

Actigraphy assessment of sleep disturbance in patients with atopic dermatitis: An objective life quality measure

Bruce G. Bender, PhD,^{a,b} Susan B. Leung, RN,^a and Donald Y. M. Leung, MD, PhD^{a,b}

Denver, Colo

Background: Patients with atopic dermatitis (AD) frequently report compromised quality of life because of disturbed sleep and daytime fatigue secondary to their skin disease, but few studies provide objective measurement of sleep change in this population.

Objective: The purpose of this investigation was to contrast subjective and objective measures of sleep quality in patients with AD.

Methods: Fourteen adult patients with AD and 14 adult control subjects with no skin disease wore actigraphs for 1 week and completed questionnaires about sleep, itch, and quality of life.

Results: As measured by self-report and actigraphy, the AD group slept more poorly and reported more daytime fatigue than the control group. Actigraphy alone was correlated with itch and quality of life and was able to discriminate movement during sleep, number of awakenings, minutes asleep, and minutes awake.

Conclusions: Results from this study demonstrate that sleep is significantly compromised in patients with AD. Patients' perception of their sleep provides less detail and accuracy than actigraphy. The actigraph is an objective, unobtrusive measure of sleep at home in patients with skin disease and can provide an important outcome measure in clinical trials. (J Allergy Clin Immunol 2003;111:598-602.)

Key words: Atopic dermatitis, sleep, actigraph

Atopic dermatitis (AD) is a chronic, relapsing, pruritic, inflammatory skin disease with significant costs and morbidity to patients.¹ Quality of life in patients with AD can be significantly compromised by their disease.^{2,3} Sleep disturbance associated with AD is a particularly troublesome factor contributing to irritability, daytime fatigue, increased absence, decreased performance, and general malaise.^{4,5} Improved sleep quality and consequent daytime functioning is therefore an important endpoint for evaluation of treatment success. Clinical trials of AD treatment can measure sleep through objective measurement or patient reporting. Objective measure-

Abbreviations used

AD: Atopic dermatitis

DLQI: Dermatology Life Quality Index

PSQI: Pittsburgh Sleep Quality Index

ment of sleep in patients with AD has included the use of polysomnography,^{6,7} video monitoring,⁸ and scratch electrodes.⁶ Such technology is both expensive and intrusive and can be difficult to use over many nights. Self-report measures, typically involving completion of paper-and-pencil questionnaires, are relatively easy and inexpensive to administer but cannot provide information that is as detailed and accurate as that provided by technology-based assessment.^{5,9} Wrist actigraphy, which is unobtrusive and can be easily used over repeated nights, discriminates well between sleep and wakefulness¹⁰ and provides information consistent with polysomnography^{11,12} in normal subjects.

METHODS

Subjects

Fourteen adult patients with AD (11 female, 3 male; mean age, 40.1 ± 12.8 years) and 14 adults without skin disease (11 female, 3 male; mean age, 40.0 ± 8.4 years) participated in this study. All patients had moderate to severe AD; the percent of body surface involvement ranged from 5% to 55% (mean, 21.1%; SD, 17.3%). Sleep history was not examined in determining eligibility.

Procedures

Each participant attended 2 study visits. At the first visit, informed consent was obtained and the participant completed the Pittsburgh Sleep Quality Index (PSQI); each patient with AD also completed the Dermatology Life Quality Index (DLQI) and Itch Rating Scale. Each participant was instructed to wear the actigraph on the nondominant wrist (Fig 1) until the second visit, 1 week later, at which time the actigraph was collected and the questionnaires were again completed.

Pittsburgh Sleep Quality Index. The PSQI is a 23-item questionnaire that generates scales reflecting daytime dysfunction (eg, "How often have you had trouble staying awake while driving, eating meals, or engaging in social activity?"), sleep latency (eg, "How long has it usually taken you to fall asleep at night?"), disturbance (eg, "How often have you had trouble sleeping because you wake up in the middle of the night or in the early morning?"), duration (eg, "How many hours of actual sleep did you get at night?"), quality (eg, "How would you rate your sleep quality overall?"), and efficiency (time asleep vs total time in bed).

From ^athe Division of Pediatric Allergy/Immunology, National Jewish Medical and Research Center, and ^bthe Department of Pediatrics, University of Colorado Health Sciences Center.

Received for publication November 1, 2002; revised December 5, 2002; accepted for publication December 10, 2002.

Reprint requests: Donald Y. M. Leung, MD, PhD, National Jewish Medical and Research Center, 1400 Jackson Street, Room K926i, Denver, CO 80206.

© 2003 Mosby, Inc. All rights reserved.

0091-6749/2003 \$30.00 + 0

doi:10.1067/mai.2003.174

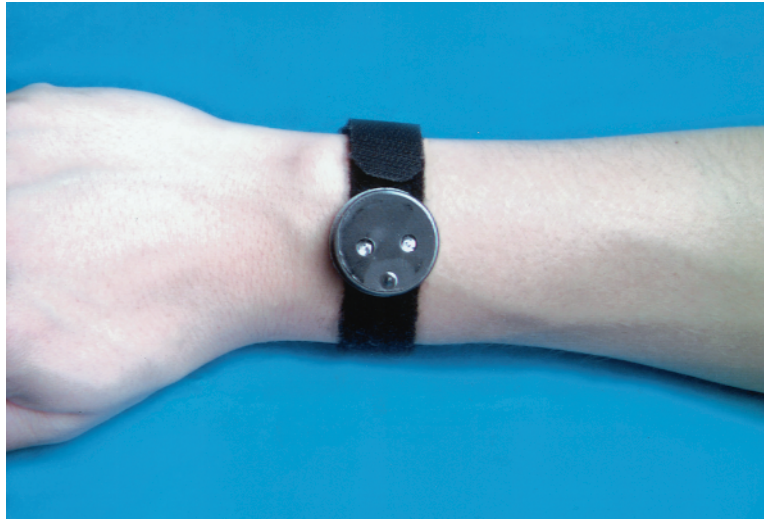


FIG 1. The MicroMini Motionlogger. Infrared transmitters and sensors, seen as small metallic dots in the face of the device, are used to communicate with the computer base device, identifying the device and downloading activity recordings during study visits.

TABLE I. Descriptive statistics and *P* values for comparisons of questionnaire variable and objective sleep measures between 2 groups: atopic dermatitis and control

Variable	Group	N	Mean	SE	<i>P</i> value
Self-report					
Awakenings	AD	14	2.14	0.258	.0435
	Control	14	1.33	0.279	
Sleep quality	AD	14	1.36	0.15	.0045
	Control	14	0.58	0.16	
Sleep latency	AD	14	1.43	0.22	.1004
	Control	14	0.58	0.24	
Sleep duration	AD	14	0.71	0.20	.1510
	Control	14	0.25	0.21	
Sleep efficiency	AD	14	0.64	0.25	.0946
	Control	14	0.00	0.27	
Sleep disturbance	AD	14	1.43	0.16	.142
	Control	14	1.17	0.18	
Daytime dysfunction	AD	14	1.21	0.16	.0017
	Control	14	0.33	0.17	
Global PSQI score	AD	14	7.00	0.75	.0044
	Control	14	3.42	0.81	
Actigraphy					
Time in bed	AD	14	459.3	16.1	.4795
	Control	14	474.3	12.7	
Activity episodes	AD	14	18.1	2.3	.0445
	Control	14	10.6	2.5	
Minutes awake	AD	14	57.3	9.5	.0480
	Control	14	32.3	10.3	
Minutes asleep	AD	14	402.0	14.2	.0472
	Control	14	442.1	15.4	
Sleep efficiency	AD	14	90.6	1.6	.0305
	Control	14	95.0	1.8	
Average sleep episode (min)	AD	14	44.4	6.6	.0193
	Control	14	198.5	57.7	
Longest sleep episode (min)	AD	14	156.8	23.1	.0253
	Control	14	273.3	44.1	
Sleep latency (min)	AD	14	14.4	2.8	.4550
	Control	14	11.3	3.1	
Awake episodes	AD	14	13.9	2.1	.0250
	Control	14	7.2	2.3	
Average awake episodes (min)	AD	14	4.0	0.6	.0232
	Control	14	2.0	0.7	
Longest awake episodes (min)	AD	14	18.3	2.9	.0346
	Control	14	10.9	3.1	

AD, Atopic dermatitis.

TABLE II. Associations between sleep measure, itch, and quality of life

	Self-report						
	Awakenings	Sleep quality	Sleep latency	Sleep duration	Sleep efficiency	Sleep disturbance	Daytime dysfunction
Itch score	0.005	0.096	0.507*	0.027	0.150	0.002	0.163
Health Status Survey Scores	0.119	0.080	0.046	0.107	0.019	0.141	0.122

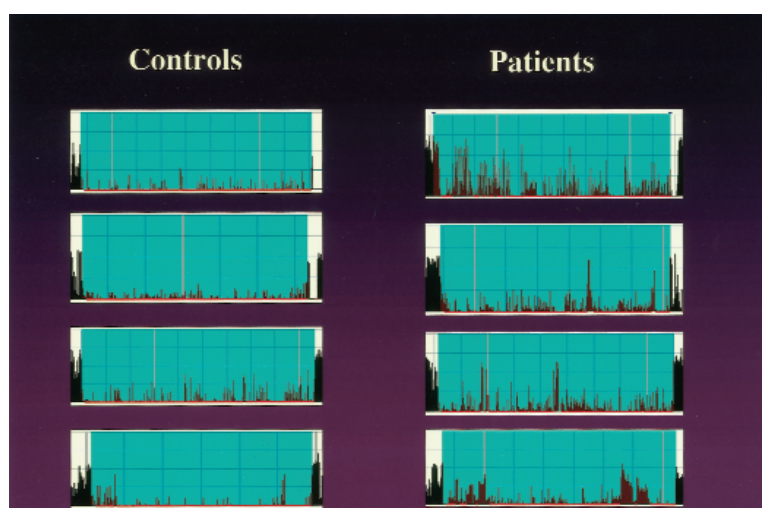
* $P < .05$.** $P < .10$.

FIG 2. Nocturnal actigraph readings from selected participants. Increased nighttime activity is identified in larger vertical lines; periods of deep sleep are reflected in very small lines. Assessment of asleep and awake intervals was completed with software provided by the manufacturer.

Dermatology Life Quality Index. The 10-item DLQI (developed by Finlay and Khan³ in 1994) is a well-established questionnaire that inquires about the impact of AD on the patient's life (eg, "How embarrassed or self conscious have you been because of your skin?").

Itch rating. The itch rating scale consists of a 100-mm line on which the patient indicates a point between "Worst itch imaginable" and "No itch."

Actigraph. Actigraph technology was established by the US Army in the early 1980s to assess sleep in battlefield conditions; it was later used to assess sleep in astronauts. The MicroMini Motionlogger (Ambulatory Monitoring, Inc, Ardsley, NY) uses this technology in a small, durable device that can be worn on the wrist in almost any environment. The MicroMini Motionlogger produces a piezoelectric bimorph-ceramic cantilevered beam, which generates a voltage each time the actigraph is moved. That voltage is passed to the second essential element of the MicroMini Motionlogger, the analog circuitry. Here the original signal is amplified and filtered according to a 2- to 3-Hz bandpass filter.

With frequency of movement selected as a collection mode in this study, a counter was incremented each time the movement signal crossed a threshold set to correspond to approximately 0.01g of acceleration. This derived information was accumulated over a fixed 1-minute period. Once data were retrieved from the device, sections corresponding to time spent trying to sleep were marked and scored by means of a sleep estimation algorithm validated to agree with polysomnographically scored sleep to approximately 88% in normal subjects, discriminating well between sleep and awake states. Careful adherence to calibrations standards ensures actigraph reproducibility to within 10% for

normal motion for measurement of motion frequency, duration, and intensity.¹⁰

RESULTS

Self-report sleep measure

Mean scores of the AD group were significantly different from those of the control group on 3 of 8 variables and the global score from the PSQI ($P < .05$; Mann-Whitney U test; Table I). The AD group, on average, reported lower sleep quality and more awakening and daytime dysfunction than did the control group. No significant between-group differences emerged with respect to the sleep latency, duration, efficiency, or sleep disturbance variables, though sleep efficiency approached significance ($P = .0946$).

Actigraphy sleep measurement

Time in bed did not differ between the 2 groups. Nine of the 10 sleep measure mean scores of the AD group were significantly different from those of the control group ($P < .05$; Mann-Whitney U test; Table I). Although they did not take longer to fall asleep initially, patients with AD slept less, awoke more often, and spent more time awake during these waking episodes, the result being lower overall sleep efficiency than was seen in the controls (Fig 2).

Global PSQI score	Activity episodes	Actigraphy							
		Minutes awake	Minutes asleep	Sleep efficiency	Average sleep episode	Longest sleep episode	Sleep latency	Awake episodes	Longest awake episode
0.030	0.392**	0.350*	0.047	0.384*	0.462*	0.291**	0.022	0.298**	0.322**
0.001	0.181	0.267**	0.000	0.285**	0.266**	0.276**	0.006	0.253**	0.122

Relationships between sleep quality, perceived itch, and quality of life

Spearman correlations between the 18 sleep measures, including those based on self-reporting and actigraphy, and each of the itch and quality-of-life scores were generated (Table II). Overall, more associations were found with the actigraph than with the self-report scores. Of the 8 self-report sleep measures, one correlated significantly with the itch score and none correlated with the quality-of-life score. For the 9 actigraph sleep measures, 3 correlated significantly with the itch score, whereas correlations approached significance with itch on 4 actigraph scores and with the quality-of-life score on 5 actigraph scores.

DISCUSSION

This study demonstrates through objective measurement that adults with AD sleep less well than those without the disease. Furthermore, sleep loss secondary to AD is associated with increased itching and decreased quality of life. There were no differences between patients with AD and control patients in sleep latency or total amount of time spent in bed; only 40 minutes separated the 2 groups with respect to the total amount of time spent sleeping each night. Most striking were the increased activity levels and awakening episodes in the members of the AD group, who on average awoke twice as often as the members of the control group. Such fragmented sleep likely led to increased reports of daytime fatigue and impaired functioning in the AD group.

Actigraphy provided more discriminating information about sleep fragmentation in the patients with AD than did self-reporting. Group differences emerged on more actigraph variables than self-report variables, and actigraphy variables alone were significantly associated with itch score. Perception of itch increased with increasing minutes awake and decreasing sleep efficiency. In addition, nonsignificant trends ($P < .10$) suggested that increasing minutes awake and number of awake episodes were associated with increasing itch and decreasing quality of life. Although participants appeared able to judge frequent awakening, overall poor sleep quality, and daytime fatigue, more precise estimates of the numbers of minutes slept each night and exact counts of movement or awakening were possible only with actigraphy.

Discrepancies between self-reporting and objective measurement of sleep have been previously reported.^{9,11} Adults with nocturnal asthma, in contrast to

control subjects, reported reduced overall sleep quality but not increases in frequency of awakenings even though polysomnographic measurement revealed differences in sleep efficiency, latency, and awakenings.¹³ Daily sleep diaries might provide more accurate sleep estimates than self-report summaries of extended time periods. However, compliance with daily sleep diaries (71%) was less than actigraphy compliance (90%) in a study of ambulatory blood pressure monitoring.¹⁴ Self-assessment of sleep was limited to the PSQI; it remains to be determined whether similar measurement discrepancies would emerge if patients were to complete daily sleep diaries.

Results from this study indicate that actigraphy can provide detailed assessment of sleep in patients with AD. Actigraphy has also been used in studies of childrens' sleep⁹ and by clinical sleep laboratories to assess sleep at home over short and long periods.¹⁵ Such measurement provides an alternative and objective means of assessing the impact both of AD and its treatment on patient quality of life. Furthermore, actigraphy is unobtrusive, is well-accepted by patients, and can measure sleep over many nights, providing the opportunity to assess changes in sleep patterns. This measure can therefore be used to provide accurate and objective assessment of response to treatment in AD clinical trials.

REFERENCES

1. Leung DY. Atopic dermatitis: new insights and opportunities for therapeutic intervention. *J Allergy Clin Immunol* 2000;105:860-76.
2. Bender BG. Psychological dysfunction associated with atopic dermatitis. *Immunol Allergy Clin No Am* 2002;22:43-53.
3. Finlay AY, Khan GK. Dermatology Life Quality Index (DLQI)—a simple practical measure for routine clinical use. *Clin Exp Dermatol* 1994;19:210-6.
4. Ebata T, Iwasaki S, Kamide R, Niimura M. Use of a wrist activity monitor for the measurement of nocturnal scratching in patients with atopic dermatitis. *Br J Dermatol* 2001;144:305-9.
5. Dahl RE, Bernhisel-Broadbent J, Scanlon-Holdford S, Sampson HA, Lupo M. Sleep disturbances in children with atopic dermatitis. *Arch Pediatr Adolesc Med* 1995;149:856-60.
6. Reuveni H, Chapnick G, Tal A, Tarasiuk A. Sleep fragmentation in children with atopic dermatitis. *Arch Pediatr Adolesc Med* 1999;153:249-53.
7. Stores G, Burrows A, Crawford C. Physiological sleep disturbance in children with atopic dermatitis: a case control study. *Pediatr Dermatol* 1998;15:264-8.
8. Ebata T, Aizawa H, Kamide R. An infrared video camera system to observe nocturnal scratching in atopic dermatitis patients. *J Dermatol* 1996;23:153-5.
9. Corkum P, Tannock R, Moldofsky H, Hogg-Johnson S, Humphries T. Actigraphy and parental ratings of sleep in children with attention-deficit/hyperactivity disorder (ADHD). *Sleep* 2001;24:303-12.

10. Cole RJ, Kripke DF, Gruen W, Mullaney DJ, Gillin JC. Automatic sleep/wake identification from wrist activity. *Sleep* 1992;15:461-9.
11. Sadeh A, Sharkey KM, Carskadon MA. Activity-based sleep-wake identification: an empirical test of methodological issues. *Sleep* 1994;17:201-7.
12. Jean-Louis G, Kripke DF, Cole RJ, Assmus JD, Langer RD. Sleep detection with an accelerometer actigraph: comparisons with polysomnography. *Physiol Behav* 2001;72:21-8.
13. Fitzpatrick MF, Engleman H, Whyte KF, Deary IJ, Shapiro CM, Douglas NJ. Morbidity in nocturnal asthma: sleep quality and daytime cognitive performance. *Thorax* 1991;46:569-73.
14. Eissa MA, Poffenbarger T, Portman RJ. Comparison of the actigraph versus patients' diary information in defining circadian time periods for analyzing ambulatory blood pressure monitoring data. *Blood Press Monit* 2001;6:21-5.
15. Practice parameters for the use of actigraphy in the clinical assessment of sleep disorders. American Sleep Disorders Association. *Sleep* 1995;18:285-7.