The AASM Manual for the Scoring of Sleep and Associated Events

Summary of Updates in Version 2.1

July 1, 2014

The American Academy of Sleep Medicine (AASM) is committed to ensuring *that The AASM Manual for the Scoring of Sleep and Associated Events* reflects the best and most current evidence in sleep medicine. The online format of the manual makes it particularly amendable to periodic updates based on new evidence in the literature and feedback from users and beneficiaries. A Scoring Manual Committee oversees the content and makes recommendations when content changes are indicated, need for clarification exists, there is new technology or the literature suggests that updates are needed.

Based on the recommendations of the AASM Scoring Manual Committee, the AASM Board of Directors has approved changes to the Sleep Staging rules (previously Visual rules) and updated the Respiratory rules for adults for scoring hypopneas. The updated manual was released July 1, 2014, as Version 2.1. All AASM-accredited sleep facilities and HSAT programs are required to implement the new rules in Version 2.1 by October 1, 2014.

The following summary provides an overview of the changes that have been incorporated in Version 2.1.

I. User Guide

- No revisions

II. Parameters to be Reported for Polysomnography

- No revisions

III. Technical and Digital Specifications

- No revisions

IV. Sleep Staging Rules (formerly 'Visual Rules')

Part 1: Rules for Adults

A. Technical Specifications for Electroencephalogram (EEG)

- Note 3 was slightly clarified as follows:
  Note 3. *Fz-Cz is not appropriate for measuring the amplitude of frontal activity for determination of slow wave activity. When using the* ***acceptable*** *EEG derivations and the* ***acceptable*** *EOG derivations (Figure 2), the E1-Fpz derivation should be used to measure frontal slow wave amplitude. Used in this way, Fpz will be the active electrode recording frontal activity and E1 the reference electrode in a referential derivation.*

*When using the **acceptable** EEG derivations and the **recommended** EOG derivations, EEG amplitude to determine slow wave activity should be measured using the C4-M1 derivation (C3-M2 if either C4 or M1 electrodes malfunction). When using the **recommended** EEG derivations and **recommended** EOG derivations, the EEG amplitude is measured using the derivation F4-M1.*

B. Technical Specifications for Electrooculogram (EOG)
   - No revisions

C. Technical Specifications for Electromyogram (EMG)
   - Electrodes a, b, and c were renamed ChinZ (upper midline), Chin2 (lower right lateral), and Chin1 (lower left lateral) in Rule 1, Figure 3, and Note 1.

D. General Scoring of Sleep Stages
   - A new rule was added:

     Rule 3. Score in accordance with the following definitions for EEG frequencies: RECOMMENDED

     a. Slow wave activity – frequency of 0.5-2.0 Hz and minimum amplitude of 75 μV peak to peak in frontal derivations
     b. Delta waves are 0-3.99 Hz
     c. Theta waves are 4-7.99 Hz
     d. Alpha waves are 8-13 Hz
     e. Beta waves are greater than 13 Hz

   - Note 1 (Stage N3 represents slow wave sleep and replaces the Rechtschatten and Kales nomenclature of stage 3 and stage 4 sleep.) was moved to section H.

E. Scoring Stage W
   - In Rule 1 and Note 2, "Alpha rhythm" was changed to "Alpha rhythm (posterior dominant rhythm)".

   - Rules 2 and 3 were combined and epochs with both alpha and the findings in b (below) are addressed as follows:
     Rule 2. Score epochs as stage W when more than 50% of the epoch contains EITHER 2a or 2b or BOTH: (see Figure 4) RECOMMENDED

     a. Alpha rhythm (posterior dominant rhythm) over the occipital region (individuals generating alpha rhythm with eye closure)
     b. Other findings consistent with stage W (all individuals)
        i. Eye blinks (0.5 to 2 Hz)
        ii. Rapid eye movements associated with normal or high chin muscle tone
        iii. Reading eye movements

   - Figure 4 is a new figure.

F. Scoring Stage N1

- Three new rules were added:

  Rule 4. An epoch is scored as stage N1 if the *majority* of the epoch meets the criteria for stage N1 (EEG showing LAMF EEG activity) in the absence of evidence for another sleep stage. Subsequent epochs with an EEG showing LAMF EEG activity are scored as stage N1 until there is evidence for another sleep stage (usually stage W, stage N2 or stage R). RECOMMENDED

  Rule 5. When an arousal interrupts stage N2 sleep, score subsequent segments of the recording as stage N1 if the EEG exhibits low-amplitude, mixed-frequency activity without one or more K complexes and/or sleep spindles until there is evidence for another stage of sleep (see G. Scoring Stage N2). RECOMMENDED

  Rule 6. When an arousal interrupts stage R sleep and is followed by a low-amplitude, mixed-frequency EEG without posterior dominant rhythm AND with slow eye movements, score the segments of the record containing the eye movements as stage N1 even if the chin EMG activity remains low (at the stage R level). Continue to score stage N1 until there is evidence for another stage of sleep, usually stage N2 (see G.2) or stage R (see I.2 and I.3). RECOMMENDED

- Figure 5 is a new figure.

G. Scoring Stage N2

- Figures 4 and 5 in version 2.0.3 of the manual were updated and are now Figures 6 and 8 in the current version (v2.1).

- Figure 7 is a new figure.

- Rule 2b was revised from "One or more trains of sleep spindles" to "One or more sleep spindles"

- The following new rules were added:

  Rule 3. Score a given epoch as stage N2 if the majority of the epoch meets criteria for stage N2. If the waveforms in rule G.2.a or G.2.b are followed by an arousal in the same or subsequent epoch (see Figure 6)**, the segment of the recording preceding the arousal is considered stage N2 (see rule G.6.b).**[N1,N5]

  Rule 5. Epochs following an epoch of stage N3 that do not meet criteria for stage N3 are scored as stage N2 if there is no intervening arousal and the epoch does not meet criteria for stage W or stage R. (see Figure 7)

- The phrase “and there is no intervening arousal” was added to the end of Rule 4 (formerly Rule 3).

- Rule 6b (formerly Rule 4b) was revised to “An arousal followed by low-amplitude, mixed-frequency EEG (change to stage N1 until a K complex unassociated with an arousal or a sleep spindle occurs) (see Figure 6). This assumes that the epoch does not meet criteria for stage R (rule I.3) (see Figure 10C).”

- Note 1 was revised to include the following – “If there is a conflict between a stage N2 and stage R scoring rule, the stage R rule takes precedence (see I.4).

- Note 5 in version 2.0.3 was removed and the subsequent notes renumbered accordingly. (For scoring epochs with a mixture of K complexes and/or sleep spindles and REMs, see rule I.7.).

H. Scoring Stage N3

- A new note has been added (with the other notes renumbered accordingly):
  Note 1. Stage N3 represents slow wave sleep and replaces the Rechtschatten and Kales nomenclature of stage 3 and stage 4 sleep.

- Note 2 (now Note 3) was revised to:
  Note 3. Pathological waveforms that meet the slow wave activity criteria, such as those generated by metabolic encephalopathies, epileptic, or epileptiform activity, are not counted as slow wave activity of sleep. Similarly, waveforms produced by artifact or those of non-cerebral origin should not be included in the scoring of slow waves.

I. Scoring Stage R

- Rule 2. was further clarified as follows:

  Rule 2. Score stage R sleep in epochs with ALL of the following phenomena (definite stage R): RECOMMENDED

  a. Low-amplitude, mixed frequency (LAMF) EEG activity without K complexes or sleep spindles
  b. Low chin EMG tone for the majority of the epoch and concurrent with REMs
  c. Rapid eye movements (REMs) at any position within the epoch

- **The following new rules were added:**
  Rule 3. Score segments of sleep preceding and contiguous with an epoch of definite stage R (as defined in I.2), ***in the absence of rapid eye movements****, as stage R if ALL of the following are present: (see Figures 9, 10 and 11)* RECOMMENDED
  a. The EEG shows low-amplitude, mixed-frequency activity without K complexes or sleep spindles[N3]
  b. The chin EMG tone is low (at the stage R level)
  c. There is no intervening arousal (see Figure 10C)
  d. Slow eye movements following an arousal or stage W are absent[N6]

  Rule 4. If the ***majority*** *of an epoch contains a segment of the recording meeting criteria for stage R (I.2, I.3, I.5), the epoch is scored as stage R. Stage R rules take precedence over stage N2 rules. (see Figure 10, epoch 62 and Figure 11, epoch 72)* RECOMMENDED

  Rule 7. Score segments of the record with low chin EMG activity and a mixture of REMs and sleep spindles and/or K complexes as follows:[N1,N2,N3,N4,N5,N6] RECOMMENDED
  a. Segments between two K complexes, two sleep spindles, or a K complex and sleep spindle without intervening REMs are considered to be stage N2.
  b. Segments of the record containing REMs without K complexes or sleep spindles and chin tone at the REM level are considered to be stage R.
  c. If the majority of an epoch contains a segment considered to be stage N2, it is scored as stage N2. If the majority of an epoch contains a segment considered to be stage R, it is scored as stage R. (see Figure 16)

- **Figure 7 was eliminated and Figures 9, 10, 11 and 16 are new figures.**

- **Rule 3 was renumbered to be Rule 5 and revised as follows:**
  Rule 5. Continue to score segments of sleep that follow one or more epochs of definite stage R (as defined in I.2), in the absence of rapid eye movements, as stage R if ALL of the following are present: (see Figures 12-16) RECOMMENDED
  a. The EEG shows LAMF EEG activity without K complexes or sleep spindles
  b. The chin EMG tone is low (at the stage R level) for the majority of the epoch
  c. There is no intervening arousal

- **Rule 5 (Scoring epochs at the transition between stage N2 and stage R) was removed. This rule is now incorporated into rule 3 and generalized to include transitions from stage W and stage N1.**

- **Note 1. was revised to the following:**
  Note 1. Epochs defined by rule I.2 are called epochs of definite stage R.

- **Note 2 was removed.**

- **A new note has been added:**
  Note 4. ***For scoring epochs with low chin EMG tone and a mixture of REMs and K complexes or sleep spindles see I.7.***

- **Notes 5 and 6 were revised to the following:**
  Note 5. *Slow eye movements can occur during stage R but slow eye movements following an arousal in combination with an EEG showing LAMF activity suggests a transition to stage N1 even if the chin tone remains low.*

  Note 6. *Segments of the record with low chin EMG activity and a mixture of REM and sleep spindles and/or K complexes usually occur during the first REM period of the night.*

J. Scoring Epochs with Major Body Movements
- No revisions

Part 2: Rules for Children

A. Ages for Which Pediatric Visual Scoring Rules Apply
- No revisions

B. Technical Specifications
- The note regarding EEG sensitivity was removed.

C. General Scoring of Sleep Stages
- Note 1 was revised from "Sleep spindles may be seen by age 4-6 weeks post-term…" to "Sleep spindles may be seen by age 6 weeks-3 months post-term…"

- Note 2 was revised from "K complexes are usually present by age 4-6 months post-term." to "K complexes are usually present by age 3-6 months post-term."

D. Scoring Stage W
- Rule 2 ("In children the term "posterior dominant rhythm" replaces the term "alpha rhythm" for the purposes of scoring wakefulness and NREM stages.") was removed since this information is in the definition of "posterior dominant rhythm" in Rule 1.

- A table for Initial Age of Waveform Appearance was added.

- Rules 3 and 4 were combined as follows:

  Rule 2. Score epochs as stage W when more than 50% of the epoch contains EITHER or BOTH: RECOMMENDED
  a. Age-appropriate posterior dominant rhythm over the occipital region (individuals generating alpha rhythm with eye closure)

b. Other findings consistent with stage W (all individuals)
    i. Eye blinks (0.5-2 Hz)
    ii. Rapid eye movements associated with normal or high chin muscle tone
    iii. Reading eye movements

- Note 1 was removed. The information in this note was incorporated into the new table.
- Note 4 was removed.

E. Scoring Stage N1
- Rhythmic anterior theta activity was removed as one of the listed phenomena from Rule 3.

F. Scoring Stage N2
- No revisions

G. Scoring Stage N3
- No revisions

H. Scoring Stage R
- No revisions

V. Arousal Rules
- No revisions

VI. Cardiac Rules
- No revisions

VII. Movement Rules
- No revisions

VIII. Respiratory Rules

Part 1: Respiratory Rules for Adults

A. Technical Specifications
- No revisions

B. Measuring Event Duration
- No revisions

C. Scoring of Apneas
- No revisions

D. Scoring of Hypopneas
- Rule 1 in version 2.0.1 that only allowed hypopneas to be scored using a ≥3% oxygen desaturation from pre-event baseline or the event is associated with an arousal criteria was revised to the following:

1A. Score a respiratory event as a hypopnea if ALL of the following criteria are met:

N1,N2,N3 **RECOMMENDED**

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

1B. Score a respiratory event as a hypopnea if ALL of the following criteria are met:

N1,N2,N3 **ACCEPTABLE**

a. The peak signal excursions drop by ≥30% of pre-event baseline using nasal pressure (diagnostic study), PAP device flow (titration study), or an alternative hypopnea sensor (diagnostic study).
b. The duration of the ≥30% drop in signal excursion is ≥10 seconds.
c. There is a ≥4% oxygen desaturation from pre-event baseline.

E. Scoring of Respiratory Effort-Related Arousal
- No revisions

F. Scoring Cheyne-Stokes Breathing
- No revisions

Part 2: Respiratory Rules for Children
- No revisions