Sleep Diagnostic Dilemmas and PSG Puzzlers

David Schulman, MD, FCCP
Aneesa Das, MD, FCCP
Conflict of Interest Disclosure

- Aneesa Das, MD
  - Uptodate Royalties
- David Schulman, MD
  - Uptodate Royalties
• An 86 year old woman is being evaluated by a neurologist for progressive cognitive and behavioral decline

• Her neuropsychiatric and extended mental status examination is consistent with Alzheimer’s disease

• Recently started on memantine and galantamine
• Subsequently referred to sleep clinic for evaluation of daytime sleepiness, snoring and witnessed apneas

• Goes to bed around midnight and gets up by 8 am

• Denies excessive movements or arousals during sleep

• Overall AHI is 21.1 with oxygen nadir 71%
What is the waveform shown by the arrow?

A. Interictal epileptiform discharge
B. Vertex sharp wave
C. Blink artifact
D. Muscle twitch artifact
What is the waveform shown by the arrow?

A. Interictal epileptiform discharge
B. Vertex sharp wave
C. Blink artifact
D. Muscle twitch artifact
Later on in the study the following occurred...
What does this epoch show?

A. Tremor  
B. Shivering  
C. Ictal epileptiform activity  
D. Confusional arousal
What does this epoch show?

A. Tremor  
B. Shivering  
C. Ictal epileptiform activity  
D. Confusional arousal
standard EEG rate of 30mm/sec
In what physiologic stage are seizures most likely to occur?

A. REM sleep
B. NREM sleep
C. Wakefulness

In what physiologic stage are seizures most likely to occur?

A. REM sleep
B. NREM sleep
C. Wakefulness

A 71 year old patient complains of arms and legs flailing in his sleep. The following 120 second epoch is from his polysomnography and is scored as REM sleep.

120 second epoch

Register now at congress.chestnet.org
Does the following PSG fragment meet criteria for REM Behavior Disorder?

A. Yes
B. No
Does the following PSG fragment meet criteria for REM Behavior Disorder?

A. Yes
B. No
Polysomnographic Characteristics of RBD

- Sustained muscle activity in REM sleep in the chin EMG
  - An epoch of REM sleep with at least 50% of the duration of the epoch having a chin EMG amplitude greater than the minimum amplitude demonstrated in NREM sleep.

- Excessive transient muscle activity during REM in the chin or limb EMG
  - In a 30-second epoch of REM sleep divided into 10 sequential 3-second mini-epochs, at least 5 (50%) of the mini-epochs contain bursts of transient muscle activity.
  - Excessive transient muscle activity bursts are 0.1-5.0 seconds in duration and at least 4 times as high in amplitude as the background EMG activity.
Which medication is most likely to cause an increased tone in REM sleep (disrupted REM atonia)?

A. buproprion  
B. clonazepam  
C. donepezil  
D. fluoxetine
Which medication is most likely to cause an increased tone in REM sleep (disrupted REM atonia)?

A. bupropion
B. clonazepam
C. donepezil
D. fluoxetine
Disrupt REM Atonia

• serotonin-selective receptor inhibitor (SSRI’s) → fluoxetine

• tricyclic antidepressants (TCA’s)

• monoamine oxidase inhibitors (MAOI’s)
What is the best description of the following polysomnogram finding in a 49 year old male?

A. Seizure activity  
B. Head banging  
C. Bruxism  
D. Hypnic jerk

Register now at congress.chestnet.org
What is the best description of the following polysomnogram finding in a 49 year old male?

A. Seizure activity
B. Head banging
C. Bruxism
D. Hypnic jerk
Bruxism may consist of brief (phasic) or sustained (tonic) elevations of chin EMG activity that are at least twice that of the background EMG

- **Phasic:** brief elevations of 0.25-2 seconds in duration and a minimum of 3 in sequence

- **Tonic:** sustained elevations in chin EMG for greater than 2 seconds

Register now at [congress.chestnet.org](http://congress.chestnet.org)
A 43 yo female referred for evaluation of chronic insomnia. She undergoes complete evaluation and therapy is initiated. Due to snoring and continues arousals from sleep a PSG is ultimately done.
Based on the previous PSG fragment which of the following treatments was most likely initiated?

A. stimulus control therapy  
B. mirtazapine  
C. temazepam  
D. diphenhydramine
Based on the previous PSG fragment which of the following treatments was most likely initiated?

A. stimulus control therapy  
B. mirtazapine  
C. temazepam  
D. diphenhydramine
Which of the following effects on sleep are observed with the administration of benzodiazepines at therapeutic doses?

A. increased REM and decreased N3 sleep  
B. increased REM and no effect on N3 sleep  
C. decreased REM and decreased N3 sleep  
D. decreased REM sleep and increased N3 sleep
Which of the following effects on sleep are observed with the administration of benzodiazepines at therapeutic doses?

A. increased REM and decreased N3 sleep
B. increased REM and no effect on N3 sleep
C. decreased REM and decreased N3 sleep
D. decreased REM sleep and increased N3 sleep
Benzodiazepines have the following effects:

↑ increased stage N2
↑ increased sleep spindles
↓ sleep latency
↓ stage changes
↓ stage N1 sleep
↓ stage N3 sleep
↓ stage R (REM) sleep

Qureshi, A., 2004 Medical Clinics of North America 88, 751-766
A patient undergoes a multiple sleep latency test with the following results. What is this patient’s mean sleep latency?

<table>
<thead>
<tr>
<th>Nap</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep Latency</td>
<td>3 minutes</td>
<td>5 minutes</td>
<td>2 minutes</td>
<td>No sleep</td>
<td>No sleep</td>
</tr>
<tr>
<td>SOREM</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

A. 2 minutes  
B. 10 minutes  
C. 3.3 minutes  
D. 7.5 minutes
A patient undergoes a multiple sleep latency test with the following results. What is this patient’s mean sleep latency?

<table>
<thead>
<tr>
<th>Nap</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep Latency</td>
<td>3 minutes</td>
<td>5 minutes</td>
<td>2 minutes</td>
<td>No sleep</td>
<td>No sleep</td>
</tr>
<tr>
<td>SOREM</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

A. 2 minutes  
B. 10 minutes  
C. 3.3 minutes  
D. 7.5 minutes
### Sleep Latency

<table>
<thead>
<tr>
<th>Nap</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep Latency</td>
<td>3 minutes</td>
<td>5 minutes</td>
<td>2 minutes</td>
<td>No sleep</td>
<td>No sleep</td>
</tr>
<tr>
<td>SOREM</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

No nap counts as the full 20 minutes

\[
\frac{(3+5+2+20+20)}{5} = 10
\]
What is the best description of the findings in this epoch?

A. Sweat artifact
B. Delta waves
C. Muscle artifact
D. Electrode popping

Register now at congress.chestnet.org
What is the best description of the findings in this epoch?

A. Sweat artifact  
B. Delta waves  
C. Muscle artifact  
D. Electrode popping

Register now at congress.chestnet.org
Sweat Artifact

- Typically seen in EEG (Occipital leads- pt on back)
- Slow (<2Hz)
- Disappears in REM (no thermoregulation)
- Trouble shooting sweat artifact:
  - Lower room temp or change patient position
  - Adjust low frequency filter (increase from 0.3Hz to 0.5 or 1.0 Hz)
Sweat Artifact

- Typically seen in EEG (Occipital leads- pt on back)
- Slow (<2Hz)
- Disappears in REM (no thermoregulation)
- Trouble shooting sweat artifact:
  - Lower room temp or change patient position
  - Adjust low frequency filter (increase from 0.3Hz to 0.5 or 1.0 Hz)
  - Caution when scoring! delta wave amplitude may be attenuated if you increase low frequency filter
• Fast (10-70Hz)
• Do not misinterpret as arousals or spindles
• Fast (10-70Hz)
• Do not misinterpret as arousals or spindles
• Troubleshooting if persistent:
  • Reduce high frequency filter (reduce from 35Hz to 15Hz)
  • Caution scoring as you may miss arousals and spindles due to attenuation of higher frequency waves
REM RULES
Name that Stage!

Which of the following represents x,y,z?

A. N1, N1, N2
B. R, N2, N2
C. R, R, N2
D. R, N1, N2

A diagram showing stages R, N1, N2, and REM. EMG is also shown with a K complex.
Name that Stage!

Which of the following represents $x,y,z$?

A. $N1,N1,N2$
B. $R,N2,N2$
C. $R,R,N2$
D. $R,N1,N2$

---

A. $N1,N1,N2$
B. $R,N2,N2$
C. $R,R,N2$
D. $R,N1,N2$
Continue to score stage R even in the absence of rapid eye movements, if the EMG tone remains low and without K complexes or sleep spindles.
Name that Stage!

Which of the following represents x, y, z?

A. N1, N1, N2
B. R, N2, N2
C. R, R, N2
D. R, N1, N2
Name that Stage!

Which of the following represents x, y, z?

A. N1, N1, N2
B. R, N2, N2
C. R, R, N2
D. R, N1, N2
Continue to score stage R if the EMG tone remains low throughout the first half of epoch and without K complexes or sleep spindles.

Name that Stage!

Which of the following represents x,y,z?

A. R,R,N2
B. R,W,N2
C. R,N2,N2
D. R,N1,N2
Name that Stage!

Which of the following represents x,y,z?

A. R,R,N2
B. R,W,N2
C. R,N2,N2
D. R,N1,N2

Which of the following represents x,y,z?

A. R,R,N2
B. R,W,N2
C. R,N2,N2
D. R,N1,N2
Scoring Rule

If an arousal occurs followed by low amplitude mixed frequency EEG and the chin EMG remains low, and there are no slow eye movements score as stage R.
Name that Stage!

Which of the following represents x,y,z?

A. R,R,R
B. R,N2,R
C. R,N2,N2
D. N2,N2,N2
Name that Stage!

Which of the following represents x,y,z?

A. R,R,R
B. R,N2,R
C. R,N2,N2
D. N2,N2,N2

A. R,R,R
B. R,N2,R
C. R,N2,N2
D. N2,N2,N2
If the majority of an epoch contains a segment of the recording meeting criteria for stage R, the epoch is scored as stage R. Stage R rules take precedence over stage N2 rules.

(Scoring stage R, see figure 11A for rule) American Academy of Sleep Medicine. The AASM Manual for the Scoring of Sleep and Associated Events: Rules, Terminology and Technical Specifications, Version 2.3
Name that Stage!

Which of the following represents x, y, z?

A. R, R, N1  
B. W, N1, N1  
C. R, N1, N1  
D. N1, N1, N1  

Chest Congress 2019
Thailand
Bangkok | 10-12 April

Register now at congress.chestnet.org

Connecting a Global Community in Clinical Chest Medicine
Name that Stage!

Which of the following represents x,y,z?

A. R,R,N1
B. W,N1,N1
C. R,N1,N1
D. N1,N1,N1
Scoring Rule: Major Body Movements

- If alpha rhythm is present for any part of the epoch (even <15 seconds duration), score as stage W.
- If no alpha rhythm is discernible, but the preceding or following epoch is W, then score as stage W.
- If no alpha is present and no surrounding epochs of W, score the epoch as the same stage as the epoch that follows it.

In a patient with excessive daytime sleepiness, which of the following diagnostic testing results are consistent with narcolepsy type 2 according to the ICSD3?

<table>
<thead>
<tr>
<th></th>
<th>PSG REM Latency</th>
<th>Mean Sleep Latency on MSLT</th>
<th># SOREM’s on MSLT</th>
<th>CSF Hypocretin-1 Concentration</th>
<th>Cataplexy</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>12 minutes</td>
<td>6 minutes</td>
<td>1</td>
<td>not obtained</td>
<td>no</td>
</tr>
<tr>
<td>B.</td>
<td>62 minutes</td>
<td>7.5 minutes</td>
<td>3</td>
<td>112 pg/mL</td>
<td>yes</td>
</tr>
<tr>
<td>C.</td>
<td>27 minutes</td>
<td>2 minutes</td>
<td>2</td>
<td>100 pg/mL</td>
<td>no</td>
</tr>
<tr>
<td>D.</td>
<td>17 minutes</td>
<td>9 minutes</td>
<td>2</td>
<td>not obtained</td>
<td>no</td>
</tr>
</tbody>
</table>
In a patient with excessive daytime sleepiness, which of the following diagnostic testing results are consistent with narcolepsy type 2 according to the ICSD3?

<table>
<thead>
<tr>
<th></th>
<th>PSG REM Latency</th>
<th>Mean Sleep Latency on MSLT</th>
<th># SOREM’s on MSLT</th>
<th>CSF Hypocretin-1 Concentration</th>
<th>Cataplexy</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>12 minutes</td>
<td>6 minutes</td>
<td>1</td>
<td>not obtained</td>
<td>no</td>
</tr>
<tr>
<td>B.</td>
<td>62 minutes</td>
<td>7.5 minutes</td>
<td>3</td>
<td>112 pg/mL</td>
<td>yes</td>
</tr>
<tr>
<td>C.</td>
<td>27 minutes</td>
<td>2 minutes</td>
<td>2</td>
<td>100 pg/mL</td>
<td>no</td>
</tr>
<tr>
<td>D.</td>
<td>17 minutes</td>
<td>9 minutes</td>
<td>2</td>
<td>not obtained</td>
<td>no</td>
</tr>
</tbody>
</table>
Narcolepsy Diagnostic Criteria

At least 3 months of excessive daytime sleepiness not otherwise explained

Narcolepsy Type 1

• Cataplexy and a MSL of ≤ 8 minutes and ≥ 2 SOREM on an MSLT. (A SOREM (within 15 minutes of sleep onset) on the preceding PSG may replace one of the SOREMs on the MSLT.)

  OR

• CSF hypocretin-1 concentration, is either ≤ 110 pg/mL or <1/3 of mean normal values with the same standardized assay.
Narcolepsy Diagnostic Criteria

At least 3 months of excessive daytime sleepiness not otherwise explained

**Narcolepsy Type 2**

- A MSL of \( \leq 8 \) minutes *and* \( \geq 2 \) SOREM on an MSLT. (A SOREM (within 15 minutes of sleep onset) on the preceding PSG may replace one of the SOREMs on the MSLT.)
- Cataplexy is absent.
- *Either* CSF hypocretin-1 concentration has not been measured *or* CSF hypocretin-1 concentration, is either > 110 pg/mL or >1/3 of mean normal values with the same standardized assay.
<table>
<thead>
<tr>
<th></th>
<th>PSG REM Latency</th>
<th>Mean Sleep Latency on MSLT</th>
<th># SOREM’s on MSLT</th>
<th>CSF Hypocretin-1 Concentration</th>
<th>Cataplexy</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>12 minutes</td>
<td>6 minutes</td>
<td>1</td>
<td>not obtained</td>
<td>no</td>
</tr>
<tr>
<td>B.</td>
<td>62 minutes</td>
<td>7.5 minutes</td>
<td>3</td>
<td>112 pg/mL</td>
<td>yes</td>
</tr>
<tr>
<td>C.</td>
<td>27 minutes</td>
<td>2 minutes</td>
<td>2</td>
<td>100 pg/mL</td>
<td>no</td>
</tr>
<tr>
<td>D.</td>
<td>17 minutes</td>
<td>9 minutes</td>
<td>2</td>
<td>not obtained</td>
<td>no</td>
</tr>
</tbody>
</table>

**Choice A** has no cataplexy and normal hypocretin-1 in the setting of an MSL ≤8 and 2 SOREM’s (one is in the PSG) consistent with narcolepsy type 2.

**Choice B** has cataplexy making it consistent with narcolepsy type 1.

**Choice C** has CSF hypocretin ≤110 making it consistent with narcolepsy type 1.

**Choice D** has an MSL >8 making it inconsistent with narcolepsy.

Join colleagues from around the region to gain access to the CHEST learning and training experience at our regional congress. This unique program will go beyond the classroom-style setting to connect you to leading experts who will teach and develop you and your team.

Learn More: athens.chestnet.org