

# Sleep staging: Good old R & K! Do we need a revised AASM criteria?

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## History of sleep staging

The stages of sleep were first described in 1937 by Alfred Lee Loomis and coworkers who separated different EEG features of sleep into 5 levels (A to E) representing the spectrum from wakefulness to deep sleep. In 1953, REM sleep was discovered as distinct phase and thus William Dement and Nathaniel Kleitman reclassified sleep into 4 NREM stages and REM. The staging criteria were standardized in 1968 by Allan Rechtschaffen and Anthony Kales in the "R & K sleep scoring system". [1] In the R&K standard, normal sleep is divided into NREM and REM sleep. NREM sleep was divided into 4 stages, stage I (light sleep/theta wave), stage II (sleep spindles/ K complex), stages III and IV (deep sleep / slow-wave or delta-wave), In stage 3, delta waves constitute less than 50% of the total wave-patterns, and more than 50% in stage 4. Furthermore, REM sleep is sometimes referred to as stage 5. Effective July 1, 2008, the American Academy of Sleep Medicine (AASM) scoring manual replaces the "R&K Scoring Bible". [2] AASM mandated the use of its new scoring manual by AASM-accredited sleep centers. The rules also state that new PSG equipment purchased on or after July 1, 2008, must fulfill the revised technical and digital specifications.

## American Academy of Sleep Medicine (AASM) sleep staging

Amongst several changes, the most significant was the combination of stages 3 and 4 into Stage N3. The sequence

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of NREM sleep stages 1 to 4 (R&K classification) are now N1 to N3 (AASM classification). Wake now being referred to as stage W, REM should now be labeled stage R. Arousals respiratory, cardiac, and movement events were also added [2]. The new AASM scoring manual proposes the addition of frontal leads to the R&K manual specified central EEG derivations (either C3-A2 or C4-A1) for the scoring of higher percentages of slow wave sleep. Frontal EEG leads are more likely to detect eye movements, which could be misinterpreted as slow EEG waves. The occurrence of frontal intermittent delta activity, a phenomenon sometimes associated with cognitive impairment in the elderly, may also be misinterpreted as slow wave sleep. Moreover, as stages 3 and 4 sleep are combined, the importance of quantifying deep slow wave sleep is diminished. Finally, the clinical value of elevating the overall percentage of slow wave sleep remains unclear. The new manual also offers the option of alternative EOG derivations, using Fpz as a reference for the right and left outer canthus electrodes to differentiate between vertical and horizontal eye movements, a distinction that has no practical value. Using the alternative EOG derivations eye movements that appear as in-phase deflections can easily be confused with artifacts. [3] The continuous positive airway pressure (CPAP) headgear used during titration sleep studies may increase the incidence of these artifacts by pressing against the Fpz electrode. However, aside from the addition of frontal leads and the option of alternative derivations most proposed changes to the R&K manual are relatively minor. Nomenclature changes include the renaming of stages 1, 2, 3, and 4 sleep as N1, N2, and N3, with stages 3 and 4 combined. Stage REM is renamed as stage R. The A1 and A2 reference electrode sites are renamed as M1 and M2. A few modifications are made to mark the beginning and ending of sleep stages. The 3-minute rule for continuing stage 2 sleep in the absence of K-complexes and sleep spindles has been discontinued, as well as the use of "movement time" to denote epochs that are unscorable due to artifact. [3]

## Additional problems

Visual sleep scoring is considered the “Gold standard” for sleep analysis and scoring, necessary for sleep staging. Although visual sleep scoring was appropriate and sufficient for few signals recorded in the analog mode as curves on paper.[4] This staging may be insufficient for digitally recorded and stored multichannel sleep data and imposes a heavy load on the human visual analyzer.[4] Computer algorithms have been constructed to match visual scoring with the R&K rules as closely as possible, AASM will require new algorithms and the cost of changing the existing equipments is not justified [5].

## Summary

The AASM manual is largely consensus-based and does not meet scientific evidence levels of standard practice parameters. The task force members involved in the consensus did not have an opportunity to review the contents of the manual before its publication. The manual presents a number of technical and practical concerns that remain unresolved. Consensus-based recommendations are generally scrutinized, debated, and are eventually either accepted or rejected on the basis of merit and practicality. This was the case with the R and K manual nearly 40 years ago. It seems reasonable to expect

the same level of scrutiny of the AASM manual, before the changes are implemented as a new standard. [3] R and K system was useful as it established minimal criteria for staging sleep that efficiently produced comparable and relatively accurate results for the clinician or researcher, among studies, scorers, and sleep laboratories. It allowed for different epoch sizes, but the 30-second epoch continued to provide adequate detail supported by its continued, consistent use in clinical and research practice. Perhaps the old R and K scoring system was good enough!

## References

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