

SPECIAL POPULATIONS

Assessment of Intervention for Infant Night Waking: Parental Reports and Activity-Based Home Monitoring

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Sleep patterns of 50 infants (aged 9–24 months) with sleep disturbances were studied by using an activity monitor (actigraph) and parental reports during the baseline and intervention periods. Two behavioral intervention methods were used to treat the multiple or prolonged night-waking problems. Infant sleep significantly improved during the period of intervention as measured by both actigraphic and parental monitoring. The discrepancy between parental and actigraphic measures increased over time, as did the number of omitted items from the parental daily logs. The results highlight some of the advantages as well as some of the limitations of actigraphic and parental monitoring of infant sleep, and they suggest that the two methods may have complementary roles in assessing intervention efficacy in this field.

Sleep-wake organization and consolidation of sleep are major developmental tasks during the first year of life. Surveys of infant sleep indicate that 10–30% of all children experience difficulties in this area during the first few years of life (e.g., Johnson, 1991; Richman, 1987). Longitudinal studies have indicated that infant sleep problems are persistent and may become a chronic problem if not treated (Kataria, Swanson, & Trevathan, 1987; Richman, Stevenson, & Graham, 1982; Zuckerman, Stevenson, & Bailey, 1987). Most infants wake up during the night (Anders, 1978; Paret, 1983). However, some infants signal their wakefulness whereas others do not (Keener, Zeanah, & Anders, 1988; Sadeh, Lavie, Scher, Tirosh, & Epstein, 1991). Whether infants signal when they wake up is a crucial issue both in the evaluation of sleep problems and with regard to parents' knowledge about their infant's sleep.

Sleep problems in early childhood and possible intervention methods have been extensively described and discussed in the clinical literature (e.g., Douglas & Richman, 1984; Ferber, 1985). In the few studies focusing on assessment of intervention or prevention efficacy, assessment was based solely on parental reports (e.g., Adair, Zuckerman, Bauchner, Philipp, & Levenson, 1992; Jones & Verduyn, 1983; Richman, Douglas, Hunt, Lansdown, & Levere, 1985; Rickert & Johnson, 1988; Wolfson, Lacks, & Futterman, 1992). This method has serious limitations because parents' perceptions of their infant's sleep behavior may be significantly distorted by their own fatigue or biased by motivational factors unrelated to the actual sleep problems.

Recently, a new ambulatory method for the longitudinal study of sleep-wake patterns in pediatrics has been introduced

(Sadeh et al., 1991). This method is based on the actigraph, which is a small solid-state computerized activity monitor that continuously registers motility data for prolonged periods. These data can be used to derive measures of sleep-wake patterns and sleep quality with demonstrated reliability and validity (Sadeh, Alster, Urbach, & Lavie, 1989; Sadeh et al., 1991). Actigraphy has also been shown to efficiently differentiate between normal and disturbed sleep-wake patterns of adults, young children, and infants. In the present study, this method was used to conduct a systematic assessment of changes in infant sleep during behavioral intervention.

Method

Fifty healthy infants with sleep disturbances (28 boys and 22 girls), ranging in age from 9 to 24 months ($M = 14.11$, $SD = 4.21$), participated in the study. All were referred to the Technion Sleep Disorders Center by their parents because of the child's night waking problems. The severity of the problem ranged between 1 and 8 wakings each night. Infants with less than 3 wakings per night were included only if their night wakings were prolonged and lasted for more than 30 min each night. All children were from middle-class, intact families. The parents were informed about the research aspects of their child's treatment program. Their rights to refrain from participating or to discontinue their participation in the study without compromising their clinical services were also explained. During the first consultation, both parents were interviewed by a clinical psychologist. The interview was followed by a week of obtaining baseline actigraphic measures (which was completed by using an actigraph (Ambulatory Monitoring Inc., Ardsley, NY) and parental assessment of the infant's sleep. Data collected during the baseline period were used for reevaluation of the severity of the problem and for screening problems that should be treated with a different intervention strategy (one child was excluded because of inappropriate parental expectations). The results of this baseline evaluation were discussed with the parents during the second consultation, and intervention guidelines were given. Each child was randomly assigned to one of two intervention methods. The first method was the checking procedure described by Douglas and Richman (1984) and modified by Ferber (1985).

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Table 1

Actigraphic and Parental Sleep-Wake Measures During the Baseline and Intervention Periods: Means, Standard Deviations, and F Values for Differences Between Periods

Measure	Baseline				Intervention				F
	1st half		2nd half		1st half		2nd half		
	M	SD	M	SD	M	SD	M	SD	
Actigraphic									
Sleep onset time (hr)	21.2	0.96	21.3	0.88	21.3	0.90	21.3	0.91	0.1
Sleep duration (min)	585	60	567	49	575	49	564	57	2.9*
Sleep percent (%)	81.2	6.2	81.7	6.8	84.8	5.4	86.0	4.5	15.6**
Night wakings (n)	4.36	1.7	4.41	1.5	3.23	1.2	3.20	1.2	18.8**
Quiet sleep (%)	50.0	13.4	49.9	13.1	49.5	15.6	51.2	14.2	0.4
Active sleep (%)	31.2	12.6	31.8	12.8	35.3	14.2	34.8	12.2	3.4*
Parental									
Sleep onset time (hr)	20.8	0.75	20.8	0.74	20.8	0.83	20.7	0.64	1.0
Sleep duration (min)	598	49	591	52	598	57	599	56	0.5
Sleep percent (%)	92.4	6.8	94.5	4.6	95.7	3.8	97.4	2.5	9.2**
Night wakings (n)	3.70	1.8	3.52	2.1	2.01	1.3	1.61	1.2	30.9**

* $p < .05$. ** $p < .0001$.

According to this method, after the child was put to bed the parent left the room with no further involvement. If the child protested or cried, the parent waited for 5 min and then went to check the child. At this point the parent was instructed to minimize his or her involvement. This routine was repeated in exactly the same manner as long as the child continued to protest or cry. The rationale for this method was based on the behavioral extinction of active parental involvement in the child's process of self-soothing and sleep onset. According to this approach, the child who successfully falls asleep on his or her own or who becomes a self-soother is less likely to wake up during the night (Adair, Bauchner, Philipp, Levenson, & Zuckerman, 1991). Furthermore, if night wakings do occur, the child is more likely to return to sleep without parental involvement.

The second intervention method used in this study was that of parental cosleeping with the child. According to this method, one of the parents sleeps in the child's bedroom for 1 week without having any other involvement with the child throughout the night. This method is based on the assumption that in many cases infant sleep problems are related to the child's separation anxiety. The presence of the parent in the child's room is expected to reassure the child and enable him or her to sleep soundly without waking. The random assignment procedure was monitored for sex and age balance. Post hoc analysis revealed that the two intervention groups did not differ on sex, age, or sleep measures.

The data reported are those of the 50 children whose parents complied with the intervention assigned to them for at least 1 week. During the 1-3 weeks of intervention, the child's sleep was continuously monitored by daily sleep logs completed by the parents as well as by the actigraph. Parents met with the clinician on a weekly basis during the intervention. These meetings were focused on monitoring treatment progress and fidelity. In addition, the parents received further consultation and support in pursuing their program. The monitoring ended when there was an impression (usually mutual, but in some cases parental only) that the intervention had either significantly succeeded or had failed to improve the child's sleep patterns. A total number of 740 nights were monitored during the baseline and treatment periods.

Results

Actigraphic data were analyzed with an automatic program for the IBM personal computer (ASA; Actigraph Sleep Analy-

sis), which translates the activity data into sleep-wake measures according to procedures previously described in detail (Sadeh et al., 1989, 1991). The actigraphic sleep measures included sleep onset time, sleep duration (from sleep onset time to morning awakening), number of night wakings (of 5 min or longer), sleep percent (percentage of sleep time during sleep duration), quiet sleep (percentage of time the child was motionless during sleep duration), and active sleep (percentage of time during sleep duration that the child was active but sleeping).

Four comparable measures were obtained from the daily sleep logs recorded by the parents (sleep onset time, sleep duration, number of night wakings, and sleep percent).

In all data analysis procedures, gender was used as one of the factors in the analysis of variance (ANOVA) design. The only gender-related difference was the amount of active sleep, in both sleep disturbed and control groups (Sadeh et al., 1991). Boys spent significantly higher percentages of their sleep duration in active sleep than did girls. All statistical analyses were performed with treatment method (checking vs. cosleeping) as a between-groups factor in the ANOVA. No significant differences between intervention methods were found, nor were there any significant interactions related to the intervention method. In addition, the two intervention groups did not differ in the length of treatment. Therefore, the two intervention groups were pooled in the following analyses. In the analysis of changes from baseline to intervention, these periods were divided in half to assess both the within-period tendencies and the between-periods changes. Each sleep measure (parental and actigraphic) was averaged for each period for each subject. ANOVA for repeated measures, with the period as the repeated measure, was used to determine treatment-related effects and other possible time-related changes. Post hoc Duncan tests were conducted to test for specific within-period and between-periods differences. The results are summarized in Table 1. Raw activity data are illustrated in Figure 1. These records demonstrate the changes in sleep patterns of a 1-year-old boy, between baseline and the cosleeping intervention.

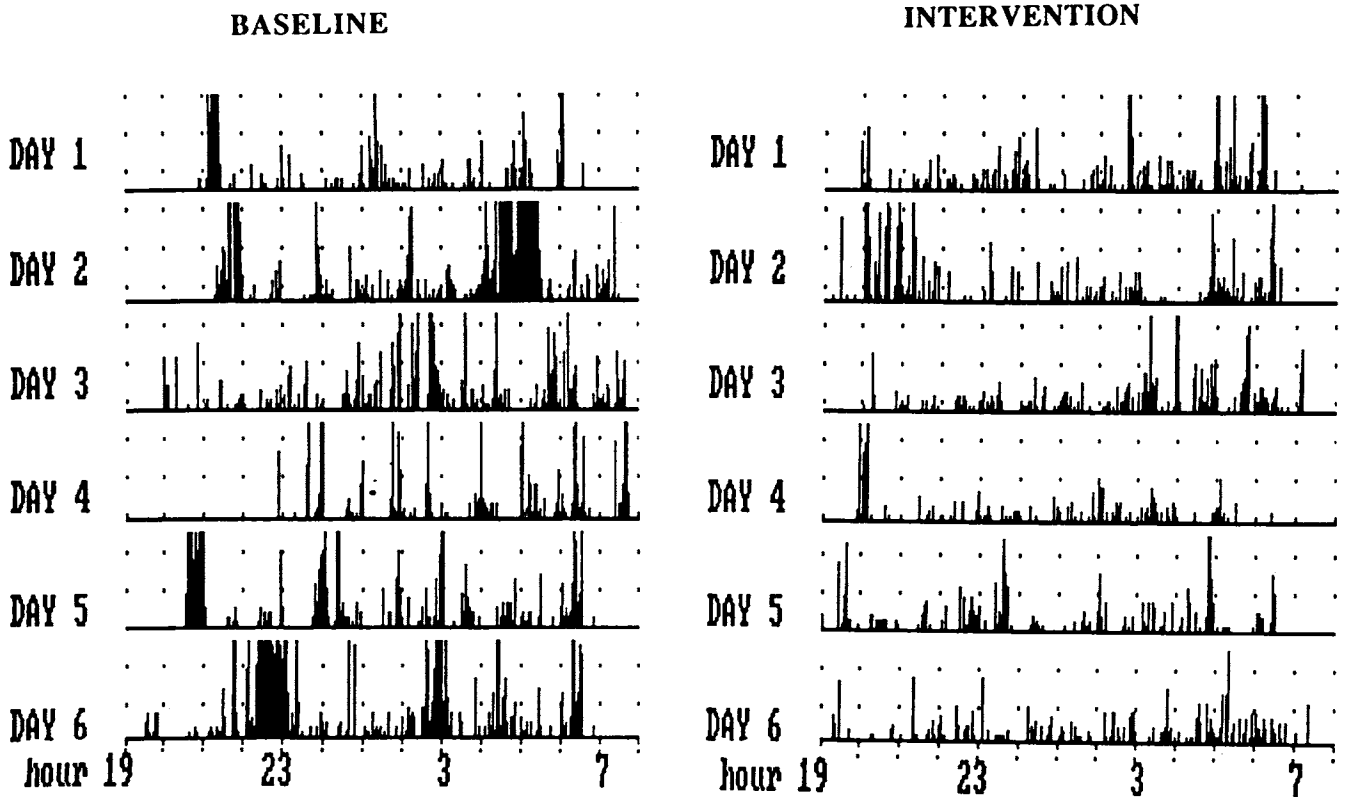


Figure 1. Raw activity data of a 1-year-old boy during the baseline and intervention periods; black bars indicate level of activity. Bedtime starts at first indication of activity and ends with the last one. Visual guideline for estimation of wake states is any activity level of more than half of the maximum activity level.

Actigraphic sleep duration changed significantly during the monitoring period, $F(3, 147) = 2.91, p < .05$. Actigraphic sleep quality measures reflected a significant improvement of sleep during the intervention period as compared with the baseline period. Actigraphic sleep percent increased from 81.2% and 81.7% during the first and second halves of the baseline period, respectively, to 84.8% and 86.0% during the two halves of the treatment period, $F(3, 147) = 15.6, p < .0001$. The number of night wakings identified by the actigraph decreased from 4.36 and 4.41 during the baseline period to 3.23 and 3.20, respectively, during the treatment period $F(3, 147) = 18.8, p < .0001$. The percent of active sleep increased from 31.2% and 31.8% during the baseline period to 35.3% and 34.7%, respectively, during the treatment period, $F(3, 147) = 3.38, p < .05$. No significant changes were found with regard to sleep onset time or percent of quiet sleep.

Sleep measures that were based on parental reports revealed comparable trends, with some notable differences. No significant changes were found for sleep duration and sleep onset time. Sleep percent increased gradually from 92.4% and 94.5% during the two halves of the baseline period to 95.7% and 97.4%, respectively, during the treatment period, $F(3, 147) = 9.12, p < .0001$. The post hoc analysis revealed that this change was gradual and started during the baseline period; the parental sleep percent in the second half of the baseline period (94.5%) was significantly higher than that of the first half (92.4%). The num-

ber of night wakings decreased significantly from 3.70 and 3.52 during the baseline periods to 2.01 and 1.61 during the treatment periods, $F(3, 147) = 30.9, p < .0001$.

To further explore the timing of the changes in the sleep quality measures (sleep percent and number of night wakings), I plotted the average values of these measures for the first 6 baseline nights and the first 12 intervention nights. Figures 2 and 3 illustrate the daily changes in the actigraphic and parental measures of night wakings and sleep percent. It is evident that the major change occurred during the first night of intervention. Also, there were differences between parental and actigraphic sleep measures, which increased during the treatment period.

To gain a better understanding of the changes occurring during the intervention periods at the individual level, I conducted a test for significance of change at the individual level and analyzed parental overall ratings of treatment success. Individual changes in sleep patterns were analyzed with Lacks's (1989) method for testing the significance of clinical changes. This method involves a repeated measures design for assessing changes from baseline to treatment period for each individual (with between-periods variability and daily individual variability used for the statistics). When this method was used, 26 children (52%) showed significant improvement with respect to their actigraphic sleep quality measures, and 30 children (60%) showed significant improvement in their sleep quality according to the measures derived from the parental daily logs. This anal-

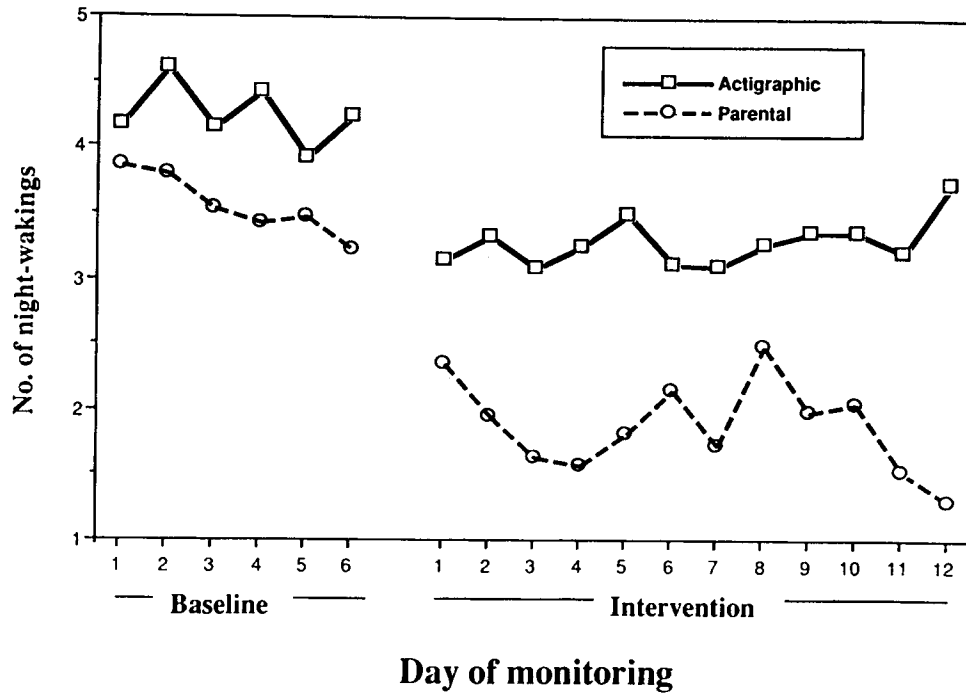


Figure 2. Night wakings during baseline and intervention periods for actigraphic and parental monitoring.

ysis method yielded only 60% agreement rate between parents and actigraphy on the issue of significant versus nonsignificant improvement during treatment. This agreement rate is not significantly higher than chance, computed with kappa statistics

($k = .19$; $z = 1.15$). Pearson product-moment correlations between actigraphic and parental measures (for the entire monitoring period) were relatively high for the sleep schedule measures of sleep onset time ($r = .89$; $p < .0001$) and sleep duration

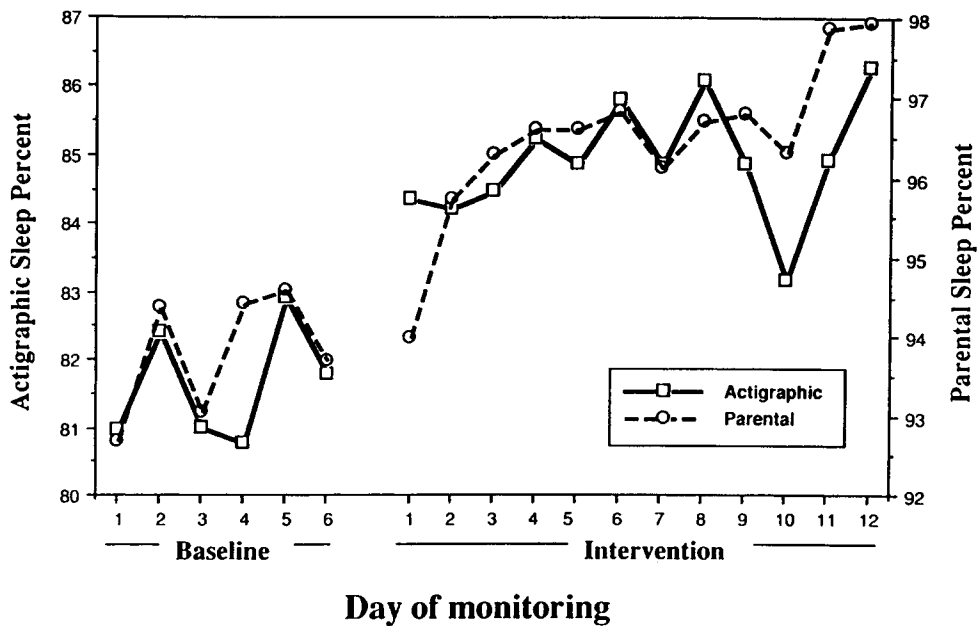


Figure 3. Sleep percentage during baseline and intervention periods for actigraphic (left scale) and parental (right scale) monitoring.

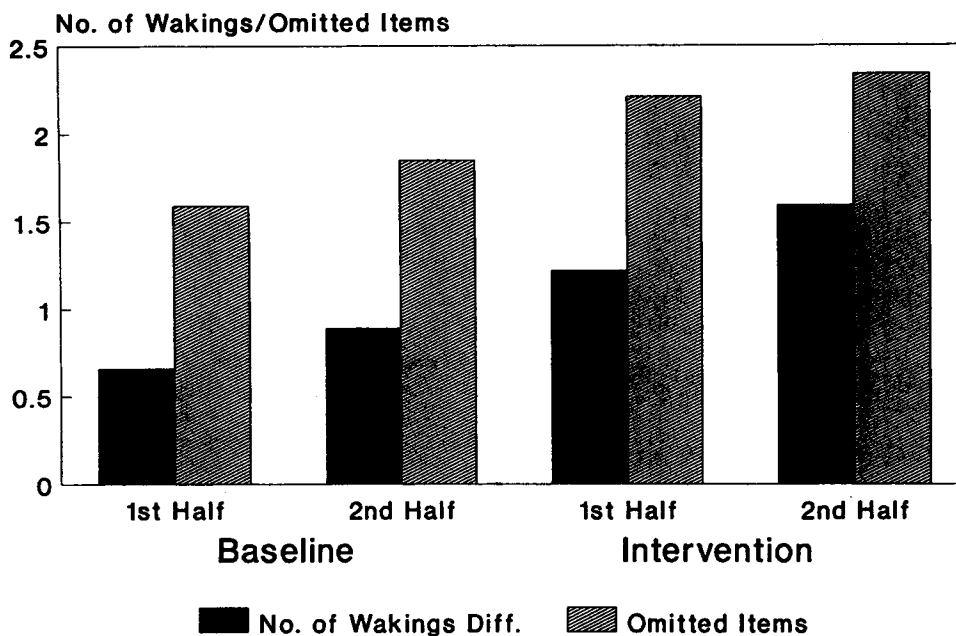


Figure 4. Differences between number of night wakings monitored by actigraphy and by parents, and number of items omitted by the parents from daily logs during the baseline and treatment periods. Diff. = difference.

($r = .82$; $p < .0001$) and low for the sleep quality measures of number of night wakings ($r = .38$; $p < .01$) and sleep percent ($r = .10$). From a subjective perspective, on an overall 5-point scale, parents of 34 children (68%) indicated that the treatment completely solved the night waking problem; for 10 children (20%) a very significant improvement was achieved; for 6 children (12%) the parents considered the treatment either totally ineffective or as having very limited positive effect. None of the parents reported that the problem worsened during treatment.

I conducted two-way ANOVAs to test differences between the parental and actigraphic measures during the baseline and treatment periods. There was a significant increase in the discrepancy between the actigraphic and the parental measure of night wakings, $F(3, 147) = 5.5$, $p < .005$. During the baseline periods the actigraphic analysis detected on average 0.66 and 0.89 wakings more than the parents reported (for the two halves of the period, respectively); during the treatment periods these differences increased to 1.22 during the first half and 1.59 during the second half (see Figure 4). Post hoc Duncan analysis revealed that only the first half of the baseline and the second half of the treatment period differed significantly.

I also tested the hypothesis that parental fatigue or other time-related effects contributed to parental failure to report on the daily logs, thus increasing the discrepancy between the measures. The number of missing items on the parents' daily logs was examined (see Figure 4). The ANOVA revealed a significant increase in the expected direction, $F(3, 147) = 12.6$; $p < .0001$. The post hoc Duncan analysis revealed that the number of items omitted from the daily logs was significantly higher during the intervention periods (2.21 and 2.34 for the first and second halves, respectively) compared with the baseline periods (1.59 and 1.85, respectively).

Discussion

In this study I explored changes in infant sleep patterns during behavioral intervention for sleep problems. In addition to the traditional parental reports, objective actigraphic monitoring was used for intervention follow-up. Both parents and actigraphy indicated improvement during the intervention period, which was demonstrated by the reduced number of night wakings and the increased sleep percent. However, the lack of control groups and the similarity in outcomes of the two intervention methods precludes interpretation of factors leading to this improvement.

Actigraphic and parental measures reflected similar trends although interesting discrepancies were noted with regard to sleep quality or sleep continuity. Of special interest is the growing discrepancy between the number of actigraphically detected night wakings and the number reported by parents. The examination of the individual clinical material and the increased tendency of parents to omit items from their daily logs suggests that two processes might have caused the discrepancy. Parents appeared to have become exhausted by the procedure (if not by the sleep problem), or perhaps they were less motivated following a positive change and consequently failed to report the occurrence of night wakings. At the same time, infants tended to signal less when they woke up, presumably because they had progressively acquired self-soothing capacities.

Parents can provide relevant information regarding infant sleep and its social context. However, often parents either are unaware of the many aspects of their infant's sleep patterns or fail to report them. Therefore, it is essential to further explore infant sleep by using both objective and subjective measures.

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