Objectives:
- Review the changes from the 2007 scoring manual to the new manual
- Identify the visual rules for sleep scoring
- Describe the rules and changes for respiratory scoring
The AASM Manual for the Scoring of Sleep and Associated Events

Version 2.0
Differences vs. 2007 Manual

- Reporting Parameters
- Technical and digital specifications
- Visual Rules
- Arousal Rules
- Respiratory Rules for Adults
REPORTING PARAMETERS
General Reporting Parameters

- ECG is now a *Recommended* reporting parameter

- Terminology
  - For both Airflow and Effort the word “Parameters” should be replaced with “Signals” in the PSG report.
# Reporting Parameters - Sleep Scoring

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>1.</td>
<td>Lights out time (hr:min)</td>
</tr>
<tr>
<td>2.</td>
<td>Lights on time (hr:min)</td>
</tr>
<tr>
<td>3.</td>
<td>Total sleep time (TST; in min)</td>
</tr>
<tr>
<td>4.</td>
<td>Total recording time (TRT; “lights out” to “lights on” in min)</td>
</tr>
<tr>
<td>5.</td>
<td>Sleep latency (SL; lights out to first epoch of any sleep in min)</td>
</tr>
<tr>
<td>6.</td>
<td>REM latency (sleep onset to first epoch of REM sleep in min)</td>
</tr>
<tr>
<td>7.</td>
<td>Wake after sleep onset (WASO; TRT – SL – TST in minutes)</td>
</tr>
<tr>
<td>8.</td>
<td>Percent sleep efficiency (TST / TRT × 100)</td>
</tr>
<tr>
<td>9.</td>
<td>Time in each stage(min)</td>
</tr>
<tr>
<td>10.</td>
<td>Percent of TST in each stage(time in each stage / TST × 100)</td>
</tr>
</tbody>
</table>

Note 1: WASO includes all wake activity including time out of bed. Time with the patient disconnected from the recording equipment should be scored as stage W. Brief episodes of sleep during this time if they occur are not considered significant for the stage scoring summary.
Reporting Parameters
-Sleep Scoring

Revision to spell out individual parameters used in calculations

Example

- Instead of the Sleep Efficiency was 87%
- **The Sleep Efficiency** (TST / TRT × 100) was 87%
Reporting Parameters - Other areas to be spelled out

- Arousal Index (# of arousals × 60 / TST)
- Movement Events
  - PLMS Index (PLMS × 60 / TST)
  - PLMS Arousal Index (PLMS with arousals × 60 / TST)
# Reporting Parameters - Respiratory

1. Number of obstructive apneas: \((OA)\)  
2. Number of mixed apneas: \((MA)\)  
3. Number of central apneas: \((CA)\)  
4. Number of hypopneas: \((H)\)  
5. Number of obstructive hypopneas: \((OH)\)  
6. Number of central hypopneas: \((CH)\)  
7. Number of apneas + hypopneas  
8. Apnea index: \((AHI)\) \(# OA’s + # CA’s + # MA’s \times 60 / (TST)\)  
9. Hypopnea Index: \((HI)\) \(# hypopneas \times 60 / (TST)\)  
10. Apnea + Hypopnea index: \((AHI)\) \(# of apneas & hypopneas \times 60 / (TST)\)  
11. Obstructive AHI: \((OAHI)\) \(# OA’s + # MA’s + # OH’s \times 60 / (TST)\)  
12. Central AHI: \((CAHI)\) \(# CA’s + # CH’s \times 60 / (TST)\)  
13. Respiratory effort-related arousals: \((RERA)\) (total number)  
14. RERA index: \(# RERA’s \times 60 / (TST)\)  
15. Respiratory Disturbance Index: \((RDI)\) \(AHI + RERA index\)  
16. Oxygen desaturations \(\geq 3\%\) total number
### Reporting Parameters - Respiratory (continued)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Recommended/Optional</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>17. Oxygen desaturation index:</strong></td>
<td><strong>OPTIONAL</strong></td>
</tr>
<tr>
<td>(ODI) (# desaturations ≥3% x 60 / TST)</td>
<td></td>
</tr>
<tr>
<td><strong>18. Arterial oxygen saturation, mean value</strong></td>
<td><strong>RECOMMENDED</strong></td>
</tr>
<tr>
<td><strong>19. Minimum oxygen saturation during sleep</strong></td>
<td><strong>RECOMMENDED</strong></td>
</tr>
<tr>
<td><strong>20. Occurrence of hypoventilation during the diagnostic study</strong></td>
<td><strong>OPTIONAL</strong></td>
</tr>
<tr>
<td>Adults</td>
<td></td>
</tr>
<tr>
<td>Children</td>
<td></td>
</tr>
<tr>
<td><strong>21. Occurrence of hypoventilation during PAP titration</strong></td>
<td><strong>OPTIONAL</strong></td>
</tr>
<tr>
<td>Adults</td>
<td></td>
</tr>
<tr>
<td>Children</td>
<td></td>
</tr>
<tr>
<td><strong>22. Occurrence of Cheyne Stokes Breathing in adults</strong></td>
<td><strong>RECOMMENDED</strong></td>
</tr>
<tr>
<td><strong>23. Duration of Cheyne-Stokes breathing (absolute or as a percentage of</strong></td>
<td><strong>RECOMMENDED</strong></td>
</tr>
<tr>
<td>total sleep time) or the number of Cheyne-Stokes breathing events</td>
<td></td>
</tr>
<tr>
<td><strong>24. Occurrence of periodic breathing in children</strong></td>
<td><strong>RECOMMENDED</strong></td>
</tr>
<tr>
<td><strong>25. Occurrence of snoring</strong></td>
<td><strong>OPTIONAL</strong></td>
</tr>
</tbody>
</table>

**Note 1.** Percent time spent below a given threshold of oxygen desaturation may be reported at the discretion of the clinician.

**Note 2.** If electing to measure arterial PCO2 or surrogate during sleep in cases where it is optional to do so, the occurrence/absence of hypoventilation must be included in the PSG Report.

**Note 3.** Reporting the occurrence of Cheyne-Stokes breathing in the PSG report is required only in central apneas are present.
TECHNICAL AND DIGITAL SPECIFICATIONS
A new note (#10) was added. Body position sensor is exempt from the digital resolution standard.

Sampling rates are now specified for Transcutaneous PCO$_2$, End-Tidal PCO$_2$, and PAP Device Flow (minimal 25Hz, 100Hz Desirable.

2007 manual grouped filter settings for all respiration channels. New manual seperates into 3 sections:

1) Oronasal Thermal Flow & Belts: still recommended LFF of 0.1Hz and HFF of 15Hz

2) Nasal Pressure: Either DC channel or LFF of .03Hz and HFF of 100Hz.

3) DC for both LFF and HFF.
New Display Requirements

- Minimum Requirement:
  - 15 inch monitor
  - 1600 Pixels Horizontal and 1050 Pixels Vertical

- Other display requirements remain the same.
VISUAL RULES FOR ADULTS
Technical Specifications for EEG (if using alternate acceptable method)

**FZ-CZ, CZ-OZ, C4-M1**

- FZ – CZ is not appropriate for measuring amplitude of frontal activity or determination of slow wave activity.

- When using alternate method for EEG Placement you should use E1$_{\text{LOC}}$ – Fpz to measure frontal slow wave amplitude. Used this way, Fpz should be the active electrode and E1 should be the referenced electrode.
Technical Specifications for EOG

**Recommended EOG:**
- Derivations: E1-M2 and E2-M2
- Electrode Positions: E1 is placed 1 cm below the left outer canthus and E2 is placed 1 cm above the right outer canthus

- Note has been added to this section (addition to “Note 1”):
  - “When using the recommended electrode derivations, conjugate eye movements result in out-of-phase deflections”
Technical Specifications for EMG & General Scoring of Sleep Stages

No Revisions to either of these sections
VISUAL RULES
FOR ADULTS
Scoring Stage W

- Alpha rhythm: Trains of sinusoidal 8-13 Hz activity recorded over the occipital region with eye closure, attenuating with eye opening.
- Eye blinks: Conjugate vertical eye movements at a frequency of 0.5-2 Hz present in wakefulness with the eyes open or closed.
- Reading eye movements: Trains of conjugate eye movements consisting of a slow phase followed by a rapid phase in the opposite direction as the subject reads.
- Rapid eye movements (REM): Conjugate, irregular, sharply peaked eye movements with an initial deflection usually lasting <500 msec. While rapid eye movements are characteristic of stage R sleep, they may also be seen in wakefulness with eyes open when subjects scan the environment.
- Slow eye movements (SEM): Conjugate, reasonably regular, sinusoidal eye movements with an initial deflection usually lasting >500 msec.
Note 5 added:

“Time with the patient disconnected from the recording equipment should be scored as stage W. Brief episodes of sleep during this time, if they occur, are not considered significant for the stage scoring summary.”
1. Score in accordance with the following definitions:
   - Slow eye movements (SEM): Conjugate, reasonably regular, sinusoidal eye movements with an initial deflection usually lasting >500 msec.
   - Low-amplitude, mixed-frequency EEG activity: Low-amplitude, predominantly 4-7 Hz activity.
   - Vertex sharp waves (V waves): Sharply contoured waves with duration <0.5 seconds maximal over the central region and distinguishable from the background activity.
   - Sleep onset: The start of the first epoch scored as any stage other than stage W. (In most subjects this will usually be the first epoch of stage N1.)
2. In subjects who generate alpha rhythm, score stage N1 if the alpha rhythm is attenuated and replaced by low-amplitude, mixed-frequency activity for more than 50% of the epoch.
3. In subjects who do not generate alpha rhythm, score stage N1 commencing with the earliest of ANY of the following phenomena:
   a. EEG activity in range of 4-7 Hz with slowing of background frequencies by ≥1 Hz from those of stage W
   b. Vertex sharp waves
   c. Slow eye movements
Rule G2: Begin scoring stage N2 (in absence of criteria for N3) if EITHER OR BOTH of the following occur during the first half of that epoch or the last half of the previous epoch:

a. One or more K complexes unassociated with arousals
b. One or more trains of sleep spindles
Continue Scoring Stage N2

Continue to score epochs with low-amplitude, mixed-frequency EEG activity without K complexes or sleep spindles as stage N2 if they are preceded by epochs containing EITHER of the following:

- K-complexes unassociated with arousals
- Sleep spindles
End Scoring Stage N2

When **ONE** of the following events occur:

- Transition to stage W
- An arousal (change to stage N1 until a K complex unassociated with an arousal or a sleep spindle occurs)
- A major body movement followed by slow eye movements and low-amplitude, mixed-frequency EEG without non-arousal associated K complexes or sleep spindles
- Transition to stage N3
- Transition to stage R
- K-Complex unassociated with arousal occurs during the first half of the epoch.
- Epoch 51 is scored as Stage N2 following the rule for continuation of Stage N2 and the fact that the arousal occurs during the second half of the epoch (majority of epoch 51 is N2).
- Epoch 52 is scored as stage N1 because there are no K complexes or sleep spindles.
- Epoch 53 is scored as Stage N2 as it has a K complex unassociated with an arousal in the first half of the epoch.
- K-Complex associated with an arousal in the last part of Epoch 61 interrupts an episode of Stage N2 Sleep
- Epoch 62 is not scored as Stage N2 because the K complex in the last half of the preceding epoch is associated with an arousal.
- Epoch 62 is scored as stage N1 because the next K complex appears in the last half of the epoch.
- Epoch 63 is scored as Stage N2 as it has a K complex unassociated with an arousal appears in the last half of the preceding epoch.
Scoring Stage N2

Changes in New Manual (2 new notes were added)

- Note 1: “An epoch of Stage N2 meeting criteria in rule G.2 is termed **definite Stage N2**.”
- Note 4: “Although sleep spindles and frequency changes associated with arousals are more typically noted in the central and occipital derivations respectively, these events should be used to score sleep even if they are only noted in the frontal derivations.”
Scoring Stage N3

- Slow wave activity: waves of frequency 0.5Hz – 2Hz and peak-to-peak amplitude of > 75μV measured over the frontal regions.
- Score and epoch as stage N3 when ≥ 20% consists of slow wave activity, irrespective of age.
- New Note added (#1): K complexes would be considered slow waves if they meet the definition of slow wave activity
Rule I.2:
- Low-amplitude, mixed-frequency EEG
- Low chin EMG tone
- Rapid eye movements
Score REM in the absence of rapid eye movements IF the EEG continues to show low-amplitude, mixed-frequency activity without K complexes or sleep spindles AND the chin EMG tone remains low for the majority of the epoch.
End Scoring REM

- There is a transition to stage W or N3
- An increase in chin EMG tone above the level of stage R is seen for the majority of the epoch and criteria for stage N1 are met
- An arousal occurs followed by low-amplitude, mixed-frequency EEG and slow eye movements (Score the epoch as stage N1)
- A major body movement followed by slow eye movements and low-amplitude, mixed-frequency EEG without non-arousal associated K complexes or sleep spindles (Score the epoch as stage N1)
- One or more non-arousal associated K complexes or sleep spindles are present in the first half of the epoch in the absence of rapid eye movements, even if chin EMG tone remains low (Score the epoch as stage N2)
Scoring Stage R

Additions in new scoring manual (3 new notes were added)

- **Note 1.** Epochs defined by rule I.2 are called epochs of definite stage R. Such epochs usually do not contain K complexes or sleep spindles. However, especially in the first REM sleep period of the night, K complexes or sleep spindles may be interspersed among epochs of what otherwise appears to be stage R sleep. Epochs defined by rule I.2 are scored as stage R even in the presence of K complexes or sleep spindles. In the absence of rapid eye movements, epochs containing sleep spindles or K complexes are not scored as stage R even if they contain low chin EMG tone.
Scoring Stage R

- **Note 2:** Definite stage N2 refers to epochs defined by G.2. The epoch contains one or both of the following: one or more sleep spindles or one or more K complexes in the first half of the epoch, and the epoch does not meet criteria for stage N3.

- **Note 5:** There are no rules specifically dealing with stage N1-R transitions. Stage R sleep will only commence when rapid eye movements are seen in association with low muscle tone and the typical EEG.
Scoring epochs with major body movements

- No revisions to this section
- Major body movement: Movement and muscle artifact obscuring the EEG for more than half an epoch to the extent that the sleep stage cannot be determined.
- If alpha rhythm is present for part of the epoch (even <15 seconds duration), score as stage W.
- If no alpha rhythm is discernible, but an epoch scorable as stage W either precedes or follows the epoch with a major body movement, score as stage W.
- Otherwise, score the epoch as the same stage as the epoch that follows it.
Visual Rules for children

No major changes
Arousal Rules

- Note 3 added:

  “Arousals meeting all scoring criteria but occurring during an awake epoch in the recorded time between lights out and lights on should be scored and used for computation of the arousal index.”
RESPIRATORY RULES FOR ADULTS
Scoring of Apneas

Similar definition with addition of Rules and notes

- If a portion of an event that would otherwise meet criteria as a hypopnea meets criteria for an apnea then the entire event should be scored as an apnea.

- There is not sufficient evidence to support a specific duration of the central and obstructive components of a mixed apnea; thus, specific durations of these components are not recommended.
Scoring of Hypopneas (General)

- New rule for scoring hypopneas (All of the following must be met)
  - The peak signal excursion drop by $\geq 30\%$
  - The duration of $\geq 30\%$ drop in signal excursion is $\geq 10$ seconds
  - There is a $\geq 3\%$ oxygen desaturation from pre-event baseline or the event is associated with an arousal.

Although AASM standard has changed, Medicare standard has not changed. You must still use the 4% criteria for Medicare patients.
Scoring of Obstructive Hypopneas (optional)

Can meet ANY of the following criteria

- Snoring during the event
- Increased inspiratory flattening of the flow signal compared to baseline breathing
- Associated thoracoabdominal paradox during the event, but not during the pre-event breathing
Scoring of Central Hypopneas (optional)

None of the following criteria can be met:

- Snoring during the event
- Increased inspiratory flattening of the flow signal compared to baseline breathing
- Associated thoracoabdominal paradox during the event, but not during the pre-event breathing
If electing to score RERA’s, score a respiratory event as a RERA if there is a sequence of breaths lasting ≥10 seconds characterized by increasing respiratory effort or by flattening of the inspiratory portion of the flow waveform leading to arousal from sleep when the sequence of breaths does not meet criteria for an apnea or hypopnea.
Scoring of Cheyne-Stokes Breathing

Score if both of the following criteria are met

- There are episodes of ≥3 consecutive central apneas and/or central hypopneas separated by a crescendo and decrescendo change in breathing amplitude with a cycle length of ≥40 seconds.

- There are ≥5 central apneas and/or central hypopneas per hour of sleep associated with the crescendo/decrescendo breathing pattern recorded over ≥2 hours of monitoring
  - Note: Central apneas that occur within a run of Cheyne-Stokes breathing should be scored as individual apneas as well