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.

TERMINOLOGY

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.

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.

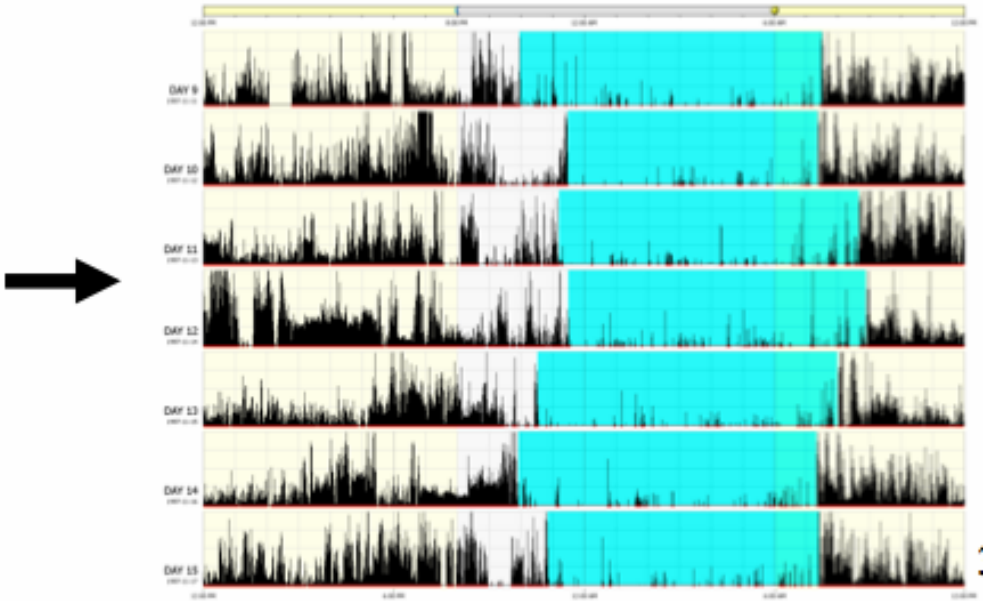
TECHNOLOGY

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.

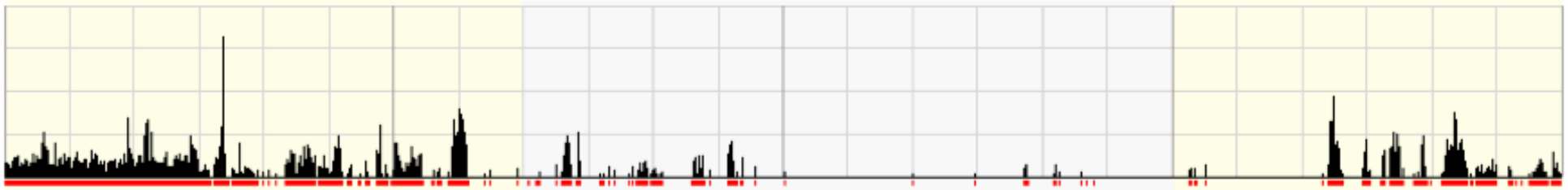
Data transfer

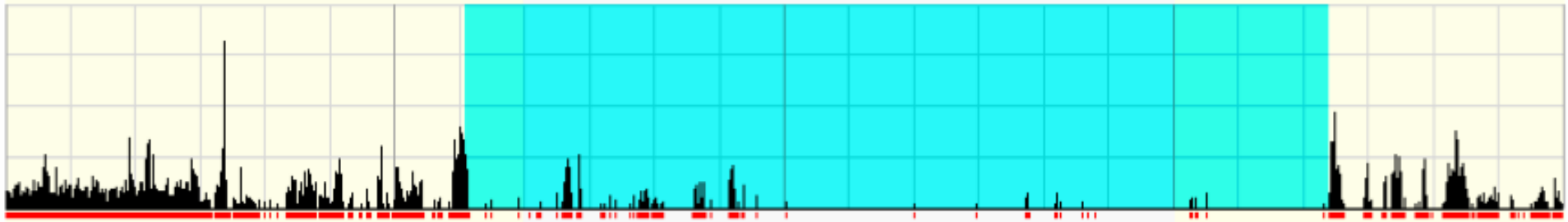
Data are downloaded to the computer using special interface units or other forms of communication channels.



Scoring

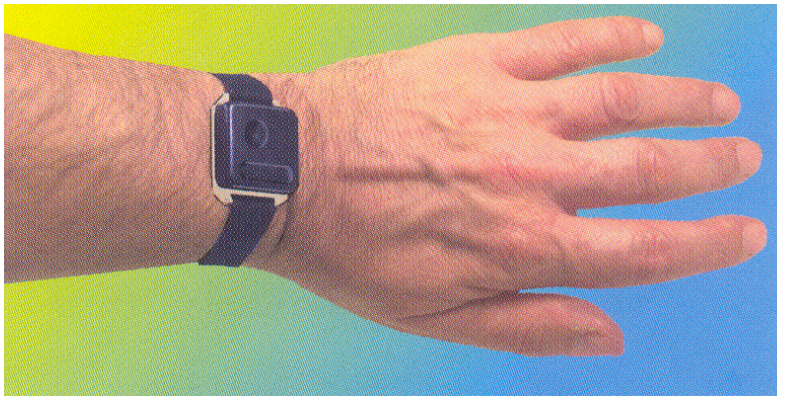
The use of computer scoring algorithms without controlling for potential artifacts can lead to inaccurate or misleading results.



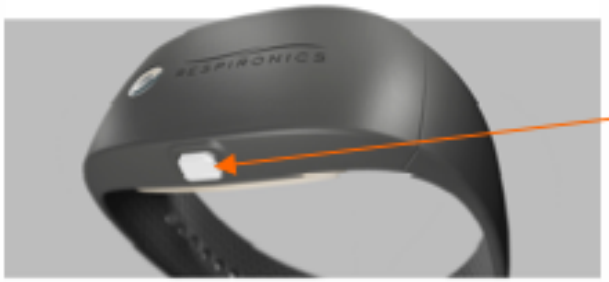


POSITIONING

- Wrist (dominant or non-dominant)
- Ankle
- Trunk



Combination with the Sleep Log / Sleep Diary



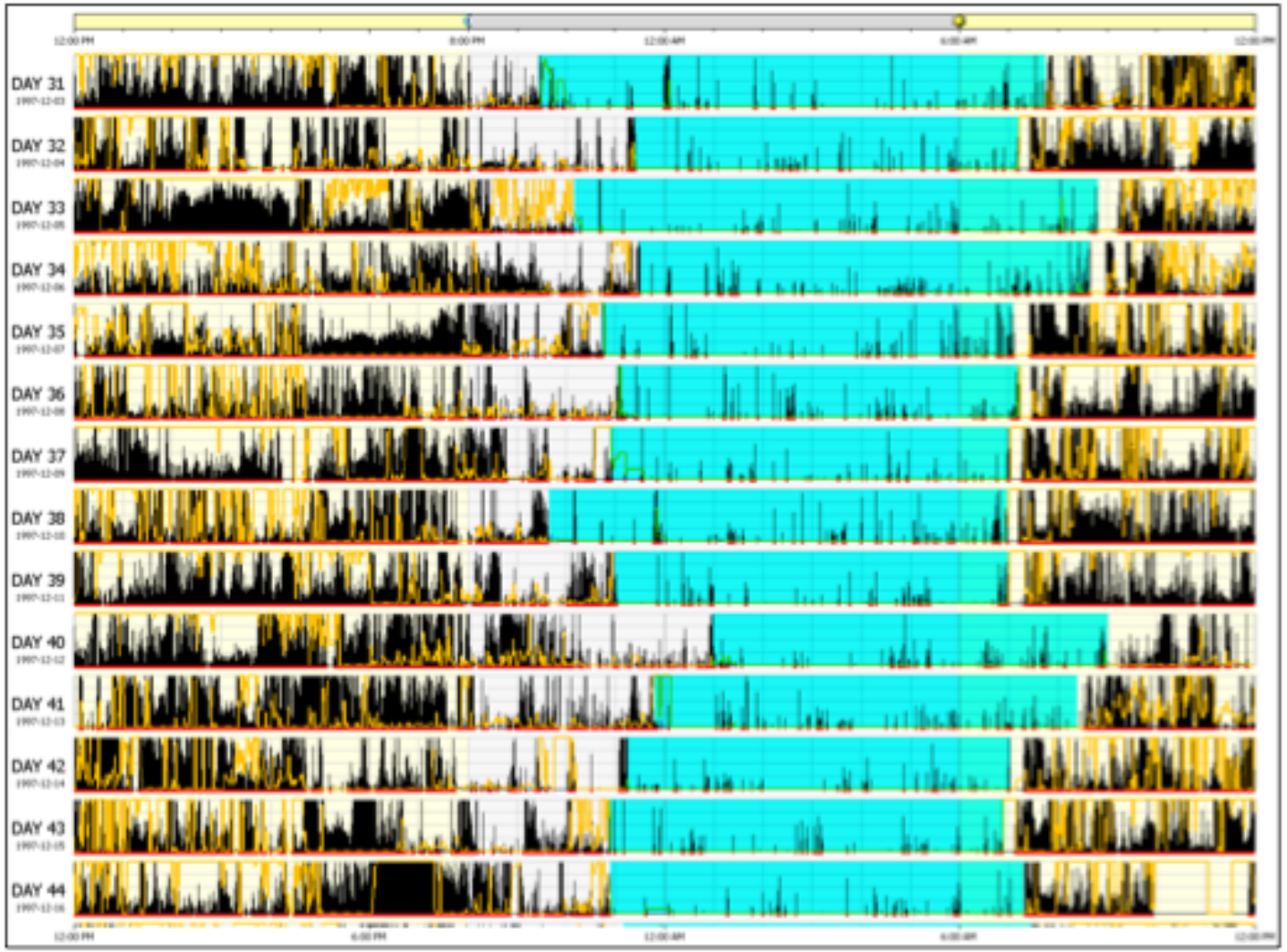
Sleep Diary

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

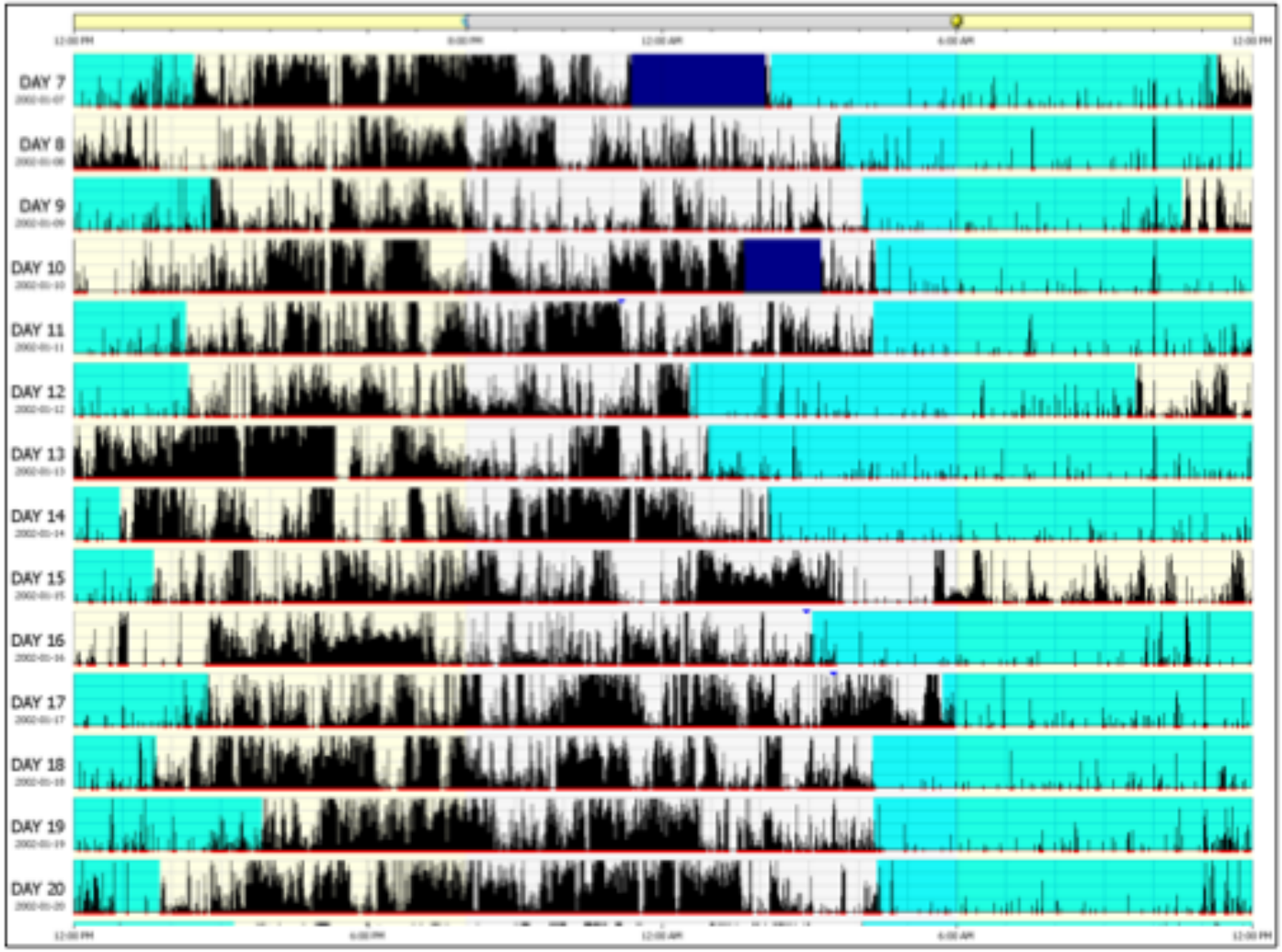
		Day	1	2	3	4	5	6	7
		Date							
Did you remove the Actiwatch?	Time removed?								
	Time replaced?								
Naps	Time started?								
	Time ended?								
Bedtime	Time got into bed?								
	Turned out lights?								
Morning	Time woke up?								
	Time turned lights on?								
	Time got out of bed?								

Additional Notes

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

	Start Time	End Time	Onset Latency	Efficiency	WASO	#Wake Bouts	Sleep Time
Interval 31	11:26:00 PM	6:04:00 AM	22.00	63.24	90.00	31	308.00
Interval 32	11:15:00 PM	6:58:00 AM	21.00	77.94	85.00	33	378.00
Interval 33	9:56:00 PM	5:05:00 AM	15.00	61.22	88.00	31	341.00
Interval 34	11:04:00 PM	6:40:00 AM	3.00	78.45	81.00	26	375.00
Interval 35	1:35:00 AM	8:48:00 AM	37.00	72.41	84.00	34	349.00
Interval 36	12:06:00 AM	8:23:00 AM	18.00	70.93	131.00	49	366.00
Interval 37	11:16:00 PM	6:59:00 AM	2.00	79.32	91.00	38	372.00
Interval 38	11:03:00 PM	6:46:00 AM	10.00	78.96	84.00	30	379.00
Interval 39	11:11:00 PM	7:17:00 AM	16.00	81.51	76.00	30	410.00
Interval 40	11:18:00 PM	7:26:00 AM	7.00	87.90	52.00	29	436.00
Interval 41	9:07:00 PM	7:30:00 AM	12.00	64.31	214.00	74	409.00
Interval 42	11:57:00 PM	8:10:00 AM	25.00	81.54	69.00	36	424.00
Interval 43	1:49:00 AM	10:32:00 AM	7.00	72.79	127.00	43	396.00
n	*	*	43	43	43	43	43
Average(n)	*	*	17.60	73.93	97.65	36.49	388.14
Std Dev(n-1)	*	*	15.51	6.38	26.57	8.68	46.05

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
- Conitnuous 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
- Acurracy of actigraphic S/W detection declines with decreased SE

Sleep Medicine Reviews, Vol. 6, No. 2, pp 113–124, 2002
doi:10.1053/smrv.2001.0182, available online at http://www.idealibrary.com on IDEAL®

SLEEP MEDICINE reviews

CLINICAL REVIEW

The role of actigraphy in sleep medicine

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KEYWORDS
actigraphy, actimetry, sleep, sleep disorders, monitoring, activity, motility

Summary During the last decade actigraphy (activity-based monitoring) has become an essential tool in sleep research and sleep medicine. The validity, reliability and limitations of actigraphy for documenting sleep–wake patterns have been addressed. Normative data on sleep–wake patterns across development have been collected. Multiple studies have documented the adequacy of actigraphy to distinguish between clinical groups and to identify certain sleep–wake disorders. Actigraphy has also been shown to be effective in documenting the effects of various behavioral and medical interventions on sleep–wake patterns. Actigraphy is less useful for documenting sleep–wake in individuals who have long motionless periods of wakefulness (e.g. insomnia patients) or who have disorders that involve altered motility patterns (e.g. sleep apnea). Potential users should be aware of a number of pitfalls of actigraphy: (1) validity has not been established for all scoring algorithms or devices, or for all clinical groups; (2) actigraphy is not sufficient for diagnosis of sleep disorders in individuals with motor disorders or high motility during sleep; (3) the use of computer scoring algorithms without controlling for potential artifacts can lead to inaccurate and misleading results.

"cost-effective method for assessing specific sleep disorders but methodological issues have not been systematically addressed in clinical research and practice"

AMERICAN ACADEMY OF SLEEP MEDICINE REVIEW PAPER

The Role of Actigraphy in the Study of Sleep and Circadian Rhythms

Sonia Ancoli-Israel PhD,[1] Roger Cole PhD,[2] Cathy Alessi MD,[3] Mark Chambers PhD,[4] William Moorcroft PhD,[5] Charles P. Pollak MD[6]

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Citation: Ancoli-Israel S, Cole R, Alessi C et al. The role of actigraphy in the study of sleep and circadian rhythms. American Academy of Sleep Medicine Review Paper. *SLEEP* 2003;26(3):342-92.

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.

AMERICAN ACADEMY OF SLEEP MEDICINE PRACTICE PARAMETERS

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, MD[12]

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PRACTICE PARAMETER

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

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Table 2—AASM Levels of Recommendations

Term	Definition
Standard	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.
Guideline	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.
Option	This is a patient-care strategy, which reflects uncertain clinical use. The term option implies either inconclusive or conflicting evidence or conflicting expert opinion.

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

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

CONCLUSIONS

Actigraphy is commonly used in patients suspected of advanced sleep phase syndrome (ASPS), delayed sleep phase syndrome (DSPS) or shift work sleep disorder.

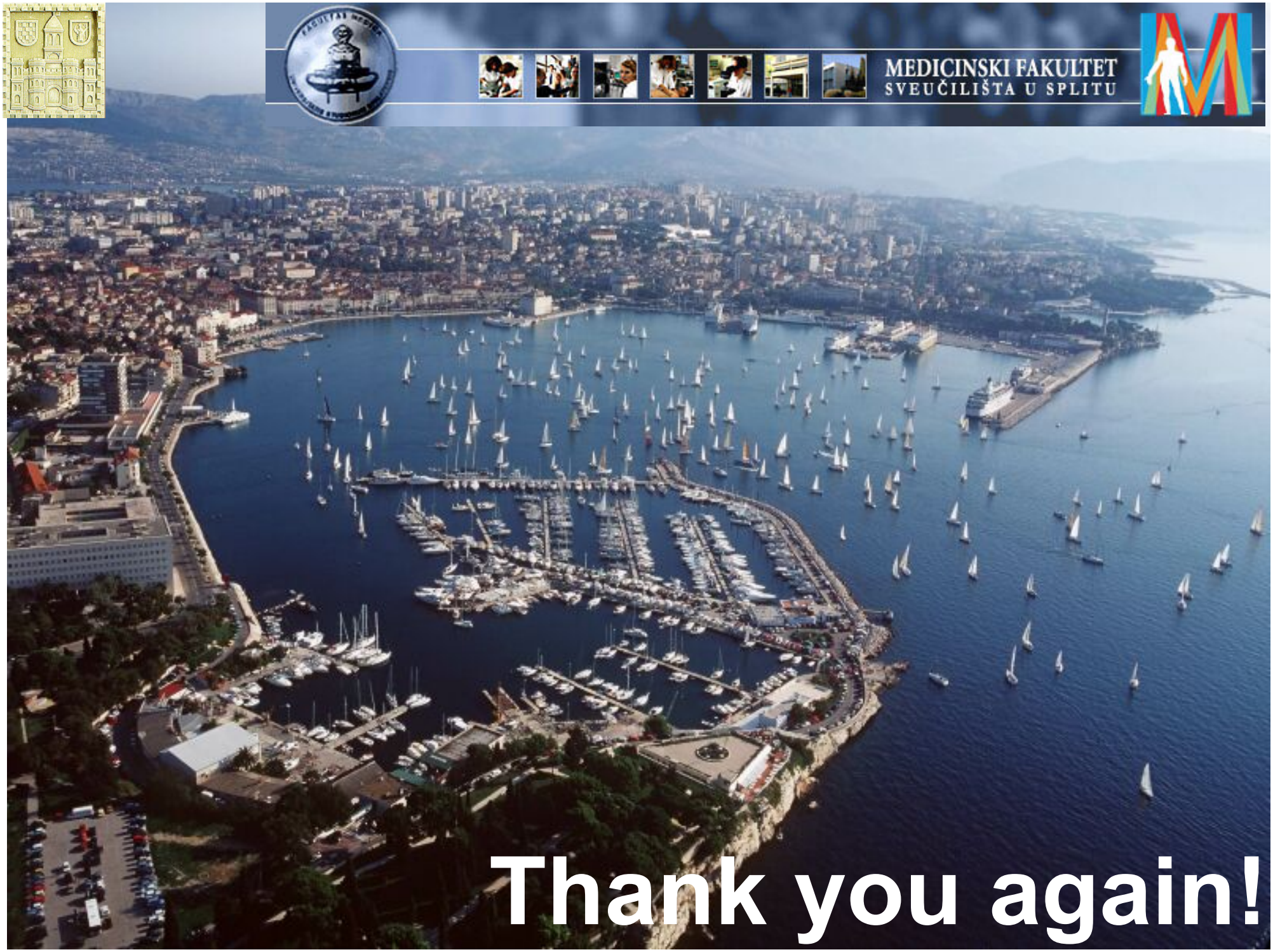
It can also be indicated in circadian rhythm disorders including jet lag and non 24-hour sleep/wake syndrome including that associated with blindness.

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.


MEDICINSKI FAKULTET
SVEUČILIŠTA U SPLITU
Thank you again!