Polysomnography and Polygraphy

Raphael Heinzer
Werner Strobel
Which type of study?

<table>
<thead>
<tr>
<th></th>
<th>Type 1</th>
<th>Type 2</th>
<th>Type 3</th>
<th>Type 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of leads</td>
<td>≥7</td>
<td>≥7</td>
<td>≥4</td>
<td>1–2#</td>
</tr>
<tr>
<td>Types of leads</td>
<td>EEG, EOG, EMG, ECG, airflow, effort, oximetry</td>
<td>EEG, EOG, EMG, ECG, airflow, effort, oximetry</td>
<td>ECG, airflow, effort, oximetry (at least two channels are respiratory movements or respiratory movement and airflow)</td>
<td>Oximetry and other (usually airflow)</td>
</tr>
<tr>
<td>Setting</td>
<td>Objectively measured Attended (usually in a sleep centre)</td>
<td>Optional Unattended</td>
<td>Optional Attended or unattended</td>
<td>Not measured Attended or unattended</td>
</tr>
<tr>
<td>Description</td>
<td>Standard PSG performed in a sleep laboratory (reference standard to which the other monitors are compared)</td>
<td>Comprehensive portable PSG</td>
<td>Portable testing limited to sleep apnoea</td>
<td>Continuous recording of 1–2 signals</td>
</tr>
</tbody>
</table>

EEG: electroencephalogram; EOG: electrooculogram; EMG: electromyogram; PSG: polysomnography. #: sometimes type 4 may measure ≥3 parameters, but does not meet all the criteria of a higher category. Modified from [35].

**PSG: the newest reference of OFSP / BAG**

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Les canaux standards sont les suivants :
- au minimum 2 canaux EEG (avec mesure de l'impédance)
- 2 canaux EOG (électro-oculographie)
- 1 canal EMG (électro-myographie) au niveau du menton
- au minimum 1 canal EMG pour le muscle tibial antérieur
- enregistrement de la position
- oxymétrie de pouls transcutanée
- effort respiratoire thoracique et abdominal
- flux respiratoire (qualitatif)
- ronflement (enregistrement microphonique ou autre)
- ECG (électro-cardio-gramme)
- surveillance vidéo et par microphone avec enregistrement

Not further specified on Tarmed, KLV. Legally only few regulations or specifications for performing PSG’s

Cited from the Swiss Sleep Society 2001 (!!), on the actual website of OFSP / BAG
Polygraphie: how it should be done by ENT doctors according to OFSP / BAG


Improved Watchpat™ from 2017 acceptable?

Schweizerische Gesellschaft für Otorhinolaryngologie 2015, source document on the website of BAG / OFSP
Recommended Reading

Journal of Clinical Sleep Medicine, Vol. 8, No. 5, 2012, p 597-619
How are you scoring?

- 2012 Rules?
- 2007 Rules?
- Chicago 1999?
- Your own Rules?

Do you mention it on the report?
How are you scoring?

2012 Rules

- 2007 Rules?
- Chicago 1999?
- Your own Rules?

Mention it on the report!
### Recommended sensors

#### Table 2—Recommended sensors for routine respiratory monitoring

<table>
<thead>
<tr>
<th>Respiratory Parameter</th>
<th>Sensor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airflow (use both oronasal thermal flow sensor and nasal pressure transducer during diagnostic study)</td>
<td>• Oronasal thermal airflow sensor* (to score apnea in diagnostic study)</td>
</tr>
<tr>
<td></td>
<td>• Nasal pressure transducer** (to score hypopnea in diagnostic study)</td>
</tr>
<tr>
<td></td>
<td>• PAP device flow signal (to score apneas and hypopneas in PAP titration study)</td>
</tr>
<tr>
<td>Respiratory Effort (select one)</td>
<td>• Esophageal manometry</td>
</tr>
<tr>
<td></td>
<td>• Dual thoracoabdominal RIP belts***</td>
</tr>
<tr>
<td></td>
<td>• Dual thoracoabdominal PVDF belts</td>
</tr>
<tr>
<td></td>
<td>[Acceptable] in adults</td>
</tr>
<tr>
<td>Oxygen Saturation</td>
<td>Pulse oximetry</td>
</tr>
</tbody>
</table>
# Alternative sensors

<table>
<thead>
<tr>
<th>Respiratory Event</th>
<th>Sensor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apnea (select one)</td>
<td>• Nasal pressure transducer*</td>
</tr>
<tr>
<td></td>
<td>• RIPsum**</td>
</tr>
<tr>
<td></td>
<td>• RIPflow**</td>
</tr>
<tr>
<td></td>
<td>• PVDFsum</td>
</tr>
<tr>
<td></td>
<td>[Acceptable] in adults</td>
</tr>
<tr>
<td></td>
<td>• End-tidal PCO₂</td>
</tr>
<tr>
<td></td>
<td>[Acceptable] in children</td>
</tr>
<tr>
<td>Hypopnea (select one)</td>
<td>• Oronasal thermal airflow sensor***</td>
</tr>
<tr>
<td></td>
<td>• RIPsum**</td>
</tr>
<tr>
<td></td>
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</tr>
</tbody>
</table>
10 seconds is 10 seconds

Apnoea and hypopnoea start «from the nadir preceding the first breath that is clearly reduced to the beginning of the first breath that approximates baseline breathing amplitude»
Scoring apneas

- Drop in peak signal excursion by ≥ 90 % of pre-event baseline (ideally using an oronasal thermal sensor)
- The duration of the ≥ 90 % drop in sensor signal is ≥ 10 sec

→ no desaturation needed, no arousal needed

Note: if a portion of a respiratory event that would otherwise meet criteria for hypopnea meets criteria for apnea, the entire event should be scored as an apnea. The duration of the event is from the nadir in flow to the start of the first breath that approximates baseline breathing (new)
Apnea?

17 sec
4 Central apneas? Bradypnea?

11 sec
Apnoea?
Obstructive Apneas (and 1 mixed apnea)
What is the difference?
Obstructive ? Central ? Mixed ?

No clear definition of the minimum or maximum length of the obstructive part in mixed apnea !!
Scoring Hypopnoeas

- peak signal excursion drops by ≥ 30 % from baseline (preferably nasal pressure) **AND**
- the duration of the ≥ 30 % drop is ≥ 10 sec **AND**
- there is a ≥ 3 % oxygen desaturation from pre-event baseline **OR** the event is associated with an arousal
2007 Hypopnea  2012

- Nasal pressure signal drop by ≥ 30% from baseline
- Duration of this drop for ≥ 10 sec
- ≥ 4% O₂ desaturation from pre-event baseline

Alternative

- Nasal pressure signal drop by ≥ 50% from baseline
- Duration of this drop for ≥ 10 sec
- ≥ 3% O₂ desaturation from pre-event baseline or event associated with an arousal

- Nasal pressure signal drop by ≥ 30% from baseline
- Duration of this drop for ≥ 10 sec
- ≥ 3% O₂ desaturation from pre-event baseline or event associated with an arousal
To differentiate between obstructive and central hypopnoeas

For an obstructive hypopnoea at least one of the following criteria must be met:

- Snoring **during** the event
- Increased inspiratory flattening of the nasal pressure device compared to baseline
- Thoracoabdominal paradox occurs during the event but not during pre-event breathing

For a central hypopnoea, none of these criteria must be present
> 10 sec
Nasal pressure ↓
≥ 3 % Desat.
Hypopnoea

> 10 sec
Nasal pressure ↓
≤ 3 % Desat.
??
> 10 sec  
Nasal pressure ↓  
≥ 3 % Desat.  
Hypopnoea

> 10 sec  
Nasal pressure ↓  
no Desat.  
no Arousal  
No Hypopnoea
Hypopnea?

Length > 10 sec
30 % drop in nasal pressure ???
Only 2 % saturation drop!
✓ Length
- Amplitude
- Desaturation
✓ Arousal
→ no hypopnea
Apnea?

Dropped bei 30 % from baseline?
Hypopneas? Length > 10 sec Decreased amplitude? Arousal??
Cheyne-Stokes-Respiration

Score as CSR, if there are

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

And

- ≥ 5 central apneoas / hypopnoeas per hour of sleep over 2 hours of monitoring
Cheyne-Stokes-Breathing?
Cheyne-Stokes-Breathing?

Cycle length 38 – 46 sec
No crescendo – decrescendo pattern
→ No Cheyne-Stokes-Breathing
Cheyne-Stokes-Breathing?

Cycle length ≈ 20 sec «apneas» partially < 10 sec
Central hypopnoeas?

- Length > 10 sec
- Flow reduced
- No desaturation → Arousal?
- No snoring
- No flattening
- No thoracoabdominal paradox
42 years old, female, daytime somnolence, ESS 14. BMI 42 kg/m²

Obstructive sleep apnea with REM-hypoventilation?

Bilevel ventilation?

- Interstitial lung disease
- Daytime PaCO₂ 4.3 KPa
- Nocturnal capnography: peak TcCO₂ 6.3 KPa
Scoring Hypoventilation

Score hypoventilation if either

• There is an increase in the arterial PaCO$_2$ (or TcCO$_2$) to a value $> 7.3$ KPa for $\geq 10$ minutes

OR

• There is $\geq 1.3$ KPa increase in PaCO$_2$ (or surrogate) during sleep (in comparison to an awake supine value) to a value $\geq 6.6$ KPa for $\geq 10$ min

→ no hypoventilation without CO$_2$-monitoring
Bad or missing signal: what are you doing?
Is the x-flow helpful?

All events > 10 sec
All events with desaturation > 3 %
No snoring, no paradox breathing
Apnea vs. hypopnea: difficult → score as hypopnea ??