The International Franco - Palestinian Congress in Sleep Medicine

“Temporomandibular Disorders and Sleep Apnea”

26 and 27 October, 2017
Notre Dame Hotel, Jerusalem
Polysomnography Reports – Interpreting the Data

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Goals

• Common report parameters
• Normal values
• Presentation options
• Interpretations
American Academy of Sleep Medicine (AASM) recommended report parameters

• General parameters – usually standard from one study to another
  • EEG Derivations, scoring leads or additional leads
  • EOG derivations
  • Chin and leg EMG
  • Airflow sensors
  • Respiratory effort transducers
  • Oximeter
  • Body position
  • ECG
  • Other sensors (esophageal pH, Et or TcCO2)
American Academy of Sleep Medicine (AASM) recommended report parameters

• Sleep Scoring Data
  • Lights out and Lights on times (hr:min)
  • Total recording time (TRT; time between lights out and lights on in minutes; TBT or TIB)
  • Total Sleep Time (TST in minutes)
    • Time in N1, N2, N3, R (in minutes)
  • Sleep Efficiency percent (100 * TST/TRT)
    • Percent TST N1, N2, N3, R (100 *N1/TST, etc.)
American Academy of Sleep Medicine (AASM) recommended report parameters

• Sleep Scoring Data
  • Sleep Latency (SL; time from lights out to sleep onset epoch, first of any sleep stage epoch)
  • Stage R latency (REM sleep latency; time from sleep onset epoch to first REM epoch in minutes)
  • Wake after sleep onset (WASO; TRT-SL-TST)
Normal Sleep Architectural Data

• Sleep efficiency & latency
  • Normal 80-85% efficient
  • WASO <1-20% of TBT
  • Sleep Latency 20-30 min, REM latency 60-120 min

• Sleep stages & architecture
  • Normal about 5% stage N1, 50% N2, 20% N3 (slow wave sleep) and 20-25% REM
    • Most N3 sleep first ½; most REM in last ½
  • Normal AI < 10-25 (large variation by age)
    • These values are approximate. There is variability based on age, resource.
Normal arousals and sleep stage distributions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>18-20</th>
<th>21-30</th>
<th>31-40</th>
<th>41-50</th>
<th>51-60</th>
<th>61-70</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arousals</td>
<td>80±27</td>
<td>83±33</td>
<td>116±44</td>
<td>109±29</td>
<td>128±40</td>
<td>130±42</td>
</tr>
<tr>
<td>ArI</td>
<td>10.6±4.0</td>
<td>10.8±4.6</td>
<td>16.8±6.2</td>
<td>16.5±5.6</td>
<td>21.9±8.9</td>
<td>21.9±6.8</td>
</tr>
<tr>
<td>TST</td>
<td>439</td>
<td>446</td>
<td>403</td>
<td>395</td>
<td>358</td>
<td>350</td>
</tr>
<tr>
<td>%N1</td>
<td>7</td>
<td>9</td>
<td>12</td>
<td>14</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>%N2</td>
<td>52</td>
<td>54</td>
<td>52</td>
<td>50</td>
<td>45</td>
<td>46</td>
</tr>
<tr>
<td>%N3</td>
<td>19</td>
<td>13</td>
<td>7</td>
<td>7</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>%R</td>
<td>18</td>
<td>19</td>
<td>18</td>
<td>14</td>
<td>17</td>
<td>15</td>
</tr>
<tr>
<td># Awakenings</td>
<td>21.5</td>
<td>21.9</td>
<td>29.8</td>
<td>34.7</td>
<td>43.3</td>
<td>42</td>
</tr>
<tr>
<td>TBT</td>
<td>480</td>
<td>480</td>
<td>480</td>
<td>480</td>
<td>465</td>
<td>456</td>
</tr>
<tr>
<td>SE %</td>
<td>95.1</td>
<td>94.6</td>
<td>88</td>
<td>85.3</td>
<td>79.2</td>
<td>80.7</td>
</tr>
</tbody>
</table>

## Sleep Architectural Data in Table

<table>
<thead>
<tr>
<th>Sleep Architecture</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lights Out</td>
<td>9:47:00 PM</td>
</tr>
<tr>
<td>Lights On</td>
<td>5:50:00 AM</td>
</tr>
<tr>
<td>Total recording time</td>
<td>483 min</td>
</tr>
<tr>
<td>Sleep period time</td>
<td>482 min</td>
</tr>
<tr>
<td>Total sleep time</td>
<td>450 min</td>
</tr>
<tr>
<td>Sleep efficiency</td>
<td>93.2%</td>
</tr>
<tr>
<td>Sleep latency</td>
<td>1.0 min</td>
</tr>
<tr>
<td># Awakenings (after sleep onset)</td>
<td>20</td>
</tr>
<tr>
<td>WASO</td>
<td>32 min</td>
</tr>
<tr>
<td>REM periods</td>
<td>4</td>
</tr>
<tr>
<td>REM latency</td>
<td>95 min</td>
</tr>
</tbody>
</table>
Graph of data for sleep stage distribution

Stage distribution (in min)

Sleep stage (%TST)

* This could also be presented in tabular data as in the previous slide
American Academy of Sleep Medicine (AASM) recommended report parameters

• Abnormal event data
  • Cardiac Events
  • Arousal Events
  • Movement Events
  • Respiratory Events
American Academy of Sleep Medicine (AASM) recommended report parameters

• Cardiac Events
  • Mean heart rate (HR) in sleep
  • Highest HR in sleep
  • Highest HR in recording
  • Bradycardia < 40 bpm for >30 seconds, yes/no (Y/N), if Y, report lowest rate
  • Asystole (> 3 seconds), Y/N, if Y, report longest pause
  • Sinus tachycardia in sleep (> 90 bpm for > 30 seconds, Y/N, if Y fastest rate
American Academy of Sleep Medicine (AASM) recommended report parameters

• Cardiac Events
  • Narrow complex tachycardia (3 or more beats > 100 bpm with QRS < 0.12 sec). No reporting characteristics recommended such as duration, fastest rate
  • Wide complex tachycardia (3 or more beats > 100 bpm with QRS ≥ 0.12 sec). No reporting characteristics recommended such as duration, fastest rate
  • Atrial fibrillation, Y/N report mean HR if present
  • Other significant arrhythmia, list if observed
American Academy of Sleep Medicine (AASM) recommended report parameters

• Arousal events
  • Number of arousals
  • Arousal Index (ArI; # of arousals per hour of sleep or # of arousals * 60/TST in minutes)
Arousal table

<table>
<thead>
<tr>
<th>Arousals</th>
<th>Resp. Count</th>
<th>Resp. Index</th>
<th>Spontaneous Count*</th>
<th>Spontaneous Index*</th>
<th>Total Count</th>
<th>Total Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total sleep time</td>
<td>153</td>
<td>57.0</td>
<td>25</td>
<td>9.3</td>
<td>178</td>
<td>66.3</td>
</tr>
<tr>
<td>Non-REM</td>
<td>141</td>
<td>60.2</td>
<td>25</td>
<td>10.7</td>
<td>166</td>
<td>70.9</td>
</tr>
<tr>
<td>REM</td>
<td>12</td>
<td>35.1</td>
<td>0</td>
<td>0.0</td>
<td>12</td>
<td>35.1</td>
</tr>
</tbody>
</table>

* EEG Arousal activity not associated with Respiratory or PLM events.

BODY-POSITION RESULTS

![Graph showing body position results](image)

Duration (min)  
- Supine: 160.8 min  
- Prone: 0.0 min  
- Left-Side: 0.0 min  
- Right-Side: 0.0 min  
- Upright: 0.0 min

% TST  
- Supine: 99.9%  
- Prone: 0.1%  
- Left-Side: 0.0%  
- Right-Side: 0.0%  
- Upright: 0.0%
American Academy of Sleep Medicine (AASM) recommended report parameters

• Movement events
  • Number of periodic limb movements (PLMS or PLM)
  • Number of PLMS with arousals (PLMSAr or PLMAr)
  • PLMS index (PLMSI (PLMI); PLMS per hour of sleep, or 60 x PLMS/TST in minutes)
  • PLMS arousal index (PLMSArI (PLMArI); PLMS per hour of sleep, or 60 x PLMS/TST in minutes)
Abnormal Movement Disturbance

- PLMI > 15 in adults
- Bruxism ≥ 2 events with audible sound and polysomnographic evidence
- RBD no consensus concerning the number of REM epochs without atonia
- Restless Legs Syndrome – wake events not meeting limb movement scoring criteria
  - Key is history and observation with PSG as corroborative evidence.
American Academy of Sleep Medicine (AASM) recommended report parameters

• Respiratory events
  • Number of Apneas (A)
    • Number of Obstructive Apneas (OA)
    • Number of Mixed Apneas (MA)
    • Number of Central Apneas (CA)
  • Number of Hypopneas (H)
    • Number of Obstructive Hypopneas (OH)
    • Number of Mixed Hypopneas (MH) - optional
    • Number of Central Hypopneas (CH) – optional
  • Number of Apneas and Hypopneas (A+H)
American Academy of Sleep Medicine (AASM) recommended report parameters

• Respiratory events
  • Apneas index (AI; (OA+MA+CA) x 60/TST)
    • Obstructive Apnea Index (OAI)
    • Mixed Apnea Index (MAI)
    • Central Apnea Index (CAI)
  • Hypopneas index (HI; (OH+MH+CH) x 60/TST)
    • Obstructive Hypopnea Index (OHI)
    • Mixed Hypopneas (MH) - optional
    • Central Hypopneas (CH) – optional
  • Apneas-Hypopneas (AHI); (OA+MA+CA+OH+MH+CH) x 60/TST)
American Academy of Sleep Medicine (AASM) recommended report parameters

• Respiratory events
  • Obstructive apnea-hypopnea index (OAHI; (OA+OH) x 60/TST) - optional
  • Central apnea-hypopnea index (CAHI; (CA+CH) x 60/TST) – optional
  • Number of Respiratory Effort Related Arousals (RERAs) – optional
  • RERA index (RERAs x 60/TST) – optional
  • Respiratory Disturbance Index (RDI; (Apneas + Hypopneas + RERAs) x 60/TST) – optional
American Academy of Sleep Medicine (AASM) recommended report parameters

• Respiratory events
  • Number of oxygen desaturations (≥3% or ≥4%)
  • Oxygen desaturation index (ODI; # of oxygen desaturations ≥3% or ≥4% x 60/TST)
  • Mean arterial saturation
  • Minimum arterial saturation during sleep
  • Presence of hypoventilation during diagnostic
    • Adults – optional
    • Children - recommended
American Academy of Sleep Medicine (AASM) recommended report parameters

• Respiratory events
  • Presence of hypoventilation during PAP titration
    • Adults – optional
    • Children – optional
  • Occurrence of Cheyne-Stokes breathing (CSB) in adults – recommended
    • Duration of CSB (absolute or percentage of TST) or number of CSB events – recommended
  • Occurrence of periodic breathing in children - recommended
  • Occurrence of snoring - optional
Respiratory Disturbance

- AHI (adult)
  - AHI < 5 normal
  - AHI 5 – 15 mild
  - AHI 15 – 30 moderate
  - AHI > 30 severe

- AHI (pediatric)
  - AHI < 1 normal
  - AHI 1-5 mild
  - AHI 5 – 10 moderate
  - AHI > 10 severe
Respiratory event tables

<table>
<thead>
<tr>
<th>Respiratory events</th>
<th>Cen. Apneas</th>
<th>Obs. Apneas</th>
<th>Mxd. Apneas</th>
<th>Hypopneas</th>
<th>Total Apneas</th>
<th>Apnea+ Hypopnea</th>
<th>RERA</th>
<th>All Resp. Events *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count</td>
<td>0</td>
<td>52</td>
<td>0</td>
<td>155</td>
<td>52</td>
<td>207</td>
<td>0</td>
<td>207</td>
</tr>
<tr>
<td>Index (events/hr)</td>
<td>0.0</td>
<td>19.4</td>
<td>0.0</td>
<td>57.8</td>
<td>19.4</td>
<td>77.1</td>
<td>0.0</td>
<td>77.1</td>
</tr>
<tr>
<td>Mean duration (sec)</td>
<td>N/A</td>
<td>29.4</td>
<td>N/A</td>
<td>24.0</td>
<td>29.4</td>
<td>25.3</td>
<td>N/A</td>
<td>25.3</td>
</tr>
<tr>
<td>Longest event (sec)</td>
<td>N/A</td>
<td>66.1</td>
<td>N/A</td>
<td>81.9</td>
<td>66.1</td>
<td>81.9</td>
<td>N/A</td>
<td>81.9</td>
</tr>
<tr>
<td>REM count</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td>7</td>
<td>10</td>
<td>17</td>
<td>0</td>
<td>17</td>
</tr>
<tr>
<td>Non-REM count</td>
<td>0</td>
<td>42</td>
<td>0</td>
<td>148</td>
<td>42</td>
<td>190</td>
<td>0</td>
<td>190</td>
</tr>
<tr>
<td>REM index</td>
<td>0.0</td>
<td>29.3</td>
<td>0.0</td>
<td>20.5</td>
<td>29.3</td>
<td>49.8</td>
<td>0.0</td>
<td>49.8</td>
</tr>
<tr>
<td>Non-REM index</td>
<td>0.0</td>
<td>17.9</td>
<td>0.0</td>
<td>63.2</td>
<td>17.9</td>
<td>81.1</td>
<td>0.0</td>
<td>81.1</td>
</tr>
</tbody>
</table>

* Note: Does not contain Cheyne Stokes Breathing, Hypoventilation, or Periodic Breathing.
## Oxygen saturation tables

<table>
<thead>
<tr>
<th>Oxygen saturation</th>
<th>Wake</th>
<th>Non-REM</th>
<th>REM</th>
<th>TST</th>
<th>TIB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. SpO₂%</td>
<td>100.0</td>
<td>99.0</td>
<td>99.0</td>
<td>99.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Mean SpO₂%</td>
<td>89.7</td>
<td>90.6</td>
<td>80.0</td>
<td>89.3</td>
<td>89.3</td>
</tr>
<tr>
<td>Min. SpO₂%</td>
<td>51.0</td>
<td>57.0</td>
<td>54.0</td>
<td>54.0</td>
<td>51.0</td>
</tr>
<tr>
<td>SpO₂% ≤ 89% (min)</td>
<td>0.1</td>
<td>49.3</td>
<td>14.5</td>
<td>63.8</td>
<td>67.7</td>
</tr>
</tbody>
</table>

### % Time in range

<table>
<thead>
<tr>
<th>Range</th>
<th>Wake</th>
<th>Non-REM</th>
<th>REM</th>
<th>TST</th>
<th>TIB</th>
</tr>
</thead>
<tbody>
<tr>
<td>90%–100%</td>
<td>36.7%</td>
<td>59.6%</td>
<td>26.6%</td>
<td>55.4%</td>
<td>53.0%</td>
</tr>
<tr>
<td>80%–89%</td>
<td>12.7%</td>
<td>35.3%</td>
<td>23.3%</td>
<td>33.7%</td>
<td>31.1%</td>
</tr>
<tr>
<td>70%–79%</td>
<td>1.0%</td>
<td>3.9%</td>
<td>23.9%</td>
<td>6.4%</td>
<td>5.7%</td>
</tr>
<tr>
<td>60%–69%</td>
<td>3.2%</td>
<td>0.8%</td>
<td>21.5%</td>
<td>3.4%</td>
<td>3.4%</td>
</tr>
<tr>
<td>50%–59%</td>
<td>1.0%</td>
<td>0.1%</td>
<td>4.7%</td>
<td>0.7%</td>
<td>0.8%</td>
</tr>
<tr>
<td>&lt;50%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>% Artifact/bad data</td>
<td>45.4%</td>
<td>0.4%</td>
<td>0.0%</td>
<td>0.3%</td>
<td>6.0%</td>
</tr>
</tbody>
</table>
American Academy of Sleep Medicine (AASM) recommended report parameters

- Abnormal Behavioral Observations
  - Other movement disorders
    - Bruxism
      - Sustained (tonic)
      - Rhythmic Masticatory Muscle Activity (phasic)
    - Rhythmic movements
      - Body rocking (Jactatio Corporis Nocturna)
      - Head banging (Jactatio Capitis Nocturna)
American Academy of Sleep Medicine (AASM) recommended report parameters

- Abnormal Behavioral Observations
  - Parasomnias
    - Sleep walking (somnambulism)
    - Night terrors (pavor nocturnis)
    - Confusional arousals
    - Sleep talking (somniloquy)
    - Nightmares (Dream Anxiety Attacks)
    - REM sleep behavior disorder (RBD)
    - Enuresis
    - Nocturnal seizures
American Academy of Sleep Medicine (AASM) recommended report parameters

- Summary statements/comments
  - Findings related to the sleep diagnosis/diagnoses
  - EEG abnormalities if present
  - ECG abnormalities if present
  - Abnormal behavioral observations if present
    - Most likely from the technologist summary and notes
  - A sleep histogram (hypogram) - optional
Technologist Comments

A PSG report includes the attending and scoring technologist’s comments

• These key individuals, who have spent the most time with the patient and the data, can add further insight into the study

• Examples may include:
  • an account of the patient’s physical and emotional status
  • a description of audible breathing or snoring sounds
  • any atypical findings that are not evident in the routine tabulation of sleep stages and events, such as alpha sleep, medication effects on the EEG, atypical motor activity during REM sleep, parasomnia-like activity, or any other pertinent observations
    • This type of information is generally intended for the reading physician only, and should not be distributed to insurers, referral sources, or DME/homecare vendors
Hypnogram

• A picture is indeed worth a thousand words
  • Allows the interpreter to get an overview of the entire night
  • Show the relationship between sleep stages, body position, abnormal events (apnea, hypopnea, saturation), limb movements, arousals, treatment levels
  • Excellent tool for sharing information with patients helping them to understand the pathology and the results of therapy
Sleep Histogram

Hyponogram

Respiratory Events

SpO2%

CPAP / Bi-level (IPAP / EPAP)

Limb Movement Events
The Dictated Summary

The dictated sleep study summary should be presented in an orderly manner and include:

- Findings related to sleep diagnosis
  - Patient history and indications for the study
  - A description of the monitoring parameters and recording montage
- A description of the sleep architecture
- Respiratory events and O$_2$ saturation levels
- Periodic limb movements
- Arousals

*Note that much of the report can be obtained from the information derived directly from the demographics and the recording analysis of the sleep study and populated into the narrative summary.
The Dictated Summary

• Cardiac events, if present
• Other events (EEG abnormalities, parasomnias/behavioral observations), if present
• Impression
  • Diagnosis(es) with ICD-10 code(s), perhaps include degree of severity
• Comments, if applicable
• Recommendations
  • Medications, PAP and modality, pressure
  • Titration study, additional sleep studies
  • Follow-up
  • Precautionary statements
The process

• Review the patient history and complaint
• Review the comments and technologist notes
• Review the hypnogram
• View the raw data!!!
• Look at the tabular data (does it make sense with what you saw in the raw data)
  • Scoring mistakes can be made
  • Data tabulation errors could have occurred when the reports are developed
Final thoughts

- Make the report tool friendly to your needs
  - New equipment, new software, software update may be good times to do report revisions
  - Multiple report types (Diagnostic, Titration, Split protocol)
  - Different version of report for interpreter, referral source, DME, Insurer?

- If you get new equipment, software, or reports – test it for accuracy
  - Run some dummy data or dead air and do some fictitious scoring of stage and events and be sure the reports are following accurately.
References

