Poligraphy (Portable Monitoring)

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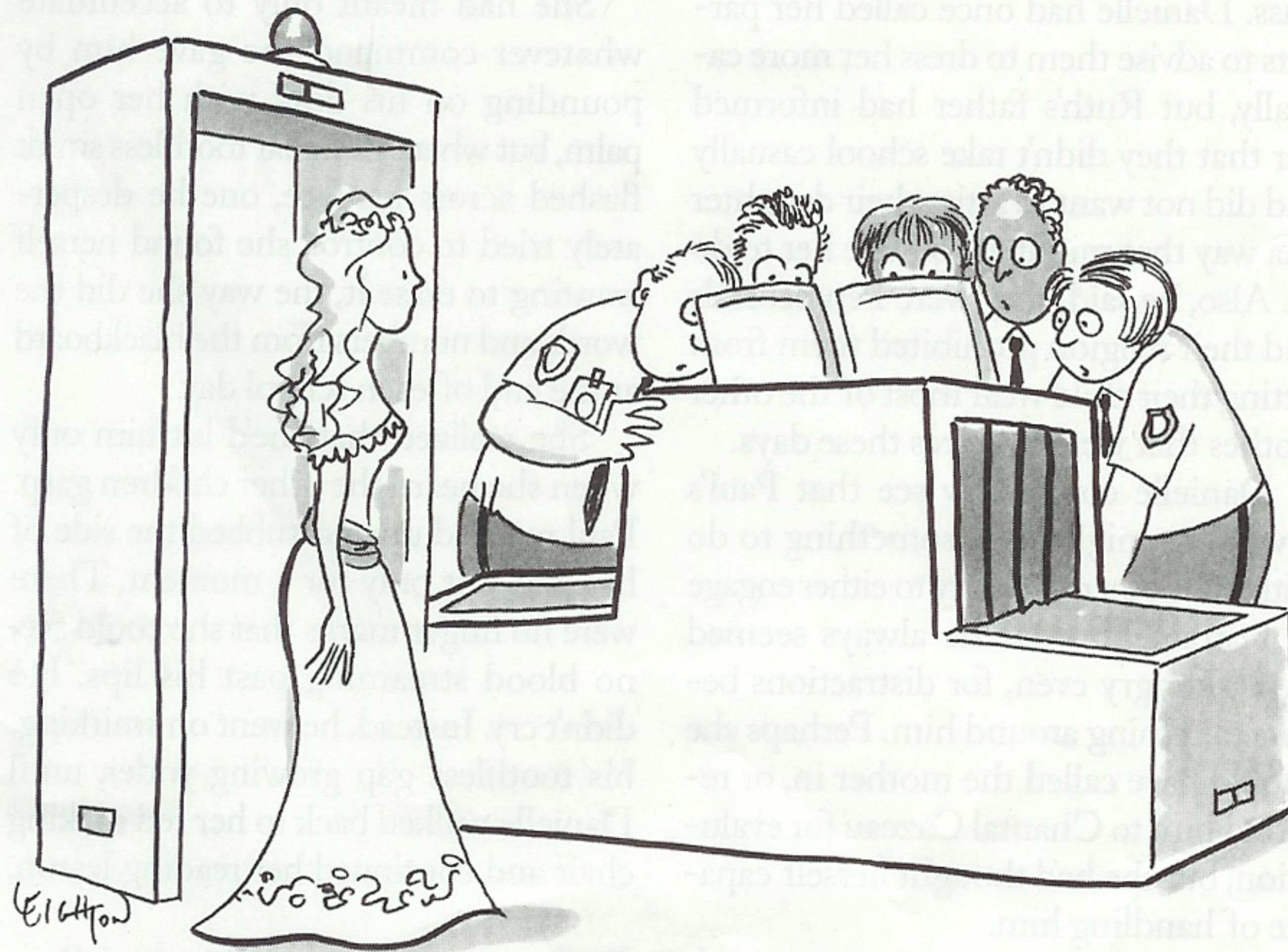
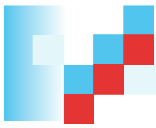
Portable (Sleep Apnea) Monitoring



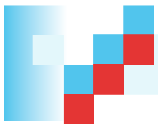


POLYGRAPHY (PORTABLE MONITORING)

The standard approach to diagnosing OSA is in-laboratory, technician-attended, polysomnography.

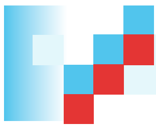
Portable monitoring (PM) has been proposed as a substitute for polysomnography in the diagnostic assessment of patients with suspected OSA.

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



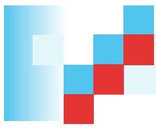
TERMINOLOGY

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 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

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

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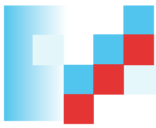
Table 1—Portable Monitoring Devices

Type of Portable Monitoring Device	**Parameters Measured**
Type 2 Comprehensive Portable	Polysomnography Minimum of 7 channels, including electroencephalogram, electrooculogram, chin electromyogram, electrocardiogram or heart rate, airflow, respiratory effort, and oxygen saturation
Type 3 Modified Portable Sleep ApneaTesting	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
Type 4 Continuous Single or Dual Bioparameters	One or 2 channels, typically including oxygen saturation or airflow



PORTABLE MONITORING DEVICES

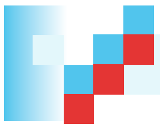
Using a categorization of sleep monitoring procedures in which Type 1 is standard attended in-lab polysomnography (PSG),

PMs are categorized into 3 types:

Type 2 - comprehensive portable polysomnography;

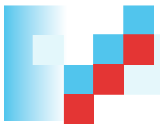
Type 3 - modified portable sleep apnea testing (also referred to as cardiorespiratory sleep studies); and

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.

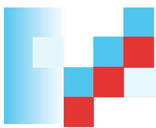
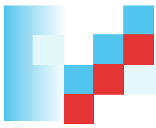


Table 3—Levels of Evidence

Level of Evidence	Study Design
I	Blinded comparison, consecutive patients, reference standard performed on all patients
II	Blinded comparison, nonconsecutive patients, reference standard performed on all patients
II	Blinded comparison, consecutive patients, reference standard not performed on all patients
IV	Reference standard not applied blindly or independently

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].



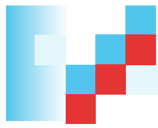
Type 2 Monitors: “Mini-PSG”

- 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

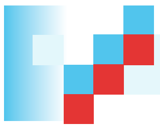
Channels of Basic Unit:

1. Thermistor Flow
2. Pressure Cannula Flow
3. Snoring via Pressure Cannula
4. Respiratory Effort Thorax, Indu
   Plethysmography
5. Respiratory Effort Abdomen, In
   Plethysmography
6. Oxygen Saturation
7. Puls Wave
8. Puls Rate
9. Body Position
10. Patient Marker



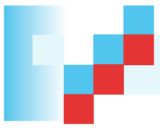
Type 3 Monitors: Cardio-respiratory studies

- 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



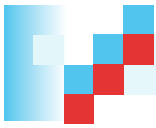
An example: Stardust

- 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



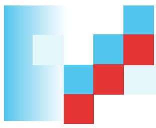
An example: Embletta

- 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

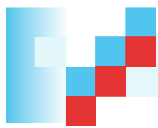


Type 3 monitor

SpO2
89 86 86 85 86 89 91 91 90 87 84 82 82 83 89 93 92 89
(+) (+)
HR
72 66 63 59 67 79 88 88 85 81 80 79 78 80 83 85 85 83
FLOW
EFFORT
(O) (O)



Type 3 monitor



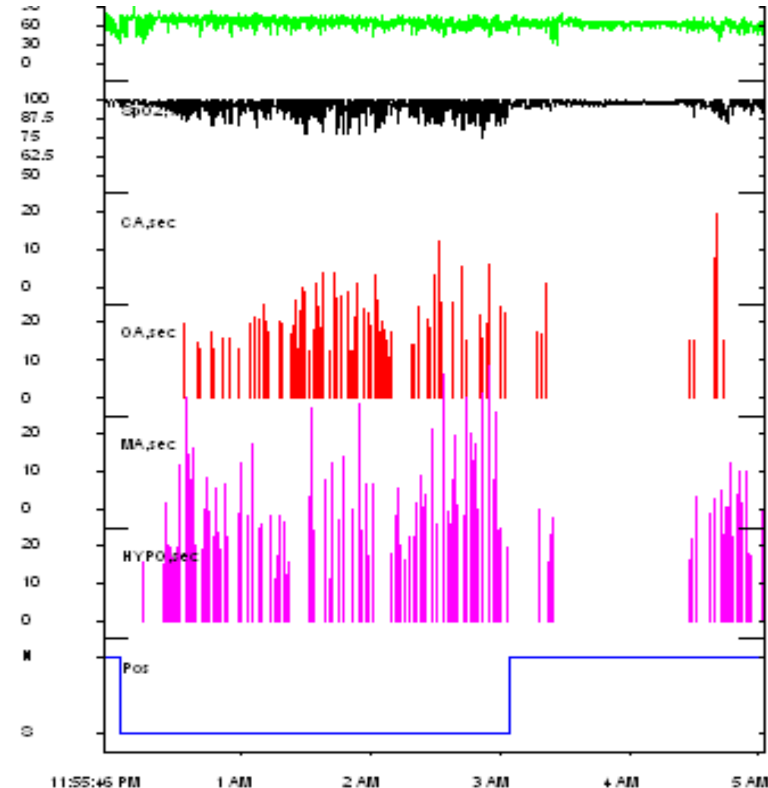
Stardust Report

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

Events

	Central Apneas	Obst Apneas	Mixed Apneas	Hypop-neas	Total
Indices (#/hour)	0	16.8	0	23.5	40.3
Total # of Events	0	86	0	120	206
Mean Dur (sec)	0	21.2	0	30.3	26.5
Max Dur (sec)	0	49	0	67.5	67.5
Supine (#)	0	76	0	98	
Non-Supine (#)	0	10	0	22	

	Total Dur	AHI
Supine	181.5	57.5
Non-Supine	125.5	15.3



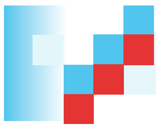
Heart Rate

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 SpO_2 (≥ 2 sec) (%)	72
# Episodes (≥5 min) ≤ 88%	0
Longest dur (min) SpO_2 ≤ 88%	0.6



WORKLOAD

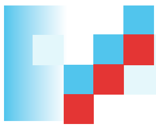
The workload comprises:

-admitting the patient by the medical specialist,

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

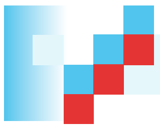
-The sleep expert subsequently reviews the scoring, creates the report, and gives feedback to the patient.

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



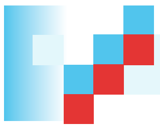
Type 4 Monitors: Oximetry +

- 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



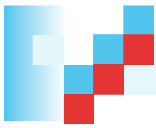
Not typical devices…

- 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

PAT
0
-980
-1960

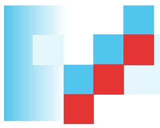
PAT Amplitude
3240
2700
1620
1080

PulseRate (BPM)
90
85
80
75
70
65
60
55

SaO2 (%)
Desaturati Desaturation Desaturation Desaturation Desaturation Desaturation Desaturation Desatu Desatura Desaturatio Desaturation Desaturati
98
96
94
92
90
88

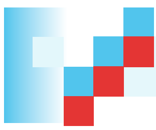
Actigraph
2025
2020
2015
2010
2005
2000
1995

WP100 Stages
REM
SL

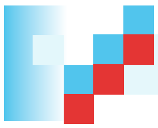


Apnea link

- 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

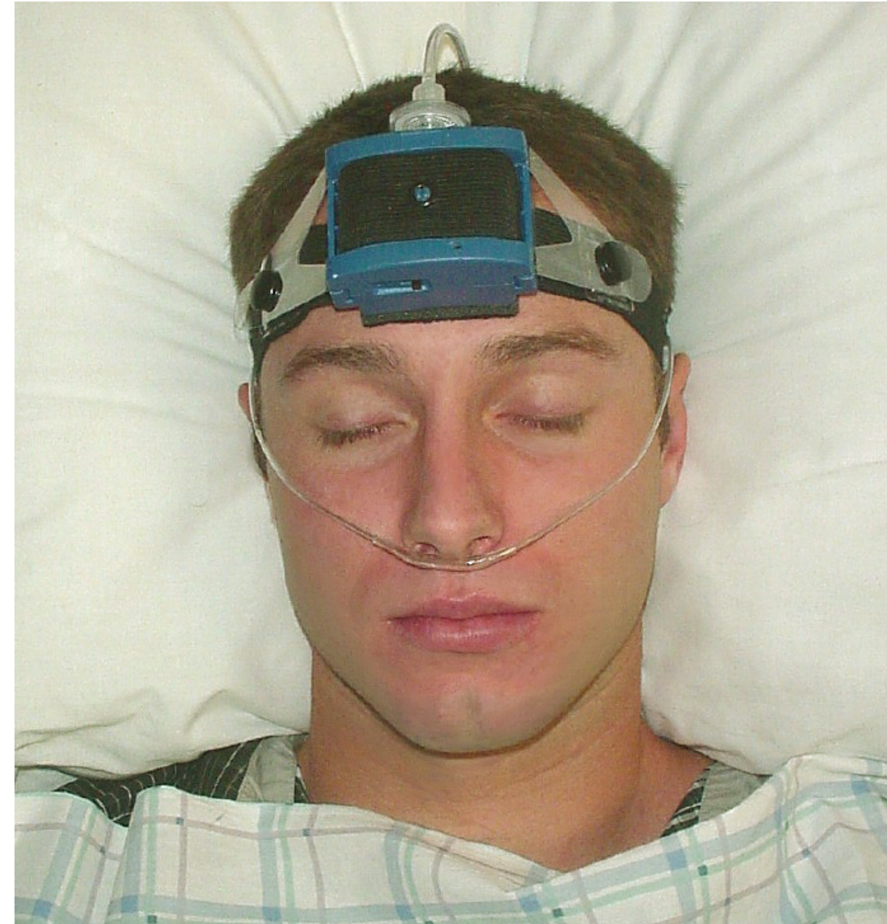


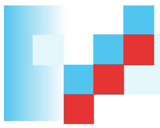
Example of moderate sleep apnea on Apnea Link



Other devices

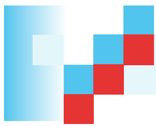
- Apnea Risk Evaluation System (ARES)
  - Cardiopulmonary monitor
  - Moderately expensive
  - Some local experience with it
  - Tech time minimal



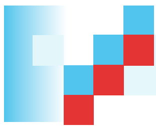


Other PM devices

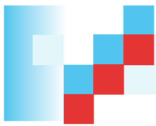
- SomnoCheck, Weinmann
- PolyMESAM, (MAP), ResMED
- etc...



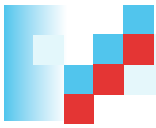
Source: SMC in Split. Croatia; Permanent apneas w/significant desaturations; Periodic breathing. Upper: Whole-night recordings; lower: 10-minute recordings



Source: SMC in Split. Croatia; Permanent apneas w/significant desaturations; Periodic breathing; 10-minutes recordings



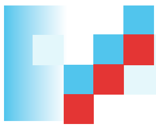
Source: SMC in Split. Croatia; Permanent apneas w/significant desaturations; Periodic breathing; 5-minutes recordings



American Academy of Sleep Medicine (AASM) Portable Testing Matrix of Device Classes

Level II	Level III	Level IV
Comprehensive Portable Polysomnography	Modified Portable Sleep Apnea Testing	Single or Dual Bioparameter Recording
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*	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	One or 2 channels, typically including oxygen saturation or airflow

Alice® PDx™



PRACTICE PARAMETER

Practice Parameters for the Indications for Polysomnography and Related Procedures: An Update for 2005

Clete A. Kushida, MD, PhD[1]; Michael R. Littner, MD[2]; Timothy Morgenthaler, MD[3]; Cathy A. Alessi, MD[4]; Dennis Bailey, DDS[5]; Jack Coleman, Jr., MD[6]; Leah Friedman, PhD[7]; Max Hirshkowitz, PhD[8]; Sheldon Kapen, MD[9]; Milton Kramer, MD[10]; Teofilo Lee-Chiong, MD[11]; Daniel L. Loube, MD[12]; Judith Owens, MD[13]; Jeffrey P. Pancer, DDS[14]; Merrill Wise, MD[15]

[1]Stanford University Center of Excellence for Sleep Disorders, Stanford, CA; [2]VA Greater Los Angeles Healthcare System and David Geffen School of Medicine at UCLA, Sepulveda, CA; [3]Mayo Sleep Disorders Center, Mayo Clinic, Rochester, MN; [4]UCLA/Greater Los Angeles Healthcare System, Sepulveda, CA; [5]Greenwood Dental Associates, Englewood, CO; [6]Middle Tennessee ENT, Murfreesboro, TN; [7]Stanford University School of Medicine, Stanford, CA; [8]Baylor College of Medicine and VA Medical Center, Houston, TX; [9]VA Medical Center and Wayne State University, Detroit, MI; [10]Maimoides Medical Center, Psychiatry Department, Brooklyn, NY and New York University School of Medicine, New York, NY; [11]National Jewish Medical and Research Center, Sleep Clinic, Denver, CO; [12]Sleep Medicine Institute, Swedish Medical Center, Seattle, WA; [13]Department of Pediatrics, Rhode Island Hospital, Providence, RI; [14]Toronto, ON, Canada; [15]Departments of Pediatrics and Neurology, Baylor College of Medicine, Houston, TX

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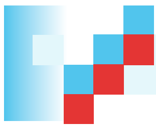
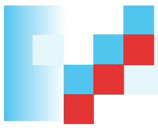
SLEEP, Vol. 28, No. 4, 2005



Standard procedures for adults in accredited Sleep Medicine Centres in Europe

Jürgen Fischer, Zoran Dogas, Claudio L. Bassetti, Søren Berg, Ludger Grote, Poul Jennum, Patrick Levy, Stefan Mihaicuta, Lino Nobili, Dieter Riemann, F. Javier Puertas Cuesta, Friedhart Raschke, Debra J. Skene, Neil Stanley, and Dirk Pevernagie

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.

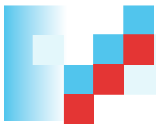
It is not useful for the diagnosis of other sleep disorders.

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.



SPECIAL CONSIDERATION

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...!