 sleep, indicating that new normality data must be established along with the adoption of the new criteria for sleep scoring of the AASM manual<sup>(15)</sup>.

With regard to the new criteria for establishing sleep parameters, one study has proposed to evaluate the impact of the new AASM manual criteria on the apnea-hypopnea index (AHI)<sup>(16)</sup>. This study compared the AHI derived from the three definitions of hypopnea available in the literature: 1) the one proposed by the AASM in 1999<sup>(5)</sup>, which defined hypopnea as the presence of a reduction in the amplitude of the recorded airflow by more than 50% or the presence of a reduction by less than 50% that was also associated with an oxyhemoglobin desaturation equal to or less than 3% and/or awakening; 2) the new rule recommended by the AASM manual, which defines hypopnea as a reduction in airflow amplitude equal to or greater than 30% that is associated with an oxyhemoglobin desaturation of at least 4% and 3) the alternative rule recommended by the AASM manual, which defines hypopnea as a reduction in airflow amplitude equal to or greater than 50% that is associated with oxyhemoglobin desaturation of at least 3% and/or awakening.

The results obtained from the evaluation of 328 consecutive patients with obstructive sleep apnea showed that, compared to the use of the 1999 AASM criteria, there was a 40% reduction in the AHI when using the recommended rule and a 25% reduction in AHI when using the alternative rule. The authors of that study suggested that one use caution when interpreting the results of AHI obtained using these different definitions and recommended the standardization of the definition of hypopnea in routine PSG.

Nonetheless, because the field of sleep is not static, another proposal of the new AASM manual is to periodically review and modify the suggested rules based on current scientific evidence.

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