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# Help Me Make It Through the Night: Behavioral Entrainment of Breast-Fed Infants' Sleep Patterns

Teresa Pinilla, PhD, and Leann L. Birch, PhD

**ABSTRACT.** The study objective was to investigate whether exclusively breast-fed infants could be taught to sleep through the night (defined from 12:00 AM to 5:00 AM) during the first 8 weeks of life. The design was short-term longitudinal, from the last trimester of pregnancy until the eighth week after birth. Twenty-six first-time parents and their newborn were randomly assigned to treatment and control groups (13 in each group). Treatment parents were instructed to offer a "focal feed" (between 10 PM and 12 AM) to their infants every night, to gradually lengthen intervals between middle-of-the-night feeds by carrying out alternative caretaking behaviors (eg, reswaddling, diapering, walking), and to maximize environmental differences between day and nighttime. All parents kept 72-hour diaries of their infants' feeding and sleeping patterns every week from birth to 8 weeks of age and rated their infants' temperament at birth and at 8 weeks. By 3 weeks, treatment infants showed significantly longer sleep episodes at night. By 8 weeks 100% of treatment infants were sleeping through the night compared to 23% of control infants. Treatment infants were feeding less frequently at night but compensated for the relatively long nighttime interval without a feed by consuming more milk in the early morning. Milk intake for 24-hour periods did not differ between groups. Treatment infants were rated as more predictable on Bates' Infant Characteristics Questionnaire. It is concluded that parents can have a powerful influence on the development of their infants' sleep patterns. Frequent night waking in breast-fed infants often results in early termination of lactation. Parents can teach their breast-fed infants to lengthen their nighttime sleep bouts, making the continuation of breast-feeding easier for the new mother. *Pediatrics* 1993;91:436-444; *breast-feeding, sleep patterns, behavioral entrainment, temperament*.

ABBREVIATION. ANOVA, analysis of variance.

Sleeping through the night has been assumed to be an early developmental milestone, governed primarily by maturational factors. Relatively little attention has been given to the hypothesis that the point at which sleeping through the night begins can be influenced by environmental factors. Especially in industrialized, Western societies where mothers need to return to work outside the home while the infant

is still relatively young, the disruption caused by an infant whose sleep/wake schedules are not synchronized with those of the parents is an issue of very high priority within the household.<sup>1</sup>

Despite the widely recognized advantages of human milk for the young infant,<sup>2,3</sup> mothers in the United States are discontinuing breast-feeding for a variety of reasons. While the incidence of lactation has been increasing over the past three decades in the United States,<sup>3,4</sup> duration of lactation is still below the recommended goal of at least 6 months.<sup>5,6</sup> Reasons for the discontinuation of breast-feeding include returning to work,<sup>7</sup> lack of support for breast-feeding, or maternal beliefs about breast-feeding.<sup>8</sup> Breast-fed infants feed more frequently and have shorter intermeal intervals, and this pattern is sustained around the clock.<sup>9-11</sup> The mother's need for an uninterrupted night's sleep may be promoting the early cessation of breast-feeding. Breast-feeding mothers, comparing the sleep behaviors of their infants with those of formula-fed infants, may develop beliefs of personal inadequacy in mothering. Wide differences in sleep patterns between breast-fed and bottle-fed infants have been noted in the literature; in particular, breast-fed infants have typically been observed to begin sleeping through the night (settling) at a later age than bottle-fed infants and to be frequent night wakers,<sup>11-16</sup> so breast-feeding mothers may be tempted to change their feeding regimen in order to get their infants to sleep through the night. Even in the popular press, sleeping through the night at an earlier age is quoted as one of the "advantages" of formula-feeding.<sup>17</sup>

Developmental factors, including biological/neurological and maturational processes, are crucial in the formation of sleep/wake cycles in infancy. The type of environment that parents provide can affect the infant's sleep patterns. Bedtime routines and/or the way parents respond in the middle of the night to their crying infant can interfere with the formation of diurnal sleep/wake cycles.<sup>18-20</sup> Finally, the infant's temperament makes unique contributions to the development of sleep/wake routines. Several investigators have observed a relationship between infant temperament characteristics and nighttime sleep disturbances. Associations between low sensory threshold<sup>14</sup> and "difficult" temperament ratings<sup>21-24</sup> and night waking problems have been reported. The problem with these studies is that parents were asked to rate their perceptions of their infants' temperament once sleep disturbances were an established difficulty. Parents' perceptions may have been

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different if the sleep problems had been avoided in the first place.

Sleeping through the night or "settling" does not refer to sleeping the entire night. In the infant sleep literature, settling is defined as sleeping without waking between about 12:00 AM and 5:00 AM for several consecutive nights.<sup>16,18-20,25,26</sup> Periodic awakenings during the night, however, are not uncommon in adults, and children and infants show this pattern as well. Anders<sup>27</sup> observed that almost 50% of the parents of 2-month-old infants reported that their children "slept through the night," but when the infants' sleep was recorded on time-lapse videotape, only 15% actually slept through the night without awakening.<sup>26-28</sup> Most infants are able to return to sleep on their own without their parents' knowledge that they had awakened.

We investigated the effects of a behavioral training program focused on facilitating the breast-fed infants' transition to sleeping through the night. The primary aim of this study was to compare the sleeping and feeding patterns of two groups of exclusively breast-fed infants from birth to 8 weeks of age. Half of the infants' parents in the study received specific instructions designed to facilitate sleeping through the night; the other half received no instructions. A secondary aim was to compare temperament ratings of infants who were taught to sleep through the night to ratings of those who were not. Parents whose infants slept through the night were expected to rate their infants' temperament more favorably than parents whose infants continued to awaken.

## METHOD

The present experiment focused on breast-fed infants' sleeping and feeding patterns. Half of the infants' parents were randomly assigned to a treatment condition that focused on behavioral techniques aimed at facilitating young infants' transition to sleeping through the night from an early age; the other half were assigned to a control condition. All parents completed 72-hour dietary-activity diaries of the infants' feeding and sleeping patterns each week from birth to 8 weeks of age and completed a revised version of Bates' Infant Characteristics Questionnaire<sup>29</sup> when the infants were 1 and 8 weeks of age. The study was approved by the Institutional Review Board of the University of Illinois.

## Subjects

Thirty-three couples were enrolled in the study during the last trimester of the wife's pregnancy. Subjects were recruited from announcements in local newspapers and through obstetricians' offices in the Champaign-Urbana, Illinois, area. Participants were selected if (1) they were first-time parents, (2) there were no medical complications during the pregnancy or the neonatal period, and (3) the mother intended to breast-feed the infant for at least 8 weeks. To be eligible to participate, infants had to be born of a single birth, with birth weights  $\geq 3000$  g, and 5-minute Apgar scores  $\geq 8$ . Once couples agreed to participate in the study, they were randomly assigned to one of two groups: treatment and control. Seven couples withdrew from the study within the first week of data collection (postbirth); enrollment and random assignment continued until 26 families (13 in each group) were included in the final analyses. A sample size of 13 per group had statistical power = .70, at  $\alpha = .05$ , for an increase of 40% of treatment infants sleeping through the night at 4 weeks of age relative to control infants, based on the results from a previous study.<sup>30</sup> Five of the seven couples who withdrew from the study did so because they reported that level of stress in their lives was too high, and they could not handle the added responsibility of participating in the study. The other two couples withdrew because the mothers were unable to breast-feed due to mastitis (infection of the mammary glands). Only one of the seven couples who with-

drew was in the treatment group. Those parents who withdrew from the study were comparable with parents who completed the study on all other measures (see next section on demographic and perinatal characteristics).

A questionnaire completed by the parents prenatally demonstrated that the treatment and control parents had comparable socioeconomic and demographic characteristics. Once the infants were born, parents were asked for information regarding the characteristics of the birth, delivery, length of labor, and 5-minute Apgar scores. Results from these questionnaires appear in Table 1. Those who completed the protocol received \$50.00 for participating in the study. Because the assignments of subjects to either the treatment or the control group was done prenatally when the sex of the infant was not known, it was not possible to balance the groups by sex. In the treatment group there were eight girls and five boys, while in the control group there were six girls and seven boys.

## Procedure

During the last trimester of pregnancy, parents in the treatment group were given verbal and written instructions on how to teach their infants to sleep through the night. All couples were asked to contact the researcher once their infants were born, within the first 4 days after the birth. Once the infants were born, parents provided information on their infant's births. Parents kept weekly diaries of the infant's feeding and sleeping patterns for 72 consecutive hours from birth until the infant was 8 weeks old. The researcher visited the parents every week for 8 weeks after the infant's birth to pick up completed feeding and sleeping diaries. Problems that arose in the course of the study were also discussed in these meetings, as were the instructions for teaching the infants in the treatment group to sleep through the night. The weekly visits were scheduled on the same day every week. Parents were instructed to begin keeping the diaries on the same evening of the visit. With the exception of the training instructions, contact with both groups was identical. The training instructions, described below, consisted of two parts, one to be carried out as soon as the mother returned home from the hospital, the other when the infant had met the following criteria: (1) was 3 weeks old, (2) was in good health, and (3) was steadily gaining weight. Parents in the control group were offered the same information on teaching their infants to sleep through the night at the end of the 8-week period.

**Test-Weighing Procedure.** The researcher visited the parents at their home within the first 4 days after the birth of the infant and delivered an electronic pediatric scale (Acme model 30 infant scale, Acme Corp, San Leandro, CA), accurate to 2.8 g (0.1 oz), which was used to determine the volume of the infants' feeding. At this time each mother was trained on an individual basis on the test weighing procedure, which involves weighing the infant immediately before and after a feeding. The difference between pre-feeding and postfeeding weights was taken as the volume of the

**TABLE 1.** Socioeconomic, Demographic, and Perinatal Characteristics of Subjects in Treatment and Control Groups\*

Variable	Treatment (n = 13)	Control (n = 13)
Mother's age, y	26.6 (1.2)	27.2 (1.2)
Father's age, y	29.8 (1.6)	28.2 (1.3)
No. of years married	2.4 (0.5)	2.8 (0.5)
Mother's education, y	16.1 (0.8)	15.7 (0.9)
Father's education, y	17.8 (0.8)	15.9 (1.0)
Infant's birth weight, g	3510.8 (93.6)	3615.8 (103.9)
Gestational age, wk	40.3 (0.49)	39.5 (0.3)
5-Minute Apgar score	9.0 (0.1)	9.0 (0.2)
Length of labor, h	22.7 (4.9)	15.3 (2.2)

\* Results are given as mean (SEM).



feed. Several test trials were performed until the mother mastered the technique consistently. This protocol to determine volume of feeding has been extensively used in other studies<sup>31,32</sup> and is considered an accurate index of human milk intake.<sup>33,34</sup>

**Infant Feeding and Sleeping Patterns.** The infant's sleep/wake and feeding patterns were recorded on the dietary-activity diaries. The record itself consisted of a 24-hour chart on which the parent shaded in the periods of time when the infant was asleep, left blank the periods of time when the infant was awake, and used a symbol (the letter "F") to designate the times when the infant was fed. Immediately under the chart were two blank lines labeled "prefeeding weight" and "postfeeding weight." On these lines, and exactly below the time block on which the parent had marked that a feed occurred, the parent recorded the corresponding weights of the infant before and after the feeding.

The diaries were adapted from similar ones used by Ferber<sup>18</sup> and from Wolfson,<sup>20</sup> who used them to determine the effects of parent training on infant sleep patterns. Similar diaries have been used in other studies.<sup>13,26,27</sup> These 24-hour diaries kept by parents were found to be highly reliable (over 90%) when compared with time-lapse video recordings of the infant's sleep patterns for the same day.<sup>26,27</sup> From the dietary activity diaries, several measures were calculated for statistical analyses: (1) total sleep; (2) longest sleep episode; (3) average length of sleep per episode; (4) volume of each feed; and (5) time of feeding. These were coded and analyzed for each 24-hour period and for a nighttime period defined between midnight and 5:00 AM.

The information the parents recorded on these forms was coded by five research assistants, who transcribed it for quantitative analysis. All coders were "blind" to experimental condition and sex of the infant. There was a principal research assistant who coded all the diaries once; then four other research assistants shared the responsibility of recoding and checking the information transcribed by the first coder. All coders worked individually and independently on the diaries, and all 624 diaries (26 subjects  $\times$  8 weeks  $\times$  3 days = 624) were coded twice. Reliability among the five coders was estimated by the percent of agreements between the principal coder and the four assistants who recoded the data. The percent of agreements ranged from 94% to 100%, and the mean was 98% for all variables derived from the diaries.

**Parent Training Protocol.** At the prebirth home visit, the researcher presented treatment group parents with the material on helping infants to sleep through the night. This consisted of a two-page handout with instructions for the parents on how to respond to the infant's signals and the establishment of a *focal feed*: a scheduled feed between 10:00 PM and midnight, from the first few days after birth. The researcher reviewed the instructions on the handout with the parents at this time and gave a brief background on the research from which these were derived. The focus was placed on getting the infant to start "on the right track"<sup>20</sup> and consisted of preparatory steps that parents could take before actually training their infants to sleep through the night. The parents were instructed to try not to hold, rock, or nurse their infants to sleep, to accentuate differences in environmental cues for day and nighttime hours (eg, high levels of stimulation during the day but low during the night), to feed the infant at a focal feeding time each night (between 10:00 PM and midnight), and to make sure the infant was really complaining before picking him or her up (the difference between crying and whimpering was discussed).

At the first home visit after the infant's birth, the researcher discussed the training instructions with the parents once more, highlighting the main points. When the infant was 3 weeks old and had met the specified criteria described earlier indicating adequate growth, parents began the second part of the program. This consisted of lengthening the latency to feeding time in the middle of the night (between midnight and 5:00 AM) by following a step-by-step procedure. Parents were instructed not to leave the infant alone crying; rather, alternative interventions were encouraged: reswaddling, patting, diapering, or walking the infant in lieu of feeding. If, after these interventions, the infant continued to cry, then a feed was offered. The goal was to "stretch" nighttime feeding intervals by breaking the association between awakening at night and being fed. The weekly home visits allowed the researcher to reinforce the parents who might experience difficulties and to make sure they were following the protocol consistently.

**Infant Temperament Measure.** An adapted version of Bates' Infant Characteristics Questionnaire<sup>29</sup> was used in this study. At the

time of data collection, no temperament instrument existed for use with newborns. The original version was designed for 6-month-old infants, and only the items that were relevant to a newborn were left in the questionnaire. Parents were asked to rate their infants on 17 aspects of the infant's behavior, using a 7-point Likert-type scale. Both parents rated the infant when the infant was 1 and 8 weeks of age. Four clusters of scores were formed according to the author's coding instructions. These are used to categorize different dimensions of infant temperament as follows: easy-difficult, unadaptability, unpredictability, and dullness. A fifth dimension was included; it consisted of a single question about the infant's ability to self-soothe and was based on previous work on infant temperament.<sup>35</sup> This item was analyzed separately in relation to the feeding and sleeping variables.

## RESULTS

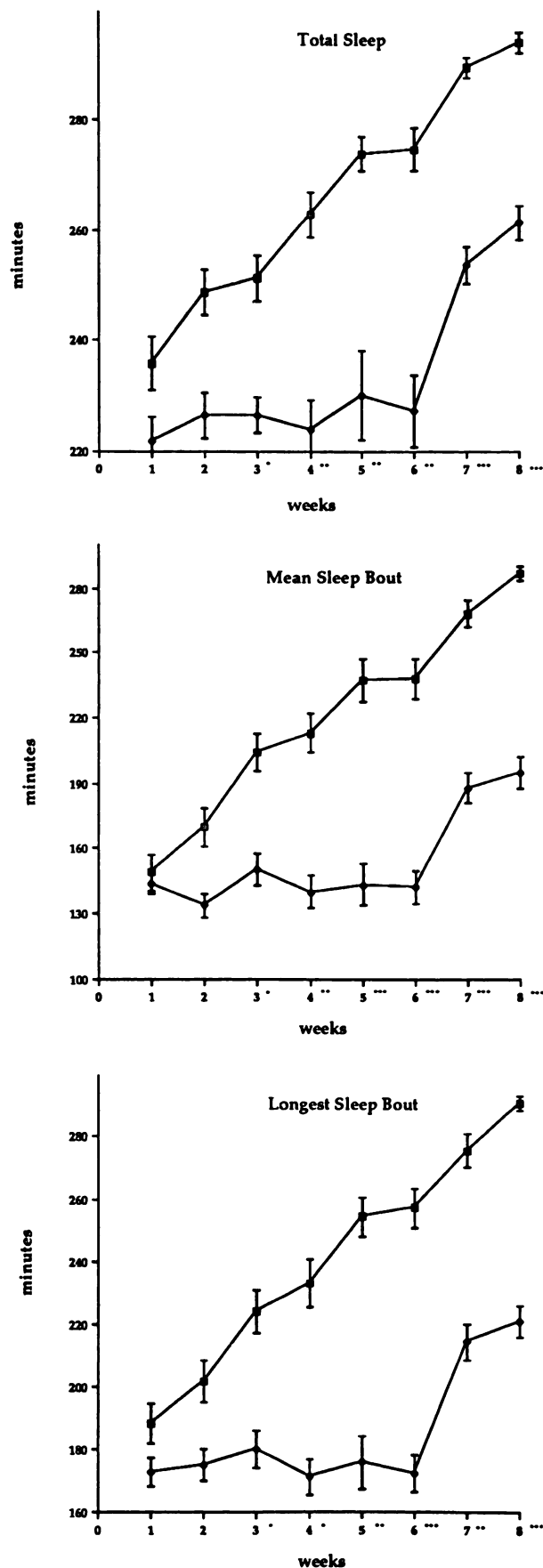
The principal question was whether the onset of sleeping through the night (defined as the period from midnight to 5:00 AM) could be facilitated among exclusively breast-fed infants. Concomitant differences in feeding patterns were evaluated. Finally, differences in temperament ratings were assessed between infants who slept and infants who did not sleep through the night.

### Parent Training Effects

To determine the effect of the training procedures on infant sleep as the infant matured over the first 8 weeks of life for 24 hours and the nighttime periods, repeated-measures analyses of variance (ANOVAs) were conducted on the sleep variables. The mean for the 72 hours of data recorded by the parents on the diaries was taken for each infant at each week separately.

**Nighttime Period.** Figure 1 shows the sleep patterns during the nighttime period (midnight to 5:00 AM) for infants in treatment and control groups over the first 8 weeks of life. From birth to week 3, treatment and control infants were comparable on all sleep variables, but treatment infants were sleeping more and sustaining longer sleep bouts thereafter. For example, at week 1, longest sleep bouts were comparable for treatment and control infants: 3 hours 8 minutes and 2 hours 53 minutes, respectively, but were significantly different by week 8: 4 hours 50 minutes compared to 3 hours 42 minutes. The sleep variables were analyzed by repeated-measures ANOVAs, and infants' sleep patterns were significantly affected by the interventions: total sleep  $F(1,24) = 16.82, P < .01$ ; average duration of sleep bout  $F(1,24) = 22.45, P < .01$ ; and longest sleep episode  $F(1,24) = 24.29, P < .01$ . There was a corresponding age effect as the sleep patterns of infants in both groups matured from birth to 8 weeks ( $P < .01$ ). The interaction of age by group was significant for all of the sleep variables, except mean total sleep ( $P < .01$ ), showing that age effects were less pronounced for the control than for the treatment group.

Week by week univariate ANOVAs revealed that at weeks 1 and 2 there were no differences in the sleep variables between the treatment and control groups. At week 3 (and thereafter), infants in the treatment group showed longer mean total sleep, longer duration of sleep per episode, and greater longest sleep episode.



**Fig 1** Sleep patterns (mean, SEM) in minutes, for breast-fed infants in treatment (□) and control (■) groups for the nighttime period, midnight to 5:00 AM, showing the effects of parent training on total sleep, mean sleep bout, and longest sleep bout. \* $P < .05$ ; \*\* $P < .01$ ; \*\*\* $P < .001$ .

**Twenty-four-Hour Period.** In contrast to the nighttime period results, sleep variables analyzed for the 24-hour period were not as affected by the training protocol. There was only one overall significant infant sleep variable affected by the treatment procedures for 24-hour period: longest sleep episode,  $F(1,24) = 9.57$ ,  $P < .01$ . Because the 24-hour period includes the nighttime period, this variable reflects the differences in sleep patterns between the groups reported for the nighttime period. There were significant age effects on all sleep variables, as sleep patterns matured from birth to 8 weeks ( $P < .01$ ). There were significant age by group interactions for two of the three of the sleep variables: mean sleep per episode, sleep episodes, and longest sleep episode. These variables increased faster over the first 8 weeks for infants in the treatment than in the control group.

**Focal Feeding Effects.** Parents in the treatment group were instructed to offer their infants a feeding between 10:00 PM and midnight. This was called a "focal feed." From the diaries it was possible to determine whether parents in the treatment group were following the instructions regarding focal feeds and whether parents in the control group were spontaneously offering a focal feed to their infants. Because the diaries provided data for 3 days and 3 nights each week, infants were categorized as "focal feeders" if they received a focal feed on at least two of the three nights of the week. Infants were also categorized as "sleepers" if they did not awaken between midnight and 5:00 AM on at least two of the three nights of the week. The treatment and control groups were compared across weeks to determine how many infants were focal feeders and how many infants were sleepers, and these results appear in Fig 2. By week 8, 100% of the infants in the treatment group were categorized as "sleepers," compared with only 31% of the infants in the control group.

To determine differences between the two groups on focal feeding and sleep status of the infants week by week, nonparametric Cochrane-Mantel-Haenszel tests were performed on these data. First, the test was performed to assess whether dividing infants according to group classification (treatment and control) could account for differences observed in sleep classifications (whether the infant was considered a "sleeper" or a "non-sleeper"). It is analogous to a  $\chi^2$  test, but it can statistically control for one variable while determining the expected frequency of the other two. In this case, "focal feed" classifications were held constant, examining the relationship between group assignment and sleep status. The test, therefore, determines the treatment effects on the sleep status of the infants, statistically controlling for the presence of "focal feed," as both treatment and control infants were sometimes fed between 10:00 PM and midnight (the time of the focal feed). After week 4, there was a significant treatment effect on the sleep status of the infants, regardless of "focal feeding" ( $P < .05$ ).

To assess the effects of focal feeding alone on the sleep status, a second Cochrane-Mantel-Haenszel test was conducted, controlling for group (treatment vs control) classifications. In this case, the single con-

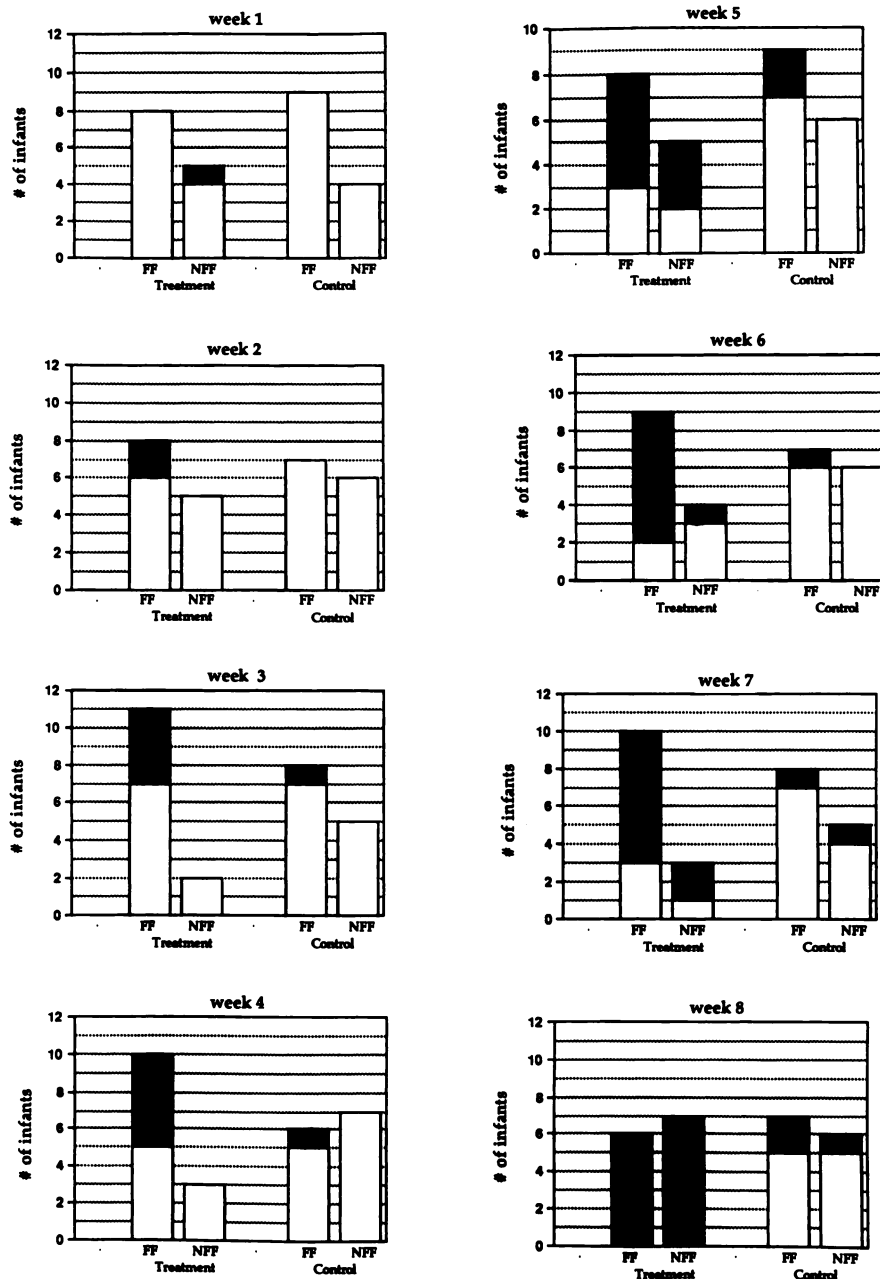


Fig 2. Number of infants in treatment and control groups categorized as either focal feeders (FF) or nonfocal feeders (NFF) and as sleepers ■ or non-sleepers □.

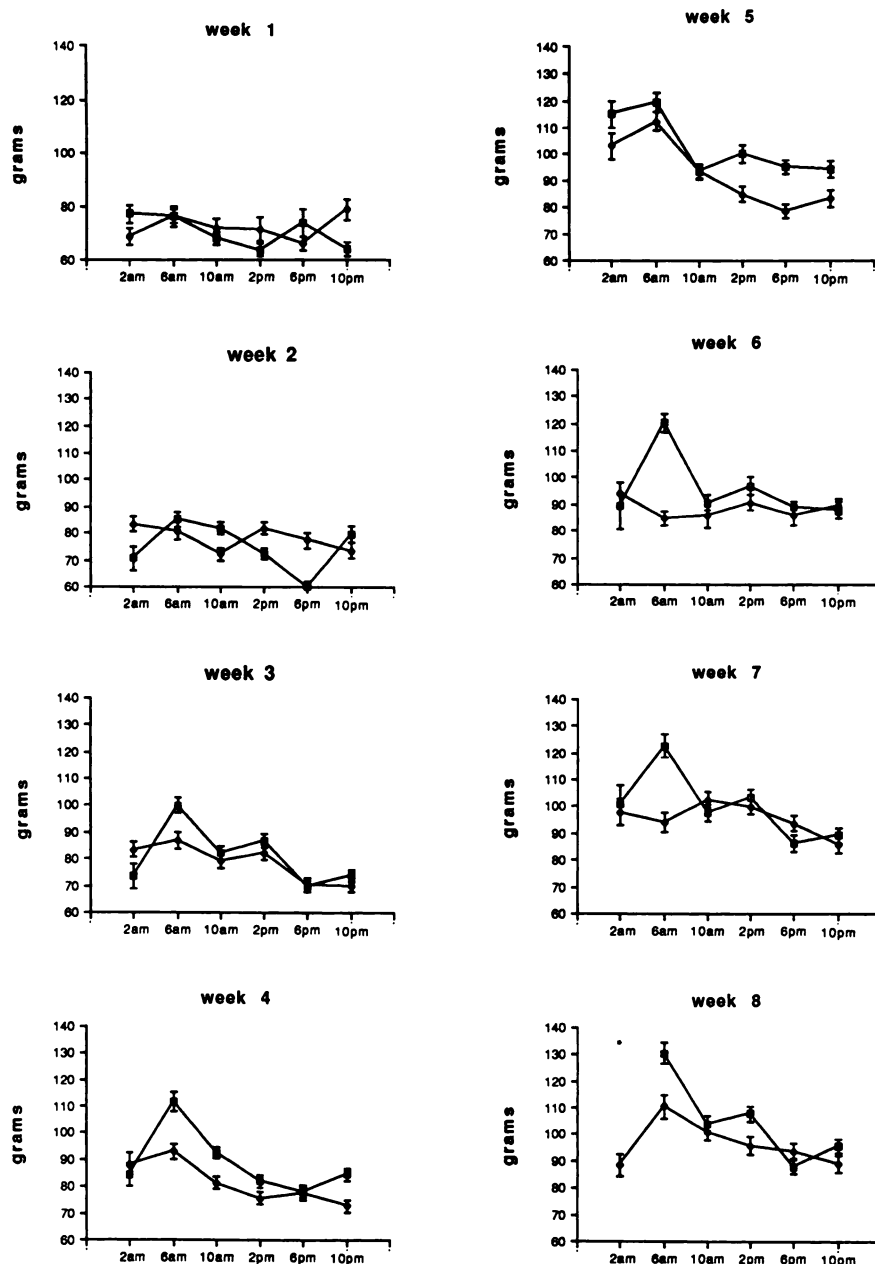
tribution of offering a focal feed on the infants' sleep status could be analyzed, given the presence of such feeds among control infants. The results showed that focal feed alone was not enough to modify sleep status ( $P > .05$ ).

#### Diurnal Variations in Feeding Patterns

To determine whether patterns of human milk intake differed for the two groups, intake data were divided into six discrete 4-hour periods as follows: 2:00 AM, 6:00 AM, 10:00 AM, 2:00 PM, 6:00 PM, and 10:00 PM. If a feed was recorded between midnight and 4:00 AM, then it was included in the 2:00 AM average; if a feed was recorded between 4:00 AM and 8:00 AM, then it was included in the 6:00 AM period. Figure 3 shows the daily patterns of human milk intake for each period of the day, from week 1 through week 8, for infants in the treatment and control groups. The 6:00 AM feed progressively increased as a function of time

for infants in the treatment group, showing that meal size was increased as the interval between feeds in the middle of the night increased. A repeated-measures ANOVA was conducted with group as the between-subjects factor (two levels), and both age (eight levels) and time of day (six levels) as the repeated measures. Results showed no significant group main effect ( $P > .05$ ), but both significant age and time of day main effects ( $P < .0001$ ), reflecting the maturational factor on one hand and the diurnal variations of human milk intake on the other. There were significant interaction effects between age  $\times$  time, time  $\times$  group ( $P < .0001$ ); the latter reflects that differences in milk intake between treatment and control infants varied according to time of the day. The three-way interaction age  $\times$  time  $\times$  group was also significant. As shown in Table 2, across weeks, the development of diurnal patterns in volume of feedings differed for treatment and control infants.

**Fig 3.** Volume of human milk intake (grams) (mean, SEM) for infants in treatment (□) and control (■) groups for six discrete periods of the day over the first 8 weeks of life. \*No treatment infants received a feed at this time.



**TABLE 2.** F Values and Significance Levels for Repeated-Measures Analysis of Variance on Mean Intake of Human Milk Consumed at Six Different Times of the Day Across 8 Weeks for Treatment and Control Groups

Source	F	df	P*
Group	0.10	1,24	NS
Age	8.56	7,168	0.0001
Time	11.79	5,120	.0001
Group × age	0.88	7,168	NS
Group × time	9.57	5,120	.0001
Age × time	2.71	35,840	.0001
Group × age × time	1.53	35,840	.03

\* NS, not significant.

Volume of intake per feed, per day, and per kilogram of body weight per day were comparable for infants in the two groups. Similarly, weekly weight and weight gain were not affected by the experimental manipulations. These variables were comparable for male and female infants.

### Infant Temperament

Table 3 shows the mean scores for each temperament dimension for infants in the treatment and control groups. There was only one significant difference between parents in the treatment and control groups: control parents rated their infants as less predictable than parents in the treatment group,  $F(1,46) = 5.93$ ,  $P < .01$ . All parents rated their infants as less dull over time,  $F(1,46) = 18.41$ ,  $P < .0001$ . There were no differences in the ratings of temperament between mothers and fathers on any of the infant temperament variables.

### DISCUSSION

The results of this study show that, from birth, parents play a very important role in the development of their infants' sleep patterns. Through a behavioral training program, parents were able to facilitate the onset of sleeping through the night and to



**TABLE 3.** Infant Temperature Questionnaire Ratings: Treatment and Control Parents (mean, SEM)

Dimension	Treatment		Control	
	Mothers	Fathers	Mothers	Fathers
Difficulty				
Week 1	19.5 (0.9)	19.8 (1.4)	19.7 (1.2)	19.7 (1.1)
Week 8	19.9 (1.9)	19.8 (1.7)	20.3 (1.8)	20.3 (1.8)
Unadaptability				
Week 1	3.2 (0.4)	3.3 (0.4)	2.8 (0.4)	2.9 (0.3)
Week 8	2.7 (0.4)	3.8 (0.8)	2.4 (0.4)	3.4 (0.9)
Unpredictability*				
Week 1	5.6 (0.6)	5.9 (0.5)	7.6 (0.7)	7.4 (0.7)
Week 8	4.9 (0.6)	5.8 (0.7)	5.1 (0.7)	6.9 (0.6)
Dullness†				
Week 1	4.5 (0.4)	4.5 (0.3)	3.8 (0.3)	4.5 (0.6)
Week 8	5.3 (0.4)	4.8 (0.3)	4.9 (0.3)	4.9 (0.4)
Self-soothing				
Week 1	3.9 (0.5)	4.0 (0.3)	4.5 (0.4)	4.0 (0.3)
Week 8	4.2 (0.2)	4.2 (0.4)	4.3 (0.3)	4.4 (0.4)

\* Group main effect,  $P < .05$ .

† Time main effect,  $P < .05$ .

modify their infants' sleep-wake schedules, reducing night waking from a very early age. At 4 weeks, 38% of infants in the treatment group were sleeping through the night, compared with 7% of control infants. By 8 weeks, all infants whose parents received training instructions were sleeping through the night, compared with only 23% in the control group. Sleep patterns changed as a function of normal development and maturation for all infants in the study; all infants were able to sustain longer sleep episodes as they matured. However, the results revealed the parents' role in establishing a diurnal organization of their infants' sleep/wake cycles.

### Sleeping Through the Night

The onset of sleeping through the night occurs later and the frequency of night waking is higher among breast-fed compared with bottle-fed infants.<sup>9,14-16</sup> This suggests that (1) breast-fed infants may be more prone to develop sleep problems in infancy, and (2) breast-feeding, despite being optimal for the infant, may be discontinued because of the frequent and continued night waking of the infant to feed and the consequent lack of sleep for the mother. The results of this study show that breast-feeding need not be associated with night waking, that breast-fed infants can be behaviorally entrained to sleep through the night, and that continued lactation can be compatible with the mother's sleep/wake patterns. The total amount of sleep per day was comparable for the two groups at all points in development, indicating that the normal sleep requirements of the infants in the treatment group were not altered by the experimental interventions.

The techniques used in this study have been used in previous research, as interventions later in infancy when parents report that their children's sleep patterns have become problematic. A study conducted by Schaefer<sup>36</sup> similarly demonstrates that a combination of interventions such as teaching the infant to fall asleep without external help, reducing or eliminating unnecessary nighttime feedings, and forming a stable sleep-wake cycle is successful in reducing night waking in older infants and toddlers. Sleep disturbances in the first and second year of life have been associated with frequent nighttime feeding and increased crying before falling asleep.<sup>37</sup>

Significant differences in sleeping through the night emerged as early as 3 weeks, indicating that behavioral entrainment of sleep can occur this early. Moreover, a developmental shift in sleep patterns emerged spontaneously among infants in the control group when they were exactly 6 weeks of age, they showed a dramatic increase in their ability to sustain longer sleep bouts and to awaken less frequently at night (see Fig 1). Because of the longitudinal design of this experiment, these developmental changes in spontaneous sleep behaviors of young infants could be observed on a weekly basis. The literature on the development of infant sleep patterns does not refer to this particular and noteworthy change that occurs spontaneously among breast-fed infants around the sixth week of life.

With respect to settling age, Wolfson<sup>20</sup> reported that many parents in her study noticed that their infants were sleeping through the night spontaneously by 8 weeks. Wolfson suggested that the focal feed and the use of the sleep charts alone may have been sufficient to have an impact on the infants' sleep/wake development. Other researchers have also observed improvements in night waking behaviors in infants with the use of sleep charts alone.<sup>38,39</sup> This suggests that the differences between treatment and control infants may have been underestimated in this research because even the control parents had the "benefit" of keeping the diaries. It is possible that the use of sleep diaries affected the development of nighttime sleep by increasing all participating parents' awareness of both the child's and their own behaviors with respect to the development of sleep/wake patterns. However, our results indicate that sleep diaries alone, and, in fact, sleep diaries plus focal feeding, were not sufficient to facilitate sleeping through the night to the extent seen in the treatment group. It is evident that offering a focal feed alone is not enough for the infant to make the transition to sleeping through the night; in fact, a sizable proportion of the families in the treatment group did not follow the instructions to focal feed. The gradual stretching of the nighttime feedings and the environmental distinctions between nighttime and daytime activities appeared to be influential for the transition to sleeping through the night. Moreover, sleeping through the night was facilitated at a very early age.

Despite the high reliability previously reported for the use of sleep diaries<sup>13,28</sup> and the high intercoder reliability reported in the present study (average 98%), a more thorough assessment would have been



accomplished with the use of videotape monitoring of infant sleep.<sup>26</sup> This technique would eliminate the effects of keeping the sleep diaries themselves and would accurately capture infants' spontaneous awakenings, infants' nighttime self-soothing behaviors, and parents' nighttime interventions, hence providing a more accurate picture of the development of sleep patterns among breast-fed infants.

#### Infant Feeding Variables

Diurnal differences between the two groups emerged when the data were analyzed for six discrete periods of the day. As expected, infants in the treatment group were taking fewer feedings in the middle of the night and were adapting to the relatively long interval without a feed by taking a large meal in the early morning. From Fig 3 it is clear that the pattern of intake for the two groups was different as a function of time of day, and even as early as week 3 treatment infants were taking their largest meal of the day in the 6:00 AM period, following the overnight fast. A similar pattern began to emerge only at 8 weeks for control infants. These differences in feeding patterns emerged when differences in sleeping through the night began to appear between the two groups, and they reflect the fact that feeding and sleep/wake patterns are closely linked in the young breast-fed infant. Volume of intake at a feeding is significantly correlated with the length of the interval since the previous feeding.<sup>10,32</sup> The results from this study show that when a breast-fed infant is encouraged to sleep through the night, parents should not worry that the infant's milk intake will be limited by missing a feeding. Infants in this study compensated for the long nighttime interval without a feeding by consuming a relatively large "breakfast." This is consistent with previous reports on breast-fed infants' mechanisms of control of milk intake.<sup>9,32</sup>

#### Infant Temperament

The results showed that parents in the treatment group rated their infants as more predictable than parents in the control group rated their infants, revealing a local effect of treatment interventions on parents' perceptions of infant temperament. As parents actively shaped their infants' sleep behavior, entraining them to a diurnal, regular, and predictable day/night cycle, they perceived their infants' temperament as more predictable. Even at 1 week, treatment parents rated their infants as more predictable than control parents. It is possible that parental perceptions were modified by the expectation that their infants would be sleeping through the night from a very early age, or that the infants already differed.

#### CONCLUSIONS/IMPLICATIONS

Although breast-feeding is typically associated with frequent and continued night waking and later "settling," this research indicates that continued night waking is not a necessary component of breast-feeding. Additional research is needed to determine which components of the training procedure are responsible for the treatment effects; keeping elaborate

feeding and sleeping diaries is not sufficient and may be unnecessary. Likewise, focal feeding was not sufficient to facilitate sleeping through the night, and the overall pattern of results suggests that teaching parents techniques for stretching the time before feeding when the infant awakens, thereby providing opportunities for self-soothing, was central in facilitating sleeping through the night. Feeding data revealed that for treatment infants, adjustment in intake was concomitant with increasingly longer sleep bouts between midnight and 5:00 AM, resulting in a large morning meal. Twenty-four-hour intake did not differ between the groups, indicating that eliminating a feed did not compromise total intake. This information can be easily provided to parents.

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## AEQUITRON MEDICAL CHALLENGES CLASS ACTION SUIT INVOLVING APNEA MONITOR

MINNEAPOLIS—Aequitron Medical, Inc. announced today that a class action suit has been initiated against the company in the Federal District Court of Western Michigan. The plaintiff in the suit seeks damages for the 1985 death of her daughter which she claims occurred while using an Aequitron apnea monitor.

According to the suit, the plaintiff alleges that Aequitron breached various warranties and duties, and violated certain federal statutes. The plaintiff seeks \$15 million in damages for herself and similarly situated members of her class, and \$15 million in damages for the estate of her deceased daughter and similarly situated members of her daughter's class. The plaintiff also seeks treble damages under one of the federal statutory claims.

Aequitron President. . . said, "We believe that this lawsuit is totally without merit, and, based on discussions with counsel, we anticipate no material adverse impact on the company."

He went on to say, "Although Aequitron remains optimistic about the outcome of the suit, the insurance company that carried Aequitron's liability insurance in 1985 is now insolvent. Consequently, any recovery by the plaintiff will have to be paid directly by the company."

Aequitron Medical challenges class action suit involving apnea monitor (Press Release). Aequitron Medical, Inc.; December 16, 1991.

Noted by J.F.L., MD

## Help Me Make It Through the Night: Behavior Entrainment Breast-Fed Infants' Sleep Patterns

Teresa Pinilla and Leann L. Birch

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