Actigraphy

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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.
ACTIWATCH® FOR SLEEP EVALUATION

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.
TECHNOLOGY

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.

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TECHNOLOGY

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
Actogram – normal findings
Actogram – Example of DSPS
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>
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<td>63.24</td>
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<td>127.00</td>
<td>43</td>
<td>396.00</td>
</tr>
</tbody>
</table>

**n**: 
- *: Average
- #: Standard Deviation

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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

Michael Littner MD,1 Clete A. Kushida MD, PhD,2 W. McDowell Anderson MD,3 Dennis Bailey DDS,4 Richard B. Berry MD,5 David G. Davila MD,6 Max Hirshkowitz PhD,7 Sheldon Kapen MD,8 Milton Kramer MD,9 Daniel Loube MD,10 Merrill Wise MD,11 Stephen F. Johnson, MD12

1VA Greater Los Angeles Healthcare System, and UCLA School of Medicine, Sepulveda, CA; 2Stanford University Center of Excellence in Sleep Disorders, Stanford, CA; 3College of Medicine, University of South Florida, Tampa, FL; 4Englewood, CO; 5University of Florida Health Science Center, Gainesville, FL; 6Baptists Medical Center, Little Rock, AK; 7Baylor College of Medicine, Houston VAMC Sleep Disorders and Research, Houston, TX; 8Neurology Service, Detroit VAMC, Detroit, MI; 9Psychiatry Department, Maimonides Medical Center, Brooklyn, NY; 10Sleep Medicine Institute, Swedish Medical Center, Seattle, WA; 11Departments of Pediatrics and Neurology, Baylor College of Medicine, Houston, TX; 12St. Patrick Hospital Sleep Center, Missoula, Montana.
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

Timothy Morgenthaler, MD, 2Cathy Alessi, MD, 3Leah Friedman, PhD, 4Judith Owens, MD, 5Vishesh Kapur, MD 6Brian Boehlecke, MD, 7Terry Brown, DO, 8Andrew Chesson, Jr., MD, 9Jack Coleman, MD, 10Teofilo Lee-Chiong, MD, 11Jeffrey Pancer, DDS, 12Todd J. Swick, MD

1Mayo Clinic, Rochester, MN; 2VA Greater Los Angeles Healthcare System-Sepulveda and University of California, Los Angeles; 3Stanford University School of Medicine, Stanford, CA; 4Rhode Island Hospital, Providence, RI; 5University of Washington, Seattle, WA; 6University of North Carolina, Chapel Hill, NC; 7St. Joseph Memorial Hospital, Murphysboro, IL; 8LSU Health Sciences Center in Shreveport, Shreveport, LA; 9Murfreesboro Medical Center, Murfreesboro, TN; 10National Jewish Medical and Research Center, Denver, CO; 11Toronto, Canada; 12Houston Sleep Center, Houston, TX;
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<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>
</tr>
<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>
</tr>
<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>
</tr>
</tbody>
</table>

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)

University of Split, School of Medicine; Department of Neuroscience
Standard procedures for adults in accredited Sleep Medicine Centres in Europe


Journal of Sleep Research, Submitted, 2011
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 again!