Behavioral Insomnia Therapy for Fibromyalgia Patients

A Randomized Clinical Trial

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Background: Insomnia is common and debilitating to fibromyalgia (FM) patients. Cognitive-behavioral therapy (CBT) is effective for many types of patients with insomnia, but has yet to be tested with FM patients. This study compared CBT with an alternate behavioral therapy and usual care for improving sleep and other FM symptoms.

Methods: This randomized clinical trial enrolled 47 FM patients with chronic insomnia complaints. The study compared CBT, sleep hygiene (SH) instructions, and usual FM care alone. Outcome measures were subjective (sleep logs) and objective (actigraphy) total sleep time, sleep efficiency, total wake time, sleep latency, wake time after sleep onset, and questionnaire measures of global insomnia symptoms, pain, mood, and quality of life.

Results: Forty-two patients completed baseline and continued into treatment. Sleep logs showed CBT-treated patients achieved nearly a 50% reduction in their nocturnal wake time by study completion, whereas SH therapy– and usual care–treated patients achieved only 20% and 3.5% reductions on this measure, respectively. In addition, 8 (57%) of 14 CBT recipients met strict subjective sleep improvement criteria by the end of treatment compared with 2 (17%) of 12 SH therapy recipients and 0% of the usual care group. Comparable findings were noted for similar actigraphic improvement criteria. The SH therapy patients showed favorable outcomes on measures of pain and mental well-being. This finding was most notable in an SH therapy subgroup that self-elected to implement selected CBT strategies.

Conclusions: Cognitive-behavioral therapy represents a promising intervention for sleep disturbance in FM patients. Larger clinical trials of this intervention with FM patients seem warranted.

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FIBROMYALGIA (FM) IS A DEbilitating condition characterized by diffuse myalgia, fatigue, psychosocial distress, and disturbed sleep.[1-3] Sleep disturbances, including difficulties with sleep onset/maintenance and/or persistent nonrestorative sleep, are particularly distressing to FM patients.[1-5] Moreover, it has been suggested that sleep difficulties may play a substantial role in perpetuating FM-related fatigue and discomfort/pain.[5-7] Given this speculation, FM may be viewed as a disorder in which symptom severity is modulated by the interaction of sleep disturbance and daytime pain/distress. Thus, therapy designed to improve sleep may interrupt the FM sleep-pain/distress cycle and lead to overall improvements.[6,8]

Sedating antidepressants, zolpidem tartrate, and sodium oxybate have shown short-term efficacy for treating FM-related insomnia, fatigue, and pain/distress, but benefits from such agents often diminish markedly over time.[9-12] An alternative approach, cognitive-behavioral therapy (CBT) for insomnia, may hold promise for FM management given its proved efficacy for treating insomnia in patients with psychiatric and other chronic medical disorders.[13-15] However, CBT's efficacy for treating insomnia and other FM symptoms is unknown. In this trial, we compared sleep and other symptom improvements shown by FM patients who received CBT, a sleep hygiene (SH) therapy, or only usual care (UC). We predicted CBT would produce greater improvements in sleep, pain, mood, and mental well-being than SH therapy or UC.

METHODS

DESIGN AND PARTICIPANTS

A single-blind, randomized, parallel-group design was used. Participants were randomized to treatment (CBT, SH therapy, or UC);

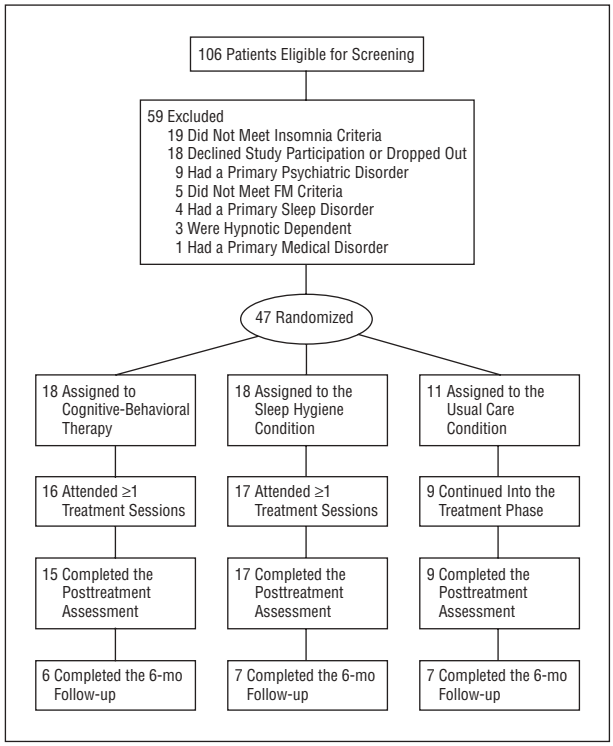

Figure 1. Participant flow diagram. FM indicates fibromyalgia.

those receiving CBT or SH therapy were randomized to study therapists. Enrollees were blinded to hypotheses but were told they had a 1 in 3 chance of receiving only ongoing FM care. Duke University Medical Center's Institutional Review Board approved the protocol, and all candidates signed the study consent form. Participants were not charged for research evaluation/therapy and were reimbursed for study-related parking expenses.

Recruitment occurred primarily through newspaper advertisements. Selection criteria were designed to enroll patients with insomnia uncomplicated by sleep-disruptive comorbidities. The inclusion criteria were as follows: (1) aged 21 to 65 years, (2) meet the American College of Rheumatology criteria for FM,[1] (3) meet structured interview criteria for insomnia,[16] and (4) have 60 minutes or more of total nocturnal wake time on average over 1 week of sleep log monitoring. The exclusion criteria were as follows: (1) currently pregnant, breastfeeding, or not practicing contraception; (2) having a comorbid sleep-disruptive medical condition; (3) meeting structured interview[17] criteria for an Axis I depressive (other than dysthymia), anxiety, or substance abuse disorder; (4) having a severe hypnotic dependence, suggested by the use of a hypnotic agent in a higher than recommended dosage or repeated episodes of rebound insomnia on withdrawal; (5) having symptoms of sleep apnea, restless legs syndrome, or circadian rhythm disorder; and (6) having an apnea-hypopnea index or periodic limb movement (PLM)-related arousal index of 15 or more per hour on a screening polysomnogram (PSG). (A physician [A.D.K.] who is board certified in sleep medicine reviewed all PSGs. Only those PSGs that showed PLMs or respiratory events were formally scored to calculate an apnea-hypopnea index and/or PLM-related arousal index for use in determining study eligibility.)

One hundred six volunteers (100 women) completed some or all screening procedures, including interviews, a medical/tender-point examination, a sleep log, and a PSG study. A licensed clinical psychologist (W.K.W.) screened candidates using structured sleep and psychiatric interviews.[16,17] A board-certified rheumatologist (J.R.R.) conducted all medical/tender-point screenings. Forty-seven persons (45 women) qualified, underwent a pretreatment assessment, and were randomized to treatment × therapist "cells." **Figure 1** shows the study's participant flow. **Table 1** and **Table 2** show demographic and medical data for the sample, respectively. Nonsignificant ($P>.10$) differences were noted for most group comparisons with these data.

MEASURES

Polysomnography

Those meeting the initial selection criteria completed 1 in-laboratory screening PSG, conducted with an 11-channel polygraph (Grass) or an 8-channel analog recorder (Oxford Medilog). The PSG monitoring included electroencephalography (2 channels), submental electromyography, bilateral electrooculography, nasal/oral airflow measurement, and bilateral anterior tibial electromyography. Findings used for screening were the apnea-hypopnea index (ie, number of apneas and hypopneas per hour of sleep) and the PLM arousal index (ie, number of PLM-related electroencephalographic arousals per hour of sleep). Although PSG typically includes additional respiratory measures (respiratory effort and oximetry), we believed that nasal/oral airflow monitoring along with our interview screening would provide a reasonable likelihood of excluding those with sleep apnea.

Sleep Logs

Participants completed sleep logs each morning during 1 screening week, a 2-week baseline, the 6-week treatment phase, a 2-week posttreatment assessment, and a 2-week follow-up 6 months later. Logs included queries about each night's bedtimes and rising times, sleep-onset latency (SOL), time awake after sleep onset (WASO), and nature/dosage of prebed medications. Measures derived from logs included total sleep time (TST), SOL, WASO, total wake time (TWT = SOL + WASO), and sleep efficiency (SE = [TST/Time in Bed {TIB}] × 100%).

Actigraphy

Actigraphs (Actiwatch; Mini-Mitter Co, Inc, Sun River, Ore) were used to assess objective sleep improvements. The actigraph monitors movement/activity, interfaces with a personal computer, and uses software (MS Windows style) to derive estimates of various sleep variables. Participants wore an actigraph nightly on their nondominant wrists throughout baseline, posttreatment, and follow-up assessments. The manufacturer's medium sensitivity algorithm was used to derive estimates of TST, TWT, SOL, WASO, and SE.

Questionnaires

Participants completed the Insomnia Symptom Questionnaire,[18] the Medical Outcomes Survey 36-Item Short-Form Health Survey,[19] the McGill Pain Questionnaire (MPQ),[20] the Brief Pain Inventory (BPI),[21] and the Profile of Mood States[22] at baseline, midtreatment (end of the third treatment week), posttreatment, and follow-up. The latter 4 questionnaires are well-validated and widely used instruments. The Insomnia Symptom Questionnaire is psychometrically sound (Cronbach $\alpha = .71$)[14] and includes 13 visual analog items measuring global insomnia symptoms. The Insomnia Symptom Questionnaire mean item score, Medical Outcomes Survey 36-Item Short-Form Health Sur-

Table 1. Demographic Characteristics of the Sample*

Variable	Total Sample (N = 47)	CBT Group (n = 18)	SH Therapy Group (n = 18)	UC Group (n = 11)	*P* Value for Group Comparisons
Age, mean (SD), y	48.6 (8.2)	50.1 (6.9)	46.5 (9.0)	48.3 (9.1)	.53
Education, mean (SD), y	15.2 (2.5)	14.6 (2.4)	15.0 (2.8)	16.3 (2.3)	.23
Female-male ratio	45:2	17:1	17:1	11:0	>.99
Marital status					
Married	37	14	14	9	.30
Single	4	0	3	1	
Divorced or widowed	6	4	1	1	
Ethnic group					
White	44	17	17	10	.77
African American	2	1	1	0	
Asian	1	0	0	1	
Work status					
Currently employed	30	11	9	10	.13
Retired	5	3	2	0	
Homemaker or unemployed	10	4	6	0	
Disabled	2	0	1	1	
Therapist assignment†					
1	20	10	10	NA	NA
2	16	8	8	NA	

Abbreviations: CBT, cognitive-behavioral therapy; NA, data not applicable; SH, sleep hygiene; UC, usual care.
*Data are given as absolute numbers of patients unless otherwise indicated. Analyses of variance were used to compare group means for age and years of education. Fisher exact tests were use to compare groups for each of the other variables listed.
†See the "Treatments" subsection in the "Methods" section for therapist descriptions.

vey mental composite score, and total scores on the Profile of Mood States, MPQ, and BPI served as outcome measures.

Therapy Evaluation Questionnaire

The credibility of CBT and SH therapy was assessed via 7-point Likert ratings to the 7 items on this scale. The first 5 items assess treatment credibility; the final 2 items assess therapist warmth/competence. Cognitive-behavioral therapy and SH therapy recipients completed the initial 5 Therapy Evaluation Questionnaire[23] items after their first therapy session and therapist ratings after their last session.

TREATMENTS

Two licensed male clinical psychologists (W.K.W. and J.D.E.) provided CBT and SH therapy guided by the study's treatment manual. When the study commenced, therapist 1 (aged 35 years) and therapist 2 (aged 48 years) had 6 and 18 years of experience, respectively, with patients with sleep disorders. Therapists delivered CBT and SH treatment in 6 weekly individual sessions, with the first session lasting 45 to 60 minutes and subsequent sessions lasting 15 to 30 minutes. Also, CBT- and SH therapy–assigned patients continued any ongoing medical care for FM.

During their initial session, CBT recipients first listened to a standardized audiocassette cognitive therapy module designed to correct misconceptions about sleep needs and the effects of aging, circadian rhythms, and sleep loss on sleep/wake functioning. The therapist then provided verbal and written (pamphlet) stimulus control instructions encouraging the following: (*a*) a standard rising time, (*b*) exiting bed during extended awakenings, (*c*) using the bedroom only for sleep and sex, and (*d*) avoiding daytime naps. An initial TIB prescription set at the average baseline log sleep time plus 30 minutes was also provided to each CBT patient. Remaining sessions entailed reviewing instructions and adjusting TIB. The TIB was increased by 15 minutes after weeks the patient showed a mean sleep log SE of 85% or greater and noted daytime sleepiness or decreased by 15 minutes after weeks the patient had a mean sleep log SE of less than 80%. Otherwise, TIB was held constant.

During their first session, SH therapy recipients first listened to an audiocassette that provided them generic sleep education (ie, descriptions of sleep stages and sleep architecture). The therapist then provided verbal and written (pamphlet) instructions to (*a*) limit caffeine and alcohol, (*b*) engage in regular moderate exercise, (*c*) have a light bedtime snack (eg, cheese or yogurt), and (*d*) keep the bedroom dark, quiet, and cool. During subsequent sessions, the therapist reviewed and individually tailored SH therapy recommendations to address adherence issues.

Patients undergoing UC received no behavioral therapy but met weekly with a study coordinator to provide sleep log/actigraphy data and to complete questionnaires while continuing their ongoing FM medical care. After their follow-up assessment, they were offered CBT.

RESULTS

CREDIBILITY/THERAPIST RATINGS

Therapy Evaluation Questionnaire item comparisons of CBT and SH therapy participants showed no significant group differences ($P>.22$ for all) at the beginning and end of treatment. Therefore, the therapies and therapists were rated similarly by the CBT and SH therapy groups.

ATTENDANCE/ADHERENCE

Figure 1 details study attrition. Of 47 enrollees, 5 completed baseline but then withdrew. One additional patient withdrew after 1 CBT session. The remaining patients completed treatment. Only half who finished treatment returned for the 6-month follow-up.

Table 2. Sleep Problem and Medical Information for the Sample*

Variable	Total Sample (N = 47)	CBT Group (n = 18)	SH Therapy Group (n = 18)	UC Group (n = 11)	*P* Value for Group Comparisons
Duration of sleep problem, mean ± SD, y	9.9 ± 10.2	7.3 ± 5.5	9.9 ± 8.3	14.4 ± 17.1	.10
Nature of sleep problem					
Onset	5	1	3	1	.19
Maintenance	24	9	9	6	
Onset and maintenance	14	7	6	1	
Other	4	1	0	3	
Current hypnotic medications					
Yes	21	9	8	4	.82
No	26	9	10	7	
Current FM medications†					
None	14	6	4	4	.17
Antidepressants only	10	1	7	2	
Analgesics only	12	6	2	4	
Antidepressants and analgesics	11	5	5	1	
Previous mental health therapy					
Yes	30	10	14	6	.30
No	17	8	4	5	
Body mass index, mean ± SD‡	26.9 ± 5.5	26.5 ± 5.6	26.9 ± 5.6	27.6 ± 5.8	.89
Comorbid medical conditions§					
None	2	0	1	1	NA
Osteoarthritis	16	5	8	3	.58
Headache	34	14	14	6	.39
GI disorder	17	7	7	3	.86
Respiratory disorder	21	9	8	4	.82
Hypertension	11	5	5	1	.42
Kidney or bladder condition	5	3	1	1	.83
Thyroid condition	6	2	4	0	.30
Sexual disinterest or dysfunction	18	8	9	1	.08
Other (miscellaneous)	4	1	2	1	>.99

Abbreviations: CBT, cognitive-behavioral therapy; FM, fibromyalgia; GI, gastrointestinal; NA, data not applicable; SH, sleep hygiene; UC, usual care.

*Data are given as absolute numbers of patients unless otherwise indicated. Analyses of variance were used to compare groups for duration of complaint and body mass index. Fisher exact tests were used to compare groups for each of the other variables listed.

†Antidepressants used included selective serotonin reuptake inhibitors (n = 13), tricyclic agents (n = 11), and trazodone hydrochloride (n = 6). Eleven patients were taking 1 antidepressant, and 10 were taking 2 or 3 antidepressants. The primary analgesics used were cyclooxygenase 2 inhibitors (n = 12), muscle-relaxing agents (n = 9), opioids (n = 5), and gabapentin (n = 5). Ten patients were using 1 analgesic, and 12 were using 2 or 3 analgesics.

‡Calculated as weight in kilograms divided by the square of height in meters.

§Patients could have more than 1 comorbid condition.

Because only CBT patients received instructions to standardize their sleep schedules, only they were expected to show reduced internight variability in the times they spent in bed through treatment. To test for this group difference in treatment enactment, a within-subject standard deviation of nightly TIB was calculated for each subject at baseline and for the 2 posttherapy time points using actigraphy and sleep log data. The treatment groups showed no significant baseline differences ($P>.14$) on actigraphy and sleep log variability indices. However, analyses of covariance (ANCOVAs) that adjusted for baseline values showed a significant group effect for the actigraphy ($F_{2,34}=6.92$, $P=.003$) and sleep log ($F_{2,38}=5.69$, $P=.007$) TIB variability indices averaged across posttherapy time points. Paired comparisons showed CBT patients had significantly lower posttherapy TIB variability on actigraphy (CBT, 38.7 minutes; SH therapy, 61.7 minutes; and UC, 67.9 minutes) and sleep logs (CBT, 41.5 minutes; SH therapy, 66.2 minutes; and UC, 71.7 minutes) ($P<.001$ for actigraphy and sleep logs) than did the other groups. Therefore, the treatment groups seemingly received and enacted distinctive treatments.

SLEEP DATA

Separate series of 3 (group) × 2 (posttreatment vs follow-up) ANCOVAs were conducted for sleep log and actigraphic measures. These analyses used subjects' averaged sleep measures at each time point and assessed group differences at posttreatment and follow-up after adjusting for respective baseline values. Some measures (eg, SOL and WASO) had highly skewed distributions, so it was necessary to normalize their distributions via data transformations (eg, square root) before conducting ANCOVAs. Sleep log analyses were conducted with all 42 treatment enrollees. An intent-to-treat data imputation (ie, last value carried forward) was used to provide the most conservative view of the treatments' long-term effects given the attrition rate at follow-up. Analyses of actigraphy data were similarly conducted with only 38 participants because actigraph battery failures caused baseline data loss in 4 cases. For all ANCOVAs, $\alpha=.05$ was used for detecting treatment effects.

Table 3 shows descriptive data and group comparisons for sleep log and actigraphic data. The ANCOVAs

Table 3. Data for Selected Sleep Measures Across Study Time Points

Measure	CBT Group*	SH Therapy Group*	UC Group*	Statistical Results for Group Main Effect†	Paired Comparisons
Sleep efficiency, %					
Sleep logs					
Baseline	80.6 ± 2.4	81.8 ± 2.2	81.2 ± 2.5	$F_{2,38} = 5.56$, $P = .008$	CBT > UC
Posttreatment	88.0 ± 1.6	84.7 ± 1.7	83.3 ± 2.4		
6-mo follow-up	89.0 ± 1.1	85.3 ± 1.9	81.3 ± 3.3		
Actigraphy					
Baseline	85.7 ± 1.1	83.6 ± 1.4	82.8 ± 2.7	$F_{2,34} = 1.04$, $P = .36$	No group differences
Posttreatment	88.0 ± 1.0	85.4 ± 1.4	82.6 ± 3.1		
6-mo follow-up	86.9 ± 1.0	84.7 ± 1.8	83.7 ± 2.1		
Total wake time, min					
Sleep logs					
Baseline	103.1 ± 13.9	94.0 ± 11.6	98.2 ± 13.1	$F_{2,38} = 6.09$, $P = .005$	CBT < UC
Posttreatment	59.8 ± 9.4	76.4 ± 7.9	88.7 ± 15.0		
6-mo follow-up	53.6 ± 5.1	75.4 ± 9.7	94.8 ± 16.5		
Actigraphy					
Baseline	74.0 ± 6.6	83.0 ± 8.4	92.5 ± 16.1	$F_{2,34} = 1.14$, $P = .33$	No group differences
Posttreatment	58.8 ± 5.0	72.0 ± 7.5	90.3 ± 17.0		
6-mo follow-up	65.6 ± 5.7	76.5 ± 9.8	87.2 ± 12.1		
Total sleep time, min					
Sleep logs					
Baseline	421.8 ± 14.0	424.2 ± 16.1	426.0 ± 23.1	$F_{2,38} = 0.89$, $P = .42$	No group differences
Posttreatment	433.2 ± 12.6	424.8 ± 15.0	432.5 ± 18.1		
6-mo follow-up	441.2 ± 12.7	426.1 ± 14.5	417.8 ± 26.3		
Actigraphy					
Baseline	440.5 ± 14.1	420.3 ± 13.9	431.4 ± 19.7	$F_{2,34} = 0.51$, $P = .60$	No group differences
Posttreatment	429.7 ± 11.6	421.6 ± 12.4	428.7 ± 26.1		
6-mo follow-up	428.8 ± 9.8	422.1 ± 11.0	446.4 ± 21.1		
Sleep latency, min					
Sleep logs					
Baseline	33.0 ± 6.2	29.1 ± 4.0	18.6 ± 2.8	$F_{2,38} = 3.20$, $P = .05$	CBT < UC
Posttreatment	17.0 ± 3.5	15.1 ± 2.7	15.9 ± 5.6		
6-mo follow-up	15.8 ± 2.7	16.7 ± 4.0	29.8 ± 13.6		
Actigraphy					
Baseline	15.6 ± 3.0	19.4 ± 6.0	13.4 ± 3.7	$F_{2,34} = 3.22$, $P = .05$	CBT < UC
Posttreatment	10.1 ± 1.7	12.4 ± 2.4	18.2 ± 4.3		
6-mo follow-up	10.3 ± 1.9	14.7 ± 4.0	15.8 ± 3.5		
Wake after onset, min					
Sleep logs					
Baseline	66.9 ± 7.9	65.2 ± 9.9	79.5 ± 12.2	$F_{2,38} = 2.79$, $P = .07$	No group differences
Posttreatment	34.1 ± 3.7	50.5 ± 6.9	65.7 ± 10.4		
6-mo follow-up	34.7 ± 3.7	51.2 ± 7.9	62.2 ± 8.1		
Actigraphy					
Baseline	58.4 ± 5.7	63.5 ± 4.7	79.1 ± 13.0	$F_{2,34} = 0.53$, $P = .59$	No group differences
Posttreatment	48.7 ± 4.6	59.6 ± 5.9	72.2 ± 13.2		
6-mo follow-up	55.3 ± 5.2	61.9 ± 6.9	71.4 ± 8.9		

Abbreviations: See Table 1.

*Data are given as mean ± SE. Data for sleep logs are based on 42 patients (CBT group, 16 patients; SH therapy group, 17 patients; and UC group, 9 patients); and for actigraphy, on 38 patients (CBT group, 15 patients; SH therapy group, 16 patients; and UC group, 7 patients). The data shown are based on 2 weeks of monitoring at each assessment phase.

†Results shown are for the group main effect from analyses of covariance (ANCOVAs) (see the "Sleep Data" subsection in the "Results" section). Normalizing data transformations were performed before the ANCOVAs conducted on sleep-onset latency and wake after onset. The F values shown for these measures are for analyses with the transformed data. However, additional ANCOVAs conducted with nontransformed data provided similar impressions. The group comparisons reflect significant group differences across the posttreatment and follow-up time points combined by pairwise tests.

showed significant group main effects for sleep log values of TWT, SE, and SOL and for actigraphic SOL. No effects for time or the group × time interaction were significant. These results collectively indicate significant group differences for the measures mentioned, and these differences were stable across posttreatment and follow-up time points. Paired comparisons (Table 3) showed the CBT group's averaged posttreatment and follow-up TWT (sleep log) and SOL (sleep log and actigraphy) were significantly lower and their mean SE (logs) was significantly higher than the respective UC group means. The SH therapy group did not differ from the other 2 groups on any of these measures.

Because those with insomnia often complain about sleep's unpredictability, we also examined night-to-night sleep variability. First, we calculated a within-subject standard deviation for each sleep measure for each participant at baseline, posttreatment, and follow-up. Be-

Table 4. Within-Subject Data Showing Night-to-Night Sleep Variability Across Study Time Points

Measure	CBT Group*	SH Therapy Group*	UC Group*	Statistical Results for Group Main Effect†	Paired Comparisons
Sleep efficiency, %					
Sleep logs					
Baseline	9.0 ± 1.2	10.0 ± 1.0	11.4 ± 1.8	$F_{2,38} = 0.75$, $P = .48$	No group differences
Posttreatment	7.0 ± 1.7	8.2 ± 1.0	6.7 ± 1.2		
6-mo follow-up	6.3 ± 1.1	8.5 ± 1.1	12.4 ± 3.0		
Actigraphy					
Baseline	5.6 ± 1.0	6.3 ± 1.0	4.9 ± 0.5	$F_{2,34} = 1.46$, $P = .25$	No group differences
Posttreatment	4.1 ± 0.5	4.6 ± 0.6	6.0 ± 1.2		
6-mo follow-up	4.3 ± 0.5	4.9 ± 0.7	5.9 ± 0.9		
Total wake time, min					
Sleep logs					
Baseline	48.8 ± 4.5	52.5 ± 5.2	60.8 ± 8.9	$F_{2,38} = 1.18$, $P = .32$	No group differences
Posttreatment	36.4 ± 9.4	44.4 ± 6.5	38.5 ± 6.4		
6-mo follow-up	31.2 ± 5.4	47.8 ± 7.5	64.8 ± 15.5		
Actigraphy					
Baseline	34.5 ± 5.7	33.2 ± 5.0	30.4 ± 4.4	$F_{2,34} = 2.68$, $P = .08$	No group differences
Posttreatment	20.9 ± 2.7	22.3 ± 2.7	32.6 ± 4.3		
6-mo follow-up	22.7 ± 2.5	23.5 ± 2.7	31.5 ± 5.8		
Total sleep time, min					
Sleep logs					
Baseline	73.2 ± 6.7	77.4 ± 4.4	89.0 ± 9.4	$F_{2,38} = 2.54$, $P = .09$	No group differences
Posttreatment	54.0 ± 8.9	67.8 ± 4.8	79.6 ± 10.3		
6-mo follow-up	51.8 ± 6.4	66.5 ± 3.7	86.8 ± 17.7		
Actigraphy					
Baseline	68.7 ± 8.5	65.0 ± 5.2	65.1 ± 6.4	$F_{2,34} = 7.16$, $P = .003$	CBT < SH therapy and UC
Posttreatment	35.5 ± 3.4	61.1 ± 6.9	67.6 ± 9.5		
6-mo follow-up	43.2 ± 3.4	63.1 ± 7.6	67.7 ± 11.0		
Sleep latency, min					
Sleep logs					
Baseline	20.7 ± 3.8	24.8 ± 4.6	14.2 ± 3.3	$F_{2,38} = 0.86$, $P = .43$	No group differences
Posttreatment	20.1 ± 6.4	17.8 ± 2.8	15.8 ± 4.5		
6-mo follow-up	16.1 ± 4.3	16.5 ± 3.0	29.5 ± 14.5		
Actigraphy					
Baseline	19.0 ± 5.6	18.3 ± 5.1	14.6 ± 4.7	$F_{2,34} = 4.37$, $P = .02$	CBT < UC
Posttreatment	9.2 ± 1.2	11.2 ± 2.0	22.2 ± 5.7		
6-mo follow-up	9.8 ± 1.6	13.0 ± 3.0	16.2 ± 3.7		
Wake after onset, min					
Sleep logs					
Baseline	39.7 ± 5.8	44.0 ± 5.4	54.4 ± 9.1	$F_{2,38} = 2.35$, $P = .11$	No group differences
Posttreatment	25.7 ± 7.5	36.9 ± 5.7	33.9 ± 3.9		
6-mo follow-up	22.4 ± 3.8	40.4 ± 6.9	49.3 ± 11.0		
Actigraphy					
Baseline	33.5 ± 5.3	35.8 ± 6.3	36.8 ± 6.9	$F_{2,34} = 0.72$, $P = .49$	No group differences
Posttreatment	24.6 ± 3.2	30.9 ± 4.6	29.7 ± 3.8		
6-mo follow-up	28.3 ± 3.3	35.1 ± 5.4	33.9 ± 5.7		

Abbreviations: See Table 1.

*Data are given as mean ± SE. Data for sleep logs are based on 42 patients (CBT group, 16 patients; SH therapy group, 17 patients; and UC group, 9 patients); and for actigraphy, on 38 patients (CBT group, 15 patients; SH therapy group, 16 patients; and UC group, 7 patients). The data shown are based on 2 weeks of monitoring at each assessment phase.

†Results shown are for the group main effect from analyses of covariance (ANCOVAs) (see the "Sleep Data" subsection in the "Results" section). Normalizing data transformations were performed before the ANCOVAs conducted with most measures shown. The F values shown for most measures are for analyses with the transformed data. However, additional ANCOVAs conducted with nontransformed data provided similar impressions. The group comparisons reflect significant group differences across the posttreatment and follow-up time points combined by pairwise tests.

cause many of the resultant measures had skewed distributions, we again used data transformations to normalize their distributions. We then conducted 3 (groups) × 2 (posttreatment vs follow-up) ANCOVAs, adjusting for baseline values, to compare treatment groups on these measures.

Table 4 shows descriptive and comparative statistics for the variability measures. Significant group effects were obtained for actigraphic TST and SOL variability. Paired comparisons showed the CBT group had less night-to-night SOL variability than did the UC group and less TST variability than did the other 2 groups at posttreatment and follow-up. A significant group × time interaction ($F_{2,38} = 3.84$, $P = .03$) was also observed for sleep log SE. Pairwise tests showed differences between the CBT and UC groups; SE variability declined from posttreatment to follow-up for the CBT group, but increased for the UC group.

Table 5. Values for Questionnaire Measures Across Study Time Points

Measure	CBT Group*	SH Therapy Group*	UC Group*	Statistical Results for Group Main Effect†	Paired Comparisons
ISQ					
Baseline	49.3 ± 4.6	54.9 ± 4.0	53.6 ± 4.2	$F_{2,38} = 9.09$, $P<.001$	CBT and SH therapy < UC
Posttreatment	36.3 ± 3.9	30.5 ± 3.3	53.2 ± 4.9		
6-mo follow-up	34.7 ± 2.8	31.3 ± 3.1	52.9 ± 5.4		
POMS					
Baseline	28.6 ± 7.9	25.2 ± 8.0	24.7 ± 6.1	$F_{2,37} = 4.22$, $P = .02$	CBT < UC
Posttreatment	11.3 ± 4.1	12.2 ± 7.3	26.8 ± 6.1		
6-mo follow-up	15.8 ± 5.2	15.5 ± 7.4	36.1 ± 10.4		
MPQ total score					
Baseline	30.6 ± 3.2	27.6 ± 4.1	27.5 ± 5.9	$F_{2,36} = 4.68$, $P = .02$	SH therapy < UC
Posttreatment	27.6 ± 3.8	23.7 ± 4.4	34.4 ± 4.1		
6-mo follow-up	28.8 ± 3.6	22.4 ± 3.9	34.1 ± 4.9		
BPI total score					
Baseline	5.0 ± 1.4	4.6 ± 1.9	4.7 ± 1.9	$F_{2,36} = 3.67$, $P = .04$	SH therapy < UC
Posttreatment	4.3 ± 1.6	3.7 ± 2.3	5.3 ± 2.0		
6-mo follow-up	4.0 ± 2.1	3.7 ± 2.3	5.4 ± 1.9		
SF-36 mental health composite score					
Baseline	47.9 ± 3.6	46.1 ± 3.3	51.3 ± 3.5	$F_{2,31} = 4.73$, $P = .02$	CBT and SH therapy > UC
Posttreatment	50.7 ± 2.6	50.3 ± 2.9	45.5 ± 3.6		
6-mo follow-up	51.3 ± 2.6	49.4 ± 2.7	40.0 ± 2.8		

Abbreviations: BPI, Brief Pain Inventory; CBT, cognitive-behavioral therapy; ISQ, Insomnia Symptom Questionnaire; MPQ, McGill Pain Questionnaire; POMS, Profile of Mood States; SF-36, Medical Outcomes Survey 36-Item Short-Form Health Survey; SH, sleep hygiene; UC, usual care.

*Data are given as mean ± SE. The ISQ data were obtained from all 42 patients (CBT group, 16 patients; SH therapy group, 17 patients; and UC group, 9 patients); POMS data from 41 patients (CBT group, 15 patients; SH therapy group, 17 patients; and UC group, 9 patients); MPQ and BPI data from 40 patients (CBT group, 15 patients; SH therapy group, 16 patients; and UC group, 9 patients); and SF-36 data from 35 patients (CBT group, 14 patients; SH therapy group, 14 patients; and UC group, 7 patients).

†Results shown are for the group main effect from analyses of covariance (see the "Outcome Questionnaires" subsection in the "Results" section). The group comparisons reflect significant group differences across the posttreatment and follow-up time points combined by pairwise tests.

CLINICAL SIGNIFICANCE

We also compared treatment groups using a priori indices of clinically significant improvement. For sleep log data, patients were classified as improved if at posttreatment they showed a mean TST of 6.5 hours or longer, a mean TWT of less than 60 minutes, and a mean SE of 85% or greater; otherwise, patients were labeled unimproved. Patients (2 in the CBT group, 5 in the SH therapy group, and 1 in the UC group) who met the improved rating at baseline were excluded from this analysis. Eight (57%) of 14 CBT patients, 2 (17%) of 12 SH therapy patients, and 0 of 8 UC patients met this criterion. The Fisher exact test showed the proportions of improved patients differed across groups ($P=.005$). Pairwise tests showed the CBT group had higher improvement rates than did the UC ($P=.007$) and SH therapy ($P=.05$) groups. The improvement rates of SH therapy and UC patients did not differ significantly ($P=.49$).

A similar actigraphic improvement criterion was derived, but included a lower TWT value because the specific scoring algorithm used tends to underestimate nocturnal wakefulness.[24] Patients with a mean TST of 6.5 hours or longer, a mean TWT of less than 45 minutes, and a mean SE of 85% or more at posttreatment were classified as improved; the remainder were labeled unimproved. After excluding patients who met the improved rating at baseline, classification results showed that 6 (43%) of 14 CBT patients, 1 (7%) of 15 SH therapy patients, and 0 of 7 UC patients included in this comparison met this criterion ($P=.03$). Paired comparisons showed the CBT group had a significantly higher improvement rate than the SH therapy group ($P=.04$). The differing improvement rates for the CBT and UC patients were just short of significance ($P=.06$).

OUTCOME QUESTIONNAIRES

Separate 3 (group) × 2 (posttreatment vs follow-up) ANCOVAs that adjusted for baseline values were conducted with these data, with in-treatment values carried forward to replace missing end points. **Table 5** shows descriptive and comparative statistics for these measures. Not all patients completed baseline questionnaires properly, so Profile of Mood States data were derived from 41 participants, MPQ and BPI data were obtained from 40 participants, and Medical Outcomes Survey 36-Item Short-Form Health Survey data were obtained from 35 participants. The ANCOVAs showed significant group main effects for each questionnaire. Pairwise tests showed the CBT and SH therapy groups had significantly lower Insomnia Symptom Questionnaire scores and more favorable Medical Outcomes Survey 36-Item Short-Form Health Survey mental health composite scores across posttherapy time points than did UC patients. Patients in the CBT group showed lower scores on the Profile of Mood States than did UC patients; SH therapy patients had lower BPI and MPQ scores than did UC patients. Thus, CBT and SH therapy had distinctive effects on the FM symptoms assessed.

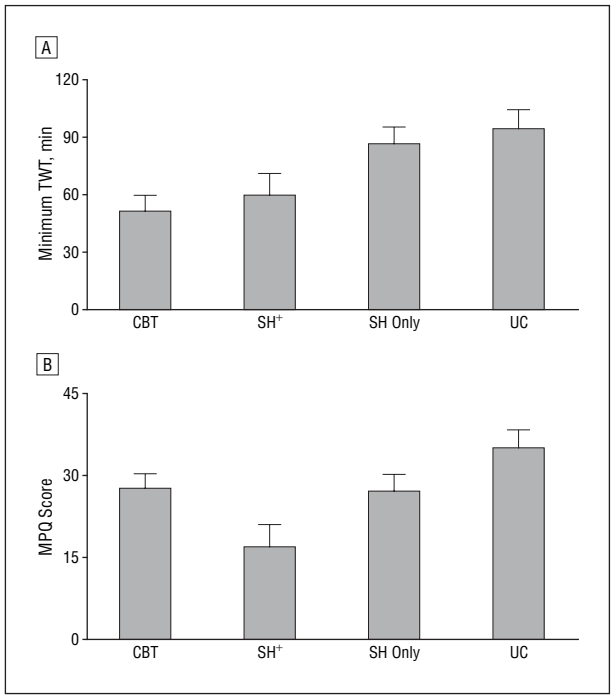

Figure 2. Total wake time (TWT) (A) and McGill Pain Questionnaire (MPQ) (B) data for the study subjects. The values shown are analyses of covariance–adjusted mean end points (ie, last data obtained) for participants in each group. CBT indicates cognitive-behavioral therapy; SH^+, sleep hygiene therapy group that made a 25% or greater reduction in their time in bed variability from pretreatment to posttreatment; SH only, sleep hygiene therapy group that showed an increase in time in bed variability throughout treatment; and UC, usual care.

MEDICATIONS

Sleep logs showed participants used some form of bedtime medication (analgesics, antidepressants, or hypnotics) for a mean ± SE of 3.4 ± 0.5 nights per week on average before therapy; by their study departure, this rate was relatively unchanged at a mean ± SE of 3.5 ± 0.7 nights per week. Kruskal-Wallis tests showed no treatment group differences in baseline rates of medication use (χ^2=0.40, P=.82), mean weekly rates of use during treatment (χ^2=0.80, P=.67), or change in rates of use throughout the study (χ^2=0.26, P=.88). It, thus, seems unlikely that bedtime medicines accounted for the group differences across study outcomes.

POST HOC ANALYSES

Analyses conducted with the whole sample showed pretherapy-to-posttherapy reductions in sleep log measures of TWT were correlated with concomitant reductions in pain scores on the BPI (r=0.34, P=.03), but uncorrelated with changes on the MPQ (r=–0.05, P=.77). Moreover, the pain reductions shown by SH therapy were unexpected. However, anecdotal observations indicated some SH therapy patients standardized their sleep schedules without instructions to do so. These patients received SH therapy and independently enacted selected CBT strategies. As such, we suspected the overall gains shown by this SH therapy group were attributable to this subgroup that enacted a combined CBT/SH therapy intervention.

To test our speculation, we reexamined sleep log TIB variability indices (within-subject standard deviations for TIB). These indices showed 6 SH therapy patients, hereafter called the SH^+ group, each made a 25% or greater reduction in their TIB variability from pretreatment to posttreatment; this change was similar to that shown by the CBT group. The UC group showed no overall change in this index, whereas the remaining SH therapy patients (SH-only group) showed an increase in TIB variability throughout treatment. A series of 4 (CBT vs SH^+ vs SH only vs UC) × 2 (posttreatment vs follow-up) ANCOVAs with study outcome measures showed a consistent pattern of results exemplified by the TWT and MPQ data in **Figure 2**. Paired comparisons showed the CBT group had significantly (P=.002) lower TWT than did the UC group, but the mean TWT for SH^+ patients approximated the mean for the CBT group. Results of similar comparisons with the MPQ data showed only the SH^+ group differed from the UC group. Thus, pain reductions in the SH therapy group occurred only in those who enacted some CBT strategies.

COMMENT

Many comparisons conducted favored CBT. Those receiving CBT reported a 48% reduction in TWT by their study departure, whereas SH therapy and UC recipients reported only 20% and 3.5% TWT reductions, respectively. Cognitive-behavioral therapy recipients showed greater reductions in TST variability than did the other groups and greater reductions in objective/subjective SOL variability than did the UC group. In addition, 57% of the CBT recipients met a strict subjective sleep improvement criterion by the end of treatment compared with 17% and 0% of SH therapy and UC patients, respectively. Likewise, 43% of the CBT patients, 7% of the SH therapy patients, and 0% of the UC patients met our objective improvement criterion. Cognitive-behavioral therapy also showed benefits over UC for reducing global insomnia symptoms, and for improving subjective mental well-being and mood. Thus, CBT may be a promising sleep therapy for FM patients.

Our SH therapy exceeded expectations on measures of mental well-being and pain. These findings, perhaps, are not surprising because SH therapy included instructions to exercise, an intervention with proved efficacy for FM management.[25] However, post hoc tests showed the SH therapy–associated improvements were attributable to a subset of SH therapy recipients who elected to implement the key CBT strategy by standardizing their sleep schedules. This subgroup likely appreciated enhanced treatment benefits by the interaction of SH therapy with the selected CBT strategies they implemented. Results from this subgroup suggest a CBT/SH therapy combination may be optimal for FM management. This combination is common practice in treating other insomnia subtypes,[13,15] and warrants testing with FM patients.

Admittedly, this trial would have benefited by use of incentives to reduce attrition and PSG to corroborate sleep improvements. Because the sleep therapies tested produced modest effects on FM pain, more omnibus CBT

models addressing sleep and pain need research consideration. Also, greater experimental control would have resulted from standardizing patients' ongoing UC and pharmacotherapy. Finally, our selection criteria may limit generalization of our findings. Nevertheless, our findings are promising and suggest CBT trials with larger FM samples and multiple therapists are warranted.

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