Sleep Diagnostic Dilemmas
and PSG Puzzlers

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Conflict of Interest Disclosure

• Aneesa Das, MD
  – Uptodate Royalties

• David Schulman, MD
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• 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

A abrupt beginning

Rhythmic waveforms
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.
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
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 muscle tone in REM sleep (disrupted REM atonia)?

A. bupropion
B. clonazepam
C. donepezil
D. fluoxetine
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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
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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
A 43 yo female referred for evaluation of chronic insomnia. She undergoes complete evaluation and therapy is initiated. Due to snoring and continued 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
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A. stimulus control therapy
B. mirtazapine
C. temazepam
D. diphenhydramine
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 using standard AASM protocol 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>
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A. 2 minutes  
B. 10 minutes  
C. 3.3 minutes  
D. 7.5 minutes
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No nap counts as the full 20 minutes

\[(3 + 5 + 2 + 20 + 20) / 5 = 10\]
A. Sweat artifact
B. Delta waves
C. Muscle artifact
D. Electrode popping
What is the best description of the findings in this epoch?

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

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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)
- 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
Electrode Popping
REM RULES
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

Stage R

x  y  z
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

Which of the following represents x,y,z?

C4-M1
O2-M1
REM
E1-M2
K complex
E2-M2
EMG

Stage R

x
y
z
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

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

Stage R  

<p>| | | |</p>
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<tr>
<td>C4-M1</td>
<td>arousal</td>
<td></td>
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<tr>
<td>O2-M1</td>
<td>RE</td>
<td>K complex</td>
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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
Scoring Rule!

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

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<th>Mean Sleep Latency on MSLT</th>
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<td>12 minutes</td>
<td>6 minutes</td>
<td>1</td>
<td>not obtained</td>
<td>no</td>
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<td>B.</td>
<td>62 minutes</td>
<td>7.5 minutes</td>
<td>3</td>
<td>112 pg/mL</td>
<td>yes</td>
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<td>C.</td>
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Narcolepsy Diagnostic Criteria

At least 3 months of excessive daytime sleepiness not otherwise explained

**Narcolepsy Type 1**

- Cataplexy *and* 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.)

  OR

- CSF hypocretin-1 concentration, is either $\leq 110$ 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 ≤ 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.)
- 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.

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**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

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