LETTERS TO THE EDITOR

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Should the Arousal Scoring Rule Be Changed?

Response to Zimmerman. Stability versus transitional changes in the EEG: from sleep to wakefulness. J Clin Sleep Med 2015;11:495.

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The letter to the editor in this issue of the *Journal of Clinical Sleep Medicine* from Dr. Zimmerman[1] challenges the answer of the 2007 Scoring Manual Steering Committee to a frequently asked question (FAQ M.3) and proposes different rules for arousals associated with events such as hypopneas and periodic limb movements ("caused arousals") versus arousals without obvious cause or association ("spontaneous" arousals). He cites a concern that the requirement for 10 seconds of stable sleep before an arousal will reduce the number of respiratory events that can be scored based on the association with an arousal. He is also concerned about the term "stable" sleep and provides some characteristics he feels are associated with transition from wake to sleep and sleep to wake.

The AASM Scoring Manual Editorial Board appreciates the thoughtful comments presented by Dr. Zimmerman. To better understand his comments, the arousal definition, the FAQ M.3 and the response of the 2007 Scoring Manual steering committee will be briefly reviewed.

The arousal rule that appears in the most current version of the Scoring Manual[2] states:

> "Score arousal during sleep stages N1, N2, N3, or R if there is an abrupt shift of EEG frequency including alpha, theta and/or frequencies greater than 16 Hz (but not spindles) that lasts at least 3 seconds, *with at least 10 seconds of stable sleep preceding the change.* Scoring of arousal during REM requires a concurrent increase in submental EMG lasting at least 1 second."

The FAQ M.3 and the response from the Steering Committee of the 2007 Scoring Manual are presented below.

> M.3.
> In our lab we score arousals associated with PLMs. Since you cannot score arousals unless there is 10 seconds of sleep preceding the arousal, can I score an arousal that is associated with a PLM when there can be as little as 5 seconds since the last PLM with arousal?

The answer from the Steering Committee is shown below and is consistent with the current Scoring Manual version 2.1.

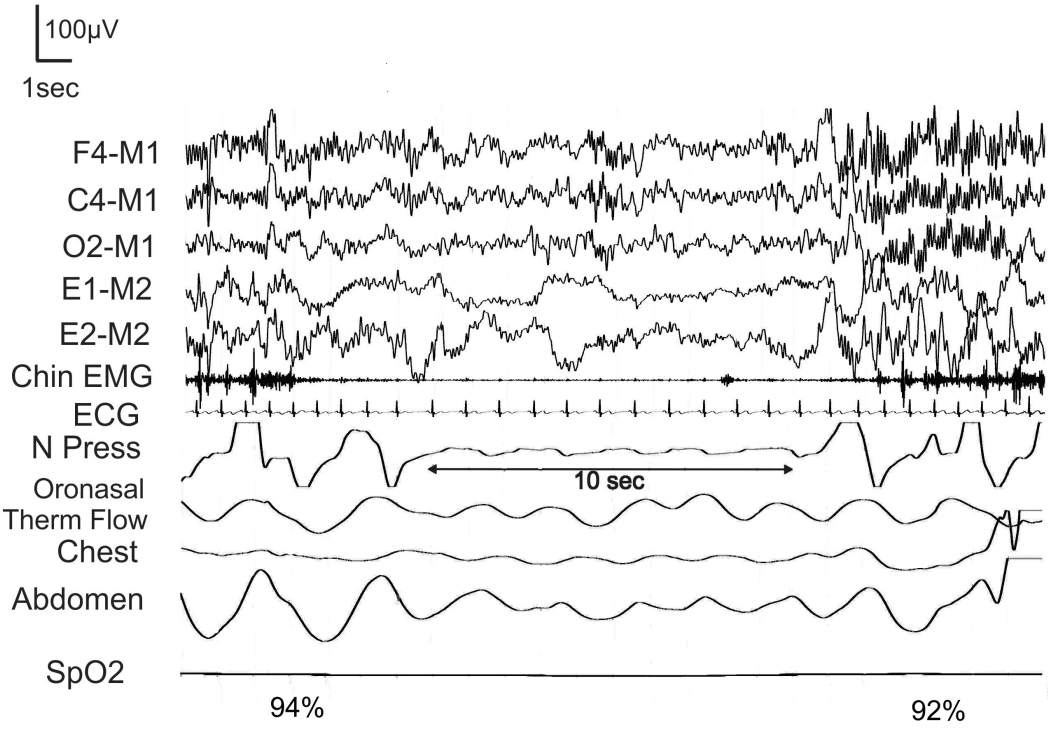
> "The short answer is no, you cannot score arousals with less than 10 seconds of intervening sleep. Members of the Movement Rules and Arousal Rule task forces[3,4] were consulted on this question. The Movement Rules perspective was that conceptually it would be possible to have multiple limb-movement related arousals with the minimal interval between limb movements (5 seconds from onset to onset). However, the Arousal Rule perspective is that the scoring of such arousals would be technically quite difficult. Since an arousal must last a minimum of 3 seconds, this would leave only 2 seconds to determine that sleep had resumed. The Steering Committee reviewed both perspectives and determined that the arousal rule should hold and that a minimum of 10 seconds is necessary to reliably determine that the patient has returned to sleep. When periodic limb movements occur with an interval of less than 10 seconds and each is associated with a 3-second arousal, only the first arousal should be scored though both limb movements may be scored. In this scenario, the arousal index and PLM index with arousal but not the Periodic Limb Movement Index would be influenced by not scoring the second 'arousal.'"

Although Dr. Zimmerman characterized the response of the Steering Committee as an "edict," both the arousal scoring rule and the answer to M.3 were thoughtfully considered by the Steering Committee after consultation with task forces that did evidence reviews prior to recommending movement and arousal scoring rules. It should be appreciated that scoring rules are meant to cover the majority of patients and the majority of events. *There will always be patients and events that require the clinician to provide a reasonable adaptation of the rules*. The goal of the Scoring Manual and charge of the Scoring Manual Editorial Board is to present reasonable guidelines for scoring events and provide a standard. The recommendations are based on consensus when there are no clear data.

The current Scoring Manual Editorial Board questioned Dr. Michael Bonnet, the first author on the arousal review paper providing evidence for the arousal rule, concerning the requirement of stable sleep.[4]

His answer is as follows:

Figure 1—A putative respiratory event with a change in airflow that would qualify the event to be scored as a hypopnea based on association with an arousal. N Press is the nasal pressure channel.



> "What we meant by 'stable' sleep referred only to the absence of alpha from the EEG. Our major goal was to assure that the patient had actually fallen asleep or returned to sleep following the preceding arousal as we were concerned with situations where normal young adults have waxing and waning of alpha while falling asleep that we did not think should be scored as a train of arousals."

The Scoring Manual Editorial Board agrees that the term "stable" is somewhat ambiguous, as only 10 seconds of EEG/EOG/EMG consistent with sleep is certainly not stable. In most centers, a 10-second segment that can be considered sleep preceding a putative arousal is the usual interpretation. Given that there have been few questions concerning the meaning of "stable sleep," the Scoring Manual Editorial Board feels that changing the wording is not indicated, and being more specific about requiring certain characteristics of the 10-second interval has the potential to further complicate the scoring of arousals.

The Scoring Manual Editorial Board also discussed the issue of respiratory events associated with arousal. In adults, the minimum **duration** of the change in the hypopnea sensor signal necessary to meet scoring criteria is 10 seconds. Most hypopneas are 15 seconds or longer. The great majority of respiratory events have at least 10 seconds of EEG consistent with sleep that precede the termination of the respiratory event. We would contend that in adults, the requirement of 10 seconds of sleep prior to the termination of the respiratory event disqualifies few putative events. In the example in **Figure 1** with a very short duration change in the nasal pressure signal, we believe most would be comfortable with scoring a hypopnea in the absence of a significant desaturation (recommended hypopnea definition).

Regarding PLM associated arousals, the 10-second requirement would affect only individual PLM events that were separated (onset to onset) by more than 5 seconds but where less than 10 seconds of sleep precedes the abrupt shift in EEG frequencies associated with the second leg movement. It would be a rare individual for whom this situation was frequent enough to substantially alter the PLM with arousal index and ultimately change the clinical impression. Indeed, there are no widely supported guidelines for what constitutes an abnormal PLM arousal index.

In summary, the Scoring Manual Editorial Board feels that having different rules for "spontaneous," PLM, and respiratory event arousals would further complicate arousal scoring without likely benefit for the majority of patients.

The scoring of arousals and interpretation of the arousal index remains an area of controversy. The normal range for the total arousal index increases with age,[5] but there are no firm guidelines for what constitutes an abnormal value. As noted previously, what constitutes an abnormal PLM arousal index is also not clearly defined. The relative impact of "spontaneous" versus respiratory and PLM associated arousals likely varies from patient to patient. In the case of "spontaneous" arousals, one would presume that these arousals are associated with some physiological event. We just don't know what the event is or the stimulus that triggered the response of the nervous system. Even noting an association does not necessarily mean causality. Until we are truly measuring the inciting drivers at a more basic neuronal level, we are only looking at shadows of other events. Using advanced EEG analysis techniques or measures of autonomic function, one is often able to detect changes associated with the termination of respiratory events

or leg movements that do not meet arousal scoring criteria but which may have physiological significance. However, the clinical significance of these events either in the short term (the restorative nature of sleep) or long term (cardiovascular outcomes) requires further study.[3] Hopefully in the future more clinical information will be available to better understand how to identify arousals and understand their significance.

In summary, we thank Dr. Zimmerman for his comments. The Scoring Manual Editorial Board has carefully considered his points. In the future, we will continue to elicit comments and review published data that have implications for the scoring rules. The major idea behind the current Scoring Manual is that it can be updated on a regular basis as needed. The rules are not fixed in stone. Up to this point, the major emphasis of revisions has been clarification and simplification of the scoring rules. However, change must be based on consideration of evidence and consensus from a wide group of experts in the field. The impact of a change in definitions on the effort required for scoring and the reliability of scoring must be also be considered.

CITATION

Berry RB, Brooks R, Gamaldo CE, Harding SM, Lloyd RM, Marcus CL, Vaughn BV. Should the arousal scoring rule be changed? *J Clin Sleep Med* 2015;11(4):497–499.

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DISCLOSURE STATEMENT

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