Poligraphy
(Portable Monitoring)

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Portable (Sleep Apnea) Monitoring

PANDORA'S CARRY-ON
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.
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

# Table 1—Portable Monitoring Devices

<table>
<thead>
<tr>
<th>Type of Portable Monitoring Device</th>
<th>Parameters Measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 2 Comprehensive Portable</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>Type 3 Modified Portable Sleep Apnea Testing</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>Type 4 Continuous Single or Dual Bioparameters</td>
<td>One or 2 channels, typically including oxygen saturation or airflow</td>
</tr>
</tbody>
</table>
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.
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>
<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: Alice® PDx™ Basic 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
An example: Stardust

- Made by Philips, Respironics
- Type 3 device
- Measures: airflow, respiratory effort (one belt), oximetry, heart rate, body position
- Well validated
- Moderately expensive, but subsequent units are cheaper
- Moderate tech time for scoring
An example: Embletta

- Somnologica/Medcare
- Type 3 device
- Measures: Airflow, respiratory effort, oximetry, body position
- Well-validated, widely used
- Moderately expensive, similar to Stardust
- Moderate tech time for scoring
Type 3 monitor

Graph showing data for SpO2, HR, FLOW, and EFFORT.
Type 3 monitor
# Stardust Report

<table>
<thead>
<tr>
<th>Gender</th>
<th>M</th>
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</thead>
<tbody>
<tr>
<td>Weight</td>
<td>175 lbs</td>
</tr>
<tr>
<td>Birth Date</td>
<td>8/6/1956</td>
</tr>
<tr>
<td>Height</td>
<td>55 in</td>
</tr>
<tr>
<td>Patient Age</td>
<td>51 years</td>
</tr>
<tr>
<td>Body Mass Index</td>
<td>40.7</td>
</tr>
</tbody>
</table>

| Patient ID:      | 459        |
| Study Number:    | 600000194  |
| Study Date:      | 4/7/2008 at 11:55:46 PM |
| Time in Bed (TIB): | 307 minutes |

**Events**

<table>
<thead>
<tr>
<th>Indices (#/hour)</th>
<th>Central</th>
<th>Obst Apneas</th>
<th>Mixed</th>
<th>Hypopneas</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total # of Events</td>
<td>0</td>
<td>16.8</td>
<td>0</td>
<td>23.5</td>
<td>40.3</td>
</tr>
<tr>
<td>Mean Dur (sec)</td>
<td>0</td>
<td>21.2</td>
<td>0</td>
<td>30.3</td>
<td>26.5</td>
</tr>
<tr>
<td>Max Dur (sec)</td>
<td>0</td>
<td>49</td>
<td>0</td>
<td>67.5</td>
<td>67.5</td>
</tr>
<tr>
<td>Supine (#)</td>
<td>0</td>
<td>76</td>
<td>0</td>
<td>98</td>
<td></td>
</tr>
<tr>
<td>Non-Supine (#)</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td>22</td>
<td></td>
</tr>
</tbody>
</table>

| Total Dur       | 181.5   |
| AHI             | 57.5    |

**Heart Rate**

| Mean HR (BPM) | 64.8 |
| LHR           | 65   |
| LHR max (BPM) | 30   |
| 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|
WORKLOAD

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.
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 in to the existing PSAT device classification?
  - WatchPAT-100
  - PTT
  - ARES
  - New systems on the horizon will have capabilities to be a type 2-4 by adding or taking away modules
WatchPAT

- Works on principle of changes in peripheral arterial tonometry
- Indirect measure of ANS activity
- PAT is a surrogate marker for apnea, hypoxia
- Moderately expensive to purchase; individual probes are recurring cost
- Minimal to no tech time for scoring
WatchPAT Example
Apnea link

- Resmed, Inc.
- Type 4 device
- Measures: airflow +/- oximetry
- Some validation; generally shows that it is accurate in detecting more severe OSA
- Relatively inexpensive
- Limited tech time
Example of moderate sleep apnea on Apnea Link
Other devices

- Apnea Risk Evaluation System (ARES)
  - Cardiopulmonary monitor
  - Moderately expensive
  - Some local experience with it
  - Tech time minimal
Other PM devices

- SomnoCheck, Weinmann
- PolyMESAM, (MAP), ResMED
- etc...
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

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<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>
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RUSleeping™

Stardust® II

Alice® PDx™
Practice Parameters for the Indications for Polysomnography and Related Procedures: An Update for 2005

Clete A. Kushida; Michael R. Littner; Timothy Morgenthaler; Cathy A. Alessi; Dennis Bailey; Jack Coleman, Jr.; Leah Friedman; Max Hirshkowitz; Sheldon Kapen; Milton Kramer; Teofilo Lee-Chiong; Daniel L. Loube; Judith Owens; Jeffrey P. Pancer; Merrill Wise

SLEEP, Vol. 28, No. 4, 2005
Standard procedures for adults in accredited Sleep Medicine Centres in Europe


Journal of Sleep Research, Submitted, 2011
HIGHLIGHTS

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)
And again...!