Diagnostic methods (Portable)

Prof. Dr. Zoran Đogaš, MD, PhD
Portable (Sleep Apnea) Monitoring

PANDORA'S CARRY-ON
The standard approach to diagnosing OSA is in-laboratory, technician-attended, polysomnography.

Portable monitoring (PM) has been proposed as a substitute for polysomnography in the diagnostic assessment of patients with suspected OSA.

PM requires less technical expertise, is less labor intensive and time consuming, and is easier for patients to access.
TERMINOLOGY

The term *portable monitoring* encompasses a wide range of devices that can record as many signals as does attended polysomnography or only 1 signal, such as oximetry.
The European Sleep Research Society (ESRS) has made the recommendations in its

**Standard procedures for adults in accredited Sleep Medicine Centres in Europe**

*Jürgen Fischer, Zoran Dogas, Claudio L. Bassetti, et al., Journal of Sleep Research, 2012*
Standard procedures for adults in accredited sleep medicine centres in Europe

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SUMMARY The present paper describes standardized procedures within clinical sleep medicine. As such, it is a continuation of the previously published European guidelines for the accreditation of sleep medicine centres and European guidelines for the certification of professionals in sleep medicine, aimed at creating standards of practice in European sleep medicine. It is also part of a broader action plan of the European Sleep Research Society, including the process of accreditation of sleep medicine centres and certification of sleep medicine experts, as well as publishing the Catalogue of Knowledge and Skills for sleep medicine experts (physicians, non-medical health care providers, nurses and technologists), which will be a basis for the development of relevant educational curricula. In the current paper, the standard operational procedures sleep medicine centres regarding the diagnostic and therapeutic management of patients evaluated at sleep medicine centres, accredited according to the European Guidelines, are based primarily on prevailing evidence-based medicine principles. In addition, parts of the standard operational procedures are based on a formalized consensus procedure applied by a group of Sleep Medicine Experts from the European National Sleep Societies. The final recommendations for standard operational procedures are categorized either as ‘standard practice’, ‘procedure that could be useful’, ‘procedure that is not useful’ or ‘procedure with insufficient information available’. Standard operational procedures described here include both subjective and objective testing, as well as recommendations for follow-up visits and for ensuring patients’ safety in sleep medicine. The overall goal of the actual standard operational procedures is to further develop excellence in the practice and quality assurance of sleep medicine in Europe.

KEYWORDS sleep medicine centres, standard procedure, sleep medicine
Polygraphy (portable monitoring)

Polygraphy (PG or portable monitoring) has four to eight channels of physiological data, but EEG is not recorded. The minimum set of channels comprises O$_2$-saturation, airflow, breathing effort, heart rate and body position. It is particularly useful for the diagnosis of obstructive sleep apnoea without significant comorbid condition (Collop et al., 2007; Kushida et al., 2005; Mayer et al., 2009; Ndegwa et al., 2009). It is not useful for the diagnosis of other sleep disorders. It has to be performed by trained and certified medical sleep specialists. Manual scoring is mandatory. Equivocal test results require the subsequent performance of full polysomnography as a standard practice. The final outcome is a report, as described in the European Guidelines for Accreditation of SMCs (Pevernagie et al., 2006) (+).

From: Jürgen Fischer, Zoran Dogas, Claudio L. Bassetti, et al., Journal of Sleep Research, 2012
The American Academy of Sleep Medicine (AASM) has made the recommendations in its Practice Parameters for Polygraphy/Portable Monitoring.

The practice parameters are a guide to the appropriate use of polygraphy as a diagnostic tool for the evaluation of sleep breathing disorders.
Practice Parameters for the Use of Portable Monitoring Devices in the Investigation of Suspected Obstructive Sleep Apnea in Adults

A joint project sponsored by the American Academy of Sleep Medicine, the American Thoracic Society, and the American College of Chest Physicians

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• American Academy of Sleep Medicine
• The American Thoracic Society
• The American College of Chest Physicians

PORTABLE MONITORING DEVICES

Using a categorization of sleep monitoring procedures in which Type 1 is standard attended in-lab polysomnography (PSG), PMs are categorized into 3 types:

Type 2 - comprehensive portable polysomnography;

Type 3 - modified portable sleep apnea testing (also referred to as cardiorespiratory sleep studies); and

Type 4 - continuous single or dual bioparameter recording.
<table>
<thead>
<tr>
<th>Type of Portable Monitoring Device</th>
<th>Parameters Measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 2</td>
<td>Polysomnography Minimum of 7 channels, including electroencephalogram, electrooculogram, chin electromyogram, electrocardiogram or heart rate, airflow, respiratory effort, and oxygen saturation</td>
</tr>
<tr>
<td>Comprehensive Portable</td>
<td></td>
</tr>
<tr>
<td>Type 3</td>
<td>Minimum of 4 channels monitored, including ventilation or airflow (at least 2 channels of respiratory movement, or respiratory movement and airflow), heart rate or electrocardiogram, and oxygen saturation</td>
</tr>
<tr>
<td>Modified Portable Sleep ApneaTesting</td>
<td></td>
</tr>
<tr>
<td>Type 4</td>
<td>One or 2 channels, typically including oxygen saturation or airflow</td>
</tr>
<tr>
<td>Continuous Single or Dual Bioparameters</td>
<td></td>
</tr>
</tbody>
</table>
AASM Diagnostic Device Classes

- Level IV: 1 or 2 channels, Screening
- Level III: Polygraphy
- Level II: Portable Polysomnography
- Level I: Stationary Polysomnography including Video
AASM Diagnostic Device Classes

- Type IV: 1 or 2 channels, Screening
- Type III: Polygraphy
- Type II: Portable Polysomnography
- Type I: Stationary Polysomnography including Video

Terminology:
Portable, Ambulatory, Out-of-Sleep Lab, etc.
### Table 3—Levels of Evidence

<table>
<thead>
<tr>
<th>Level of Evidence</th>
<th>Study Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Blinded comparison, consecutive patients, reference standard performed on all patients</td>
</tr>
<tr>
<td>II</td>
<td>Blinded comparison, nonconsecutive patients, reference standard performed on all patients</td>
</tr>
<tr>
<td>II</td>
<td>Blinded comparison, consecutive patients, reference standard not performed on all patients</td>
</tr>
<tr>
<td>IV</td>
<td>Reference standard not applied blindly or independently</td>
</tr>
</tbody>
</table>

Adapted with permission from Sackett D. Rules of evidence and clinical recommendations for the management of patients. Can J Cardiol 1993;9:487-9 and [2.3.1].
Type 2 Monitors: “Mini-PSG”

Advantages
- Multiple channels
- Flexibility of signal type
- Comprehensive
- Use standard software of a base system
- Portability
- Extensive track-record in research applications

Disadvantages
- Tech hook up
- Expensive
- Probably no reimbursement for home PSG
- Loss of signal – no way to easily correct problem
An example: PG Unit

Channels of Basic Unit:

1. Thermistor Flow
2. Pressure Cannula Flow
3. Snoring via Pressure Cannula
4. Respiratory Effort Thorax, Inductance Plethysmography
5. Respiratory Effort Abdomen, Inductance Plethysmography
6. Oxygen Saturation
7. Puls Wave
8. Puls Rate
9. Body Position
10. Patient Marker
Type 3 Monitors: Cardio-respiratory studies

Advantage
- Easy to set up: easily done by most patients; technician not required
- Inexpensive (comparing to PSG devices)
- Very portable
- Reduced number of signals

Disadvantage
- Reduced number of signals
- Signal loss at home; not way to correct
- Requires scoring or at least overview of scoring by tech; takes longer than you think
Type 3 monitor recordings
Type 3 monitor recordings
# Report

<table>
<thead>
<tr>
<th>Gender:</th>
<th>M</th>
<th>Weight:</th>
<th>175 lbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth Date:</td>
<td>8/6/1956</td>
<td>Height:</td>
<td>55 in.</td>
</tr>
<tr>
<td>Patient Age:</td>
<td>51 years</td>
<td>Body Mass Index:</td>
<td>40.7</td>
</tr>
<tr>
<td>Patient ID:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Study Number:</td>
<td>459</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Study Date:</td>
<td>4/7/2008 at 11:55:46 PM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time in Bed (TIB):</td>
<td>307 minutes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Device Serial Number:</td>
<td>600000194</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stardust Type:</td>
<td>Stardust 1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Events

<table>
<thead>
<tr>
<th>Indices (#/hour)</th>
<th>Central Apneas</th>
<th>Obst Apneas</th>
<th>Mixed Apneas</th>
<th>Hypopneas</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total # of Events</td>
<td>0</td>
<td>86</td>
<td>0</td>
<td>120</td>
<td>206</td>
</tr>
<tr>
<td>Mean Dur (sec)</td>
<td>0</td>
<td>21.2</td>
<td>0</td>
<td>67.5</td>
<td>67.5</td>
</tr>
<tr>
<td>Max Dur (sec)</td>
<td>0</td>
<td>49</td>
<td>0</td>
<td>98</td>
<td>98</td>
</tr>
<tr>
<td>Supine (#)</td>
<td>0</td>
<td>76</td>
<td>0</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>Non-Supine (#)</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Dur</th>
<th>AHI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supine</td>
<td>181.5</td>
</tr>
<tr>
<td>Non-Supine</td>
<td>125.5</td>
</tr>
</tbody>
</table>

## Heart Rate

| Mean HR (BPM) | 64.8 |
| # of LHR | 65 |
| LHR min (BPM) | 30 |
| # of HHR | 5 |
| HHR max (BPM) | 98 |

## Oximetry

| <95 % (minutes) | 68 |
| <90 % (minutes) | 25 |
| <85 % (minutes) | 8.5 |
| <80 % (minutes) | 2.5 |
| <75 % (minutes) | 0 |
| <70 % (minutes) | 0 |
| <60 % (minutes) | 0 |
| <50 % (minutes) | 0 |
| <97 % (minutes) | 117.5 |
| Average (%) | 96 |
| Desat Index (#/hour) | 41.2 |
| Desat Max (%) | 29 |
| Desat Max dur (sec) | 56 |
| Lowest SpO₂ (≥ 2 sec) (%) | 72 |
| # Episodes (≥5 min) ≤ 88% | 0 |
| Longest dur (min) SpO₂ ≤ 88% | 0.6 |
WORKLOAD ACCORDING TO SOP PAPER

The workload comprises:

- admitting the patient by the medical specialist,
- preparation of the equipment, patient hook-up, and scoring of the record performed by the sleep technician.

- The sleep expert subsequently reviews the scoring, creates the report, and gives feedback to the patient.

- Attended PG requires continuous monitoring by trained technical and nursing staff for the duration of recording.

University of Split, School of Medicine; Department of Neuroscience
Type 4 Monitors: Oximetry +

Advantage
- Most portable
- Inexpensive
- Easy to set up
- Core signals: oxygenation and airflow
- Now may include PAT signal

Disadvantage
- No reimbursement
- Minimal number of signals – may not capture important aspects of some OSA
- Signal loss
Not typical devices...

- New technologies – how do they fit into the existing devices classification?
  - Example: principle of changes in peripheral arterial tonometry
  - Indirect measure of ANS activity
Source: SMC in Split, Croatia; Permanent apneas w/significant desaturations; Periodic breathing. Upper: Whole-night recordings; lower: 10-minute recordings
Source: SMC in Split, Croatia; Permanent apneas w/significant desaturations; Periodic breathing; 10-minutes recordings
Source: SMC in Split, Croatia; Permanent apneas w/significant desaturations; Periodic breathing; 5-minutes recordings
American Academy of Sleep Medicine (AASM)
Portable Testing Matrix of Device Classes

<table>
<thead>
<tr>
<th>Level II</th>
<th>Level III</th>
<th>Level IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehensive Portable Polysomnography</td>
<td>Modified Portable Sleep Apnea Testing</td>
<td>Single or Dual Bioparameter Recording</td>
</tr>
<tr>
<td>Minimum of 7 channels, including EEG, EOG, Chin EMG, ECG or Heart Rate, Airflow, Respiratory Effort, and Oxygen Saturation, Body Position, Leg EMG or Actigraphy Desired</td>
<td>Minimum of 4 channels, including Ventilation or Airflow (at least 2 channels of Respiratory Movement, or Respiratory Movement and Airflow), Heart Rate or ECG, and Oxygen Saturation</td>
<td>One or 2 channels, typically including oxygen saturation or airflow</td>
</tr>
</tbody>
</table>

The same device could be used at three different levels
Polygraphy (PG) has four to eight channels of physiological data, but EEG is not recorded. The minimum set of channels comprises $O_2$-saturation, airflow, breathing effort, heart rate, and body position. It is particularly useful for the diagnosis of obstructive sleep apnea without significant co-morbid condition. It is not useful for the diagnosis of other sleep disorders. It has to be performed by trained and certified medical sleep specialists. Manual scoring is mandatory. Equivocal test results require the subsequent performance of full polysomnography as a standard practice. The final outcome is a report as described in the European Guidelines for Accreditation of SMCs.
Pressure for alternative approaches to current recommended in-laboratory management of patients with OSA will continue to increase given the cost of PSG and the limited number of laboratory facilities relative to patient need. There is growing evidence that PSG and limited channel monitoring should be compared in terms of outcomes rather than a simple head to head clinical comparison. (Consensus)
BE ACTIVE!

Do not exchange S/W cycle!
Let’s go to Actigraphy!
Actigraphy

Prof. Dr. Zoran Đogaš, MD, PhD

University of Split, School of Medicine; Department of Neuroscience
ACTIGRAPHY

Actigraphy is a valid way to assess sleep-wake patterns in patients suspected of certain sleep disorders, but the method cannot fully be a substitute for polygraphy or polysomnography.
The term actigraphy refers to methods using miniaturized computerized wrist watch-like devices to monitor and collect data generated by movements.
An example of the actigraphy device...
TECHNOLOGY

Most actigraphs contain an analogue system to detect movements.

In some devices, a piezo-electric beam detects movement in two or three axes and the detected movements are translated to digital counts accumulated across pre-designed epoch intervals (e.g. 1 min) and stored in the internal memory.
MECHANICALLY, the first generation actigraphs were threshold-motion detectors, which were nonlinear and failed to be sensitive enough to detect small movements.

They also tended to saturate with modest levels of movement.

Some of the newer actigraphs detect motion with linear accelerometers in a single axis or multiple axes.
Most single axis acceleration devices in use today use 0.25 to 2-3 Hz bandpass filtering before data are stored (eliminating very slow movements of less than 0.25 Hz and movements faster than 2-3 Hz).

Redmond and Hegge noted that voluntary human movement rarely exceeds 3-4 Hz, and that involuntary movements such as tremor and shivering exceed 5 Hz.

van Someren et al. suggested using 0.5-11 Hz bandpass filters that would reduce gravitational artifacts while picking up some of the faster movements that occur in younger subjects.
TECHNOLOGY

The actigraph can collect data continuously over an extended period (1 week or longer).

Some devices are programmable and enable selection of specific modes of operation (e.g. variable movement frequency bandwidths, sensitivity levels or epoch intervals) whereas other devices have only one fixed mode.
Data transfer

Data are downloaded to the computer using special interface units or other forms of communication channels.
Scoring

The use of computer scoring algorithms without controlling for potential artifacts can lead to inaccurate or misleading results.
POSITIONING

- Wrist (dominant or non-dominant)
- Ankle
- Trunk
Combination with the Sleep Log / Sleep Diary

**Sleep Diary**

This diary will help you keep track of your sleep schedule. Fill it out each day that you wear the Actiwatch.

<table>
<thead>
<tr>
<th>Day</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did you remove the Actiwatch?</td>
<td>Time removed?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Time replaced?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Naps</td>
<td>Time started?</td>
<td>Time ended?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bedtime</td>
<td>Time got into bed?</td>
<td>Turned out lights?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Morning</td>
<td>Time woke up?</td>
<td>Time turned lights on?</td>
<td>Time got out of bed?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Additional Notes
Actogram - normal findings
Actogram – Example of DSPS

University of Split, School of Medicine; Department of Neuroscience
Calculation and report of standard sleep parameters like Total Sleep Time, Wake After Sleep Onset and Sleep Efficiency

<table>
<thead>
<tr>
<th>Interval</th>
<th>Start Time</th>
<th>End Time</th>
<th>Onset Latency</th>
<th>Efficiency</th>
<th>WASO</th>
<th>#Wake Bouts</th>
<th>Sleep Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>31</td>
<td>11:26:00 PM</td>
<td>6:04:00 AM</td>
<td>22.00</td>
<td>63.24</td>
<td>90.00</td>
<td>31</td>
<td>308.00</td>
</tr>
<tr>
<td>32</td>
<td>11:15:00 PM</td>
<td>6:58:00 AM</td>
<td>21.00</td>
<td>77.94</td>
<td>85.00</td>
<td>33</td>
<td>378.00</td>
</tr>
<tr>
<td>33</td>
<td>9:56:00 PM</td>
<td>5:05:00 AM</td>
<td>15.00</td>
<td>61.22</td>
<td>88.00</td>
<td>31</td>
<td>341.00</td>
</tr>
<tr>
<td>34</td>
<td>11:04:00 PM</td>
<td>6:40:00 AM</td>
<td>3.00</td>
<td>78.45</td>
<td>81.00</td>
<td>26</td>
<td>375.00</td>
</tr>
<tr>
<td>35</td>
<td>1:35:00 AM</td>
<td>8:48:00 AM</td>
<td>37.00</td>
<td>72.41</td>
<td>84.00</td>
<td>34</td>
<td>349.00</td>
</tr>
<tr>
<td>36</td>
<td>12:06:00 AM</td>
<td>8:23:00 AM</td>
<td>18.00</td>
<td>70.93</td>
<td>131.00</td>
<td>49</td>
<td>366.00</td>
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<tr>
<td>37</td>
<td>11:16:00 PM</td>
<td>6:59:00 AM</td>
<td>2.00</td>
<td>79.32</td>
<td>91.00</td>
<td>38</td>
<td>372.00</td>
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<td>11:03:00 PM</td>
<td>6:46:00 AM</td>
<td>10.00</td>
<td>78.96</td>
<td>84.00</td>
<td>30</td>
<td>379.00</td>
</tr>
<tr>
<td>39</td>
<td>11:11:00 PM</td>
<td>7:17:00 AM</td>
<td>16.00</td>
<td>81.51</td>
<td>76.00</td>
<td>30</td>
<td>410.00</td>
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<tr>
<td>40</td>
<td>11:18:00 PM</td>
<td>7:26:00 AM</td>
<td>7.00</td>
<td>87.90</td>
<td>52.00</td>
<td>29</td>
<td>436.00</td>
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<tr>
<td>41</td>
<td>9:07:00 PM</td>
<td>7:30:00 AM</td>
<td>12.00</td>
<td>64.31</td>
<td>214.00</td>
<td>74</td>
<td>409.00</td>
</tr>
<tr>
<td>42</td>
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<td>8:10:00 AM</td>
<td>25.00</td>
<td>81.54</td>
<td>69.00</td>
<td>36</td>
<td>424.00</td>
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<tr>
<td>43</td>
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<td>10:32:00 AM</td>
<td>7.00</td>
<td>72.79</td>
<td>127.00</td>
<td>43</td>
<td>396.00</td>
</tr>
<tr>
<td>n</td>
<td>*</td>
<td>*</td>
<td>43</td>
<td>43</td>
<td>43</td>
<td>43</td>
<td>43</td>
</tr>
<tr>
<td>Average(n)</td>
<td>*</td>
<td>*</td>
<td>17.60</td>
<td>73.93</td>
<td>97.65</td>
<td>36.49</td>
<td>388.14</td>
</tr>
<tr>
<td>Std Dev(n-1)</td>
<td>*</td>
<td>*</td>
<td>15.51</td>
<td>6.38</td>
<td>26.57</td>
<td>8.68</td>
<td>46.05</td>
</tr>
</tbody>
</table>
Clinical questions to be answered:

Does the patient have relatively good sleep hygiene?

Is the sleep period too short (or too long)?

Is there an indication of an advance or delay in the sleep schedule?

Is treatment having an effect?
Actigraphy may be used effectively in the following special populations:

- Elderly
- Newborns
- Hypertension
- Depression
- Schizophrenia

Actigraphy may be useful in determining rest-activity patterns during portable sleep apnea testing.
Actigraphy

Advantages
- Non invasive
- Cheap
- Continuous activity monitoring for up to several weeks
- Naturalistic environment
- Objective method for the evaluation of S/W rhythm
- Accurate estimation of sleep patterns (quality)

Disadvantages
- Non valid discrimination between different sleep phases
- Artifacts due to the externally imposed motion
- Accuracy of actigraphic S/W detection declines with decreased SE
"cost-effective method for assessing specific sleep disorders but methodological issues have not been systematically addressed in clinical research and practice"
FOUR AREAS OF REVIEW:

1. The more recent papers on the technology and validity of actigraphy.
2. The studies examining actigraphy in populations with sleep disorders.
3. The use of actigraphy in studies of circadian rhythms.
4. The studies in which actigraphy was used as a treatment outcome measure or to examine the relationship between sleep/activity patterns and demographic or clinical variables.
The American Academy of Sleep Medicine (AASM) has made the recommendations in its Practice Parameters for Actigraphy.

The practice parameters are a guide to the appropriate use of actigraphy, both as:
- a **diagnostic tool** for the evaluation of sleep disorders and as
- an **outcome measure of treatment efficacy** in clinical settings with appropriate sleep populations.
Practice Parameters for the Role of Actigraphy in the Study of Sleep and Circadian Rhythms: An Update for 2002

An American Academy of Sleep Medicine Report

Standards of Practice Committee of the American Academy of Sleep Medicine

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Practice Parameters for the Use of Actigraphy in the Assessment of Sleep and Sleep Disorders: An Update for 2007

Standards of Practice Committee, American Academy of Sleep Medicine

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<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Standard</td>
<td>This is a generally accepted patient-care strategy, which reflects a high degree of clinical certainty. The term standard generally implies the use of Level 1 evidence, which directly addresses the clinical issue, or overwhelming Level 2 evidence.</td>
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<tr>
<td>Guideline</td>
<td>This is a patient-care strategy, which reflects a moderate degree of clinical certainty. The term guideline implies the use of Level 2 evidence or a consensus of Level 3 evidence.</td>
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<tr>
<td>Option</td>
<td>This is a patient-care strategy, which reflects uncertain clinical use. The term option implies either inconclusive or conflicting evidence or conflicting expert opinion.</td>
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The AASM Board of Directors (BOD) approved these recommendations. All members of the AASM SPC and BOD completed detailed conflict-of-interest statements and were found to have no conflicts of interest with regard to this subject.
Table 1—Evidence Levels

1. Blind, prospective comparison of results obtained by actigraphy to those obtained by a reference standard* on an appropriate spectrum of subjects and number of patients.

2. Comparison of results obtained by actigraphy to those obtained by a reference standard* but blinding not specified, not prospective, or on a limited spectrum of subjects or number of patients.

3. Comparison of results obtained by actigraphy to the mean value of a reference standard*, but not direct within-subject comparison, or otherwise methodologically limited.

4. Actigraphy compared to nonstandard reference or group differences shown:
   a. Adequate comparison of results obtained by actigraphy to those obtained by a non-standard reference*; or
   b. Actigraphy not compared to any reference, but actigraphy results demonstrated ability to detect significant difference between groups or conditions in well-designed trial.

5. Actigraphy not adequately compared to any reference, and either
   a. Actigraphy not used in a well-designed trial, or
   b. Actigraphy used in such a trial but did not demonstrate ability to detect significant difference between groups or conditions.

* Reference standards for actigraphic evaluation of sleep and circadian rhythms varied by diagnostic category, and included generally accepted “gold standards,” applied in an acceptable manner. By diagnostic category, reference standards for insomnia included PSG and/or sleep logs; for circadian rhythm sleep disorders, PSG, phase markers, and/or sleep logs; for sleep apnea, PSG; for restless legs syndrome and periodic limb movements during sleep, PSG; for infants, caregiver reported observations; for elderly or demented persons, phase markers, sleep logs, and/or caregiver reports; and for healthy controls, PSG, phase markers, or sleep logs. Nonstandard references include such items applied outside their diagnostic category, or other experimental monitors.
USE OF ACTIGRAPHY IN THE EVALUATION OF SLEEP DISORDERS

1. Actigraphy is a valid way to assist in determining sleep patterns in normal, healthy adult populations (Standard), and in patients suspected of certain sleep disorders.

2. Actigraphy is indicated to assist in the evaluation of patients suspected of advanced sleep phase syndrome (ASPS), delayed sleep phase syndrome (DSPS), and shift work sleep disorder (Guideline); and circadian rhythm disorders, including jet lag and non-24-hour sleep/wake syndrome [including that associated with blindness]. (Option)
USE OF ACTIGRAPHY IN THE EVALUATION OF SLEEP DISORDERS

3. When PSG is not available, actigraphy is indicated as a method to estimate total sleep time in patients with OSAS. Use of actigraphy may improve accuracy in assessing the severity of obstructive sleep apnea compared with using time in bed. (Standard)

4. Actigraphy is indicated as a method to characterize circadian rhythm patterns or sleep disturbances in individuals with insomnia, including insomnia associated with depression. (Option)

5. Actigraphy is indicated as a way to determine circadian pattern and estimate average daily sleep time in individuals complaining of hypersomnia. (Option)
USE OF ACTIGRAPHY IN ASSESSING THE RESPONSE TO THERAPY OF SLEEP DISORDERS

1. Actigraphy is useful as an outcome measure in evaluating the response to treatment for circadian rhythm disorders. (Guideline)

2. Actigraphy is useful for evaluating the response to treatment for patients with insomnia, including insomnia associated with depressive disorders. (Guideline)

3. Actigraphy is indicated for characterizing and monitoring sleep and circadian rhythm patterns among older nursing home residents (in whom PSG can be difficult to perform and/or interpret). (Guideline)

4. Actigraphy is indicated in normal infants and children (in whom PSG can be difficult to perform and/or interpret), and in special pediatric populations. (Guideline)
Standard procedures for adults in accredited sleep medicine centres in Europe

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SUMMARY The present paper describes standardized procedures within clinical sleep medicine. As such, it is a continuation of the previously published European guidelines for the accreditation of sleep medicine centres and European guidelines for the certification of professionals in sleep medicine, aimed at creating standards of practice in European sleep medicine. It is also part of a broader action plan of the European Sleep Research Society, including the process of accreditation of sleep medicine centres and certification of sleep medicine experts, as well as publishing the Catalogue of Knowledge and Skills for sleep medicine experts (physicians, non-medical health care providers, nurses and technologists), which will be a basis for the development of relevant educational curricula. In the current paper, the standard operational procedures sleep medicine centres regarding the diagnostic and therapeutic management of patients evaluated at sleep medicine centres, accredited according to the European Guidelines, are based primarily on prevailing evidence-based medicine principles. In addition, parts of the standard operational procedures are based on a formalized consensus procedure applied by a group of Sleep Medicine Experts from the European National Sleep Societies. The final recommendations for standard operational procedures are categorized either as ‘standard practice’, ‘procedure that could be useful’, ‘procedure that is not useful’ or ‘procedure with insufficient information available’. Standard operational procedures described here include both subjective and objective testing, as well as recommendations for follow-up visits and for ensuring patients’ safety in sleep medicine. The overall goal of the actual standard operational procedures is to further develop excellence in the practice and quality assurance of sleep medicine in Europe.

KEYWORDS sleep medicine centres, standard procedure, sleep medicine
CONCLUSIONS
Actigraphy is commonly used in patients suspected of advanced sleep phase syndrome (ASPS), delayed sleep phase syndrome (DSPS) or shift work sleep disorder.

It can also be indicated in circadian rhythm disorders including jet lag and non 24-hour sleep/wake syndrome including that associated with blindness.

However, since actigraphic rest-activity patterns cannot provide an undisputable marker of circadian timing, circadian rhythm assessment (e.g. melatonin, core body temperature, cortisol) is useful for diagnosis.
CONCLUSIONS

Currently the timing of the melatonin rhythm (e.g. time of melatonin onset) is considered the most reliable marker of circadian phase.

In patients with insomnia (including those with depression), excessive daytime sleepiness/hypersomnia (including those with behaviourally induced sleep insufficiency syndrome), or sleep related movement disorders, actigraphy can be of additive diagnostic value.
Thank you!
**Diagnostic Methods – Portable**

**Polygraphy / Actigraphy**

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*Polygraphy (portable monitoring)*

The standard approach to diagnosing OSA is in-laboratory, technician-attended, polysomnography. Portable monitoring (PM) has been proposed as a substitute for polysomnography in the diagnostic assessment of patients with suspected OSA. PM requires less technical expertise, is less labor intensive and time consuming, and is easier for patients to access. The term portable monitoring encompasses a wide range of devices that can record as many signals as does attended polysomnography or only 1 signal, such as oximetry.

Polygraphy (PG) has four to eight channels of physiological data, but EEG is not recorded, and the sleep stages are not scored. The minimum set of channels comprises O$_2$-saturation, airflow, breathing effort, heart rate, and body position. It is particularly useful for the diagnosis of obstructive sleep apnea without significant co-morbid condition. It is not useful for the diagnosis of other sleep disorders. It has to be performed by trained and certified medical sleep specialists. Manual scoring is mandatory. Equivocal test results require the subsequent performance of full polysomnography as a standard practice. The final outcome is a report as described in the European Guidelines for Accreditation of Sleep Medicine Centers.

The workload comprises admitting the patient by the medical specialist, and preparation of the equipment, patient hook-up, and scoring of the record are performed by the sleep technician. The sleep expert subsequently reviews the scoring, creates the report, and gives feedback to the patient. Attended PG requires continuous monitoring by trained technical and nursing staff for the duration of recording.

*Actigraphy*

Actigraphy is a valid way to assess sleep-wake patterns in patients suspected of certain sleep disorders, but the method cannot fully be a substitute for polygraphy or polysomnography.

The term actigraphy refers to methods using miniaturized computerized wrist watch-like devices to monitor and collect data generated by movements. Most actigraphs contain an analogue system to detect movements. In some devices, a piezo-electric beam detects movement in two or three axes and the detected movements are translated to digital counts accumulated across pre-designed epoch intervals (e.g. 1 min) and stored in the internal memory. The actigraph can collect data continuously over an extended period (1 week or longer). Some devices are programmable and enable selection of specific modes of operation (e.g. variable movement frequency bandwidths, sensitivity levels or epoch intervals) whereas other devices have only one fixed mode. Data are downloaded to the computer using special interface units or other forms of communication channels. The use of computer scoring algorithms without controlling for potential artifacts can lead to inaccurate or misleading results. Actigraphy is commonly used in patients suspected of advanced sleep phase syndrome (ASPS), delayed sleep phase syndrome (DSPS) or shift work sleep disorder. It can also be indicated in circadian rhythm disorders including jet lag and non 24-hour sleep/wake syndrome including that associated with blindness. However, since actigraphic rest-activity patterns cannot provide an undisputable marker of
circadian timing, circadian rhythm assessment (e.g. melatonin, core body temperature, cortisol) is useful for diagnosis. Currently the timing of the melatonin rhythm (e.g. time of melatonin onset) is considered the most reliable marker of circadian phase. In patients with insomnia (including those with depression), excessive daytime sleepiness/hypersomnia (including those with behaviourally induced sleep insufficiency syndrome), or sleep related movement disorders, actigraphy can be of additive diagnostic value.