The International Palestinian Congress in Sleep Medicine

“Temporomandibular Disorders and Sleep Apnea”

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Notre Dame Hotel, Jerusalem
Recording & Scoring Polysomnographic Recordings

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Objectives

- Review PSG recording parameters
- Review AASM Scoring Rules for PSG Recordings
Recording the PSG

• What we record for sleep staging & arousal scoring
  • EEG
    • F4-M1 (frontal)
    • C4-M1 (central)
    • O2-M1 (occipital)
    • Placed according to the International 10-20 System of electrode placement
  • EOG
    • E1-M2 (left outer canthus)
    • E2-M2 (right outer canthus)
  • Chin EMG
    • Chin1 or Chin2-ChinZ

Recording the PSG

• What we record for respiratory event scoring
  • Airflow
    • Oronasal thermal airflow (apnea)
    • Nasal pressure transducer (hypopnea)
    • PAP flow device signal (apnea or hypopnea)
  • Respiratory Effort
    • Dual thoracoabcominal RIP belts
    • Dual thoracoabcominal PVDF belts
  • Oximetry
    • Pulse oximetry with slow averaging time (≤3 seconds)
  • Snoring
    • Microphone, piezoelectric sensor, or nasal pressure transducer

Recording the PSG

• What we record for limb movement event scoring
  • Anterior tibialis EMG (bilateral)

• What we record for monitoring & scoring other movement events
  • Upper limbs (flexor digitorum superficialis / extensor digitorum communis)
  • Bruxism (masseter)
  • RMD (paraspinal)
  • Time synchronized video (RBD & RMD)
Recording the PSG

• Additional essential recordings
  • Cardiac monitoring
    • Lead II EKG
    • Heart rate
  • Body position
  • CO₂ (essential for pediatrics)
    • End tidal or transcutaneous

Recording the PSG

Physiological (patient) calibrations
• Perform and document
• All patients able to cooperate
• Verify working signal for all parameters
• Repeat as needed
• All recording parameters
• Repeat in AM
Staging the Adult PSG

• Score sleep stages in 30-second epochs
• If two or more stages coexist during a single epoch, assign the stage comprising the greatest portion of the epoch
• When three or more segments of an epoch meet criteria for different stages
  • Score the epoch as sleep if the majority of the epoch meets criteria for stage N1, N2, N3, or R
  • Assign the sleep stage that occurs for the majority of sleep in the epoch
Staging the Adult PSG

Use the following terminology for the stages of sleep in adults:

- Stage W (Wakefulness)
- Stage N1 (NREM 1)
- Stage N2 (NREM 2)
- Stage N3 (NREM 3)
- Stage R (REM)
Staging the Adult PSG

Stage W

50% of the epoch contains EITHER

• Alpha rhythm (posterior dominant rhythm) over the occipital region

OR

• Other findings consistent with stage W
  • Eye blinks (0.5 to 2 Hz)
  • Rapid eye movements associated with normal or high chin muscle tone
  • Reading eye movements

OR BOTH

Staging the Adult PSG

Stage W
Staging the Adult PSG

Stage N1

• Alpha rhythm is attenuated and replaced by low-amplitude, mixed-frequency activity for more than 50% of the epoch

OR

• In individuals who do not generate alpha rhythm, score stage N1 with onset of ANY of the following:
  • EEG activity in range of 4–7 Hz with slowing of background frequencies by ≥1 Hz from those of stage W
  • Vertex sharp waves
  • Slow eye movements

Staging the Adult PSG

Stage N1
Staging the Adult PSG

Begin Stage N2

• If EITHER OR BOTH
  • K complexes unassociated with arousals
  • sleep spindles
  occur during the first half of the epoch or the last half of the previous epoch

• This is considered definite stage 2

Staging the Adult PSG

Stage N2
Staging the Adult PSG

Continue Stage N2

• For epochs with low-amplitude, mixed-frequency EEG activity without K complexes or sleep spindles if they are preceded by epochs containing EITHER
  • K complexes unassociated with arousals
  • sleep spindles
  and there is no intervening arousal

Staging the Adult PSG

End Stage N2

• With a transition to stage W, N3, or R
• An arousal is followed by low-amplitude, mixed-frequency EEG (stage N1)
• A major body movement is followed by slow eye movements and low-amplitude, mixed-frequency EEG (stage N1)

Staging the Adult PSG

Stage N3

• Score stage N3 when ≥ 20% of an epoch consists of slow wave activity, irrespective of age
  • Slow wave activity is defined as waves of frequency 0.5 Hz–2 Hz and peak-to-peak amplitude >75 μV, measured over the frontal regions referenced to the contralateral ear or mastoid

Staging the Adult PSG

Stage N3
Staging the Adult PSG

Definite Stage R

• Epochs with ALL of the following
  • Low-amplitude, mixed-frequency (LAMF) EEG activity without K complexes or sleep spindles
  • Low chin EMG tone for the majority of the epoch and with REMs
  • REMs anywhere within the epoch

Staging the Adult PSG

Stage R
Staging the Adult PSG

Continue Stage R

• Epochs preceding and following an epoch of definite stage R in the absence of rapid eye movements

• In epochs with ALL of the following
  • Low-amplitude, mixed-frequency (LAMF) EEG activity without K complexes or sleep spindles
  • Chin EMG tone is low (at stage R level) for the majority of the epoch
  • There is no intervening arousal

Staging the Adult PSG

Stage R

• If the *majority* of an epoch meets criteria for stage R the epoch is scored as stage R

• Stage R rules take precedence over stage N2 rules
Staging the Adult PSG

End Stage R

• Transition to stage W or N3
• Increase in chin EMG tone for the majority of the epoch and criteria for stage N1 are met
• An arousal or major body movement occurs followed by low-amplitude, mixed-frequency EEG and slow eye movements (stage N1)
• One or more 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 (stage N2)
Staging the Adult PSG

Scoring Epochs with Major Body Movements

• If alpha rhythm is present for part of the epoch (even < 15 seconds) score as stage W
• If no alpha rhythm is seen but an epoch scored as stage W 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

Scoring Arousals

- Score an arousal during sleep (N1, N2, N3, or R)
- Abrupt shift of EEG frequency - at least 3 seconds
  - Including alpha, theta and/or frequencies greater than 16 Hz (but not spindles)
- At least 10 seconds of stable sleep must precede the change
  - This 10 seconds of stable sleep may begin in the preceding epoch, including a preceding epoch that is scored as stage W
  - An arousal can be scored in an epoch of stage W
- During REM a concurrent increase in submental EMG lasting at least 1 second is required
- An arousal may still be scored if it immediately precedes a transition to stage W
  - Both the arousal and transition to wake (awakening) are scored

Arousal Plus Awakening From Sleep

Score the arousal AND the awakening
Scoring Respiratory Events in Adults

• Event duration $\geq$ 10 seconds
  • Nadir of first clearly reduced breath
  • Beginning of first breath that approximates baseline breathing amplitude
    • OR
      • A clear sustained increase in breathing amplitude
      • Event associated resaturation of at least 2%

• Apnea
  • 90% drop in peak signal excursion
  • Duration of $\geq$ 10 seconds
Scoring Respiratory Events in Adults

• Apnea
  • 90% drop in peak signal excursion
  • Duration of ≥ 10 seconds

• Obstructive Apnea
  • Continued or increased respiratory effort throughout the event

• Central Apnea
  • Absent respiratory effort throughout the event

• Mixed Apnea
  • Absent respiratory effort initial portion of the event; resumption of respiratory effort without airflow in the second portion of the event
Scoring Respiratory Events in Adults

- **Hypopnea**
  - 30% drop in peak signal excursion
  - Duration of ≥ 10 seconds
  - 3% drop on oxygen saturation OR arousal

- **Obstructive Hypopnea**
  - Snoring during the event
  - Flattening of nasal pressure or PAP flow signal
  - Thoracoabdominal paradox during the event

- **Central Hypopnea**
  - NO snoring during the event
  - NO flattening of nasal pressure or PAP flow signal
  - NO thoracoabdominal paradox during the event
Scoring Respiratory Events in Adults

Hypopnea with arousal
Scoring Respiratory Events in Adults

• RERA (Respiratory Effort-Related Arousal)
  • Sequence of breaths ≥ 10 seconds
  • Increasing respiratory effort of flattening of nasal pressure of PAP device flow
  • Leads to an arousal from sleep
  • Does not meet criteria for an apnea or hypopnea

• Cheyne-Stokes Breathing
  • > 3 consecutive central apneas or hypopneas separated by crescendo/decrescendo breathing in a ≥ 40 second cycle
  • > 5 consecutive central apneas or hypopneas separated by crescendo/decrescendo breathing recorded over ≥ 2 hours of monitoring
Scoring Limb Movements

Scoring a Limb Movement (LM)

- Minimum duration is 0.5 seconds
- Maximum duration is 10 seconds

- Minimum amplitude is an 8 μV increase in EMG voltage above resting EMG
- Onset of a LM is defined as the point of an 8 μV increase in EMG voltage and the end the point where the EMG voltage does not exceed 2 μV above resting EMG for at least 0.5 seconds

Scoring A PLMS Series

PLMS Series

• A minimum of 4 consecutive LM events is required to define a PLMS series
• The period length between LMs in a series is 5 to 90 seconds
• LMs on 2 different legs separated by less than 5 seconds between onset are counted as a single LM

Scoring PLMS With Arousals

- A LM is associated with an arousal if they occur simultaneously, overlap, or there is ≤ 0.5 seconds between the end of one event and the onset of the other event - regardless of which is first.

Scoring PLMS With Respiratory Events

• A LM should not be scored if it occurs from 0.5 seconds before an apnea, hypopnea, or RERA to 0.5 seconds after the event.

Scoring PLMS With Intervening Wake

- When a period of wake < 90 seconds separates a series of PLMS this does not interrupt the series.
Other Movement Disorders

Be aware - there are scoring rules for a number of additional movement disorders!!! See the scoring manual!

- Alternating Leg Muscle Activation (ALMA)
- Hypnagogic Foot Tremor (HFT)
- Excessive Fragmentary Myoclonus (EFM)
- Bruxism
- REM Sleep Behavior Disorder (RBD)
- Rhythmic Movement Disorder
Performing and Scoring the PSG

Thank you!

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