Logging on for Better Sleep: RCT of the Effectiveness of Online Treatment for Insomnia

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Study Objectives: Despite effective cognitive behavioral treatments for chronic insomnia, such treatments are underutilized.[1,2] This study evaluated the impact of a 5-week, online treatment for insomnia.

Design: This was a randomized controlled trial with online treatment and waiting list control conditions.

Participants: Participants were 118 adults with chronic insomnia.

Setting: Participants received online treatment from their homes.

Intervention: Online treatment consisted of psychoeducation, sleep hygiene, and stimulus control instruction, sleep restriction treatment, relaxation training, cognitive therapy, and help with medication tapering.

Measurement and Results: From pre- to post-treatment, there was a 33% attrition rate, and attrition was related to referral status (i.e., drop-outs were more likely to have been referred for treatment rather than recruited from the community). Using a mixed model analysis of variance procedure (ANOVA), results showed that online treatment produced statistically significant improvements in the primary end points of sleep quality, insomnia severity, and daytime fatigue. Online treatment also produced significant changes in process variables of pre-sleep cognitive arousal and dysfunctional beliefs about sleep.

Conclusions: Implications of these findings are that identification of who most benefits from online treatment is a worthy area of future study.

Keywords: Online treatment, insomnia, self-administered treatment

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CHRONIC INSOMNIA IS A PROBLEM PLAGUING 9% TO 9.5% OF THE POPULATION.[1,2] SUFFERERS EXPERIENCE REGULAR NOCTURNAL PROBLEMS WITH SLEEP AND report associated daytime impairment. Cognitive behavioral and pharmacotherapies have been developed for chronic insomnia and found to produce robust changes in sleep parameters.[3] Research in the area of treatment preference shows that individuals with insomnia tend to prefer behavioral over pharmacological treatments.[4,5] Given that chronic insomnia is a prevalent condition and that individuals are favorably predisposed to behavioral methods to treat this problem, only 5% to 46% seek treatment for their sleep disorder.[1,2,6,7] This rate of treatment seeking is similar to that in the area of mental health,[8] however, relatively little is known about the reasons for failure to seek treatment for insomnia. One exception is Stinson, Tang, and Harvey[9] who surveyed help-seeking and non–help-seeking adults with insomnia regarding their reasons for failing to utilize or delaying their use of treatment for insomnia. Participants could report more than one reason. Of this sample, 57% reported a belief that poor sleep would resolve on its own and/or one should be able to manage insomnia independently, 38% indicated that there was a lack of awareness of available treatment options, 31% noted a perception of treatment as ineffective or unattractive, 17% referred to a stigma surrounding insomnia, and 11% endorsed personal constraints regarding treatment-seeking. Other surveys have found that the most frequent reasons given for not consulting about mental health problems are the beliefs that these problems will go away by themselves and that individuals can manage on their own.[10] Some of the noted impediments to help-seeking could potentially be addressed through the provision of self-administered treatment.

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Self-Administered Treatments for Insomnia

A recent review of self-help treatments for insomnia showed that there have been a number of published outcome studies in this area.[11-18] In these studies, treatment has been delivered using manuals, audiotapes, television, video, telephone consultation, and the Internet. Currie[19] reviewed the outcomes of these studies, which mainly used media-recruited individuals, and concluded that outcomes from self-help approaches were positive but less favorable than those from in-person psychological treatment. In these investigations, the degree to which self-help treatments were delivered as intended was unclear, as none of the studies assessed how adherent participants were to self-administered treatment with the exception of Mimeault and Morin.[20] Unfortunately these authors did not report on the actual frequency of adherence but did note that treated individuals were similar to controls in terms of self-reported adherence. One of the most promising self-administered approaches with the potential to reach a large number of people is Internet-based treatment. Although there have been a number of Internet-based treatments for other health problems, the only published study of such treatments for insomnia was conducted by Strom and colleagues.[18] Strom et al. developed a 5-week Swedish online treatment for insomnia and evaluated it with 109 community-recruited individuals diagnosed with DSM-IV chronic primary insomnia. A number of interesting results emerged from this study including the finding that the treatment produced changes in sleep parameters for primary study variables, and that the rate of attrition (24%) was comparable to North American in-person psychotherapy standards (22%).[21]

The purpose of the current study was to develop and evaluate a brief online treatment for chronic insomnia incorporating empirically supported interventions. An effort was made to improve upon previous work in this area by (a) incorporating multimedia clips (audiovisual clips) as the main teaching component, (b) including downloadable mp3 files for relaxation training, (c) adding pdf files for psychoeducation and cognitive therapy, and (d) using the National Sleep Foundation's Doze Family clip[22] to provided an engaging overview of sleep disorders. Methodological improvements included (a) utilizing a heterogeneous group of individuals suffering from chronic insomnia many of whom were previously medicated and hence treatment failures, and (b) incorporating weekly measurement of adherence behaviors. The hypotheses of the study were that those in receipt of Internet-based treatment would experience more improvements in primary dependent variables of total sleep time (TST), sleep-onset latency (SOL), number of nocturnal awakenings (NOW), time awake at night (WASO), sleep efficiency (SE), and sleep quality (SQ) relative to those in the control group. A second hypothesis of the study was that those in receipt of Internet-based treatment, relative to controls, would experience more improvements in sleep-related functioning such as pre-sleep cognitive arousal, insomnia severity, maladaptive beliefs about sleep, and daytime fatigue (secondary variables).

METHODS

Design

This was a 2-group (treatment, waiting list control) randomized controlled trial. A treatment integrity check was conducted by asking for the submission of weekly adherence data via the Internet. Each week, a series of questions were asked pertaining to the frequency of completion of homework assignment. A power analysis was initially conducted to determine the number of participants required to detect a 1 SD improvement in sleep and other study parameters. Data for this calculation were obtained using published data[18] and assuming a drop-out rate of 24%. With this in mind, a sample size of 118 was judged necessary to detect this level of difference after attrition.

Participants

Inclusion criteria for the study were access to high-speed Internet and a home computer; a disturbance of sleep consisting of a delay in sleep onset, return to sleep, or early-morning awakening > 30 min; at least one symptom of daytime impairment (e.g., fatigue, lack of concentration); and a duration ≥ 6 months, occurring ≥ 4 nights per week. There was no maximum allowable TST (e.g., 6.5 h) for inclusion in the study. The inclusion criteria were consistent with the general research diagnostic criteria for insomnia disorder.[23] If a comorbid sleep or psychiatric disorder was present, treatment of this condition was stable at the time of entry into the study (i.e., participants were not experiencing day-to-day variability in their comorbid sleep or psychiatric problems). All participants who had been diagnosed with sleep disorders were receiving treatment for those conditions. We did not require that medications be stable. Exclusion criteria for the study were the presence of shift work, head injury, acute suicidality, current mania, schizophrenia, current or past cognitive behavioral treatment of insomnia, or elevated substance use. Elevated substance use was defined as consuming > 14 alcoholic beverages per week for males or > 12 alcoholic beverages per week for females.

A description of participant characteristics is found in Table 1. Using χ^2 analyses, there were no significant differences between the treatment and control group on any of the demographic, sleep, or psychiatric conditions. Of the sample, 27.1% (n = 32) were using a benzodiazepine, 24.6% (n = 29) were taking zopiclone, 12.6% (n = 15) were taking an antidepressant, and 3.3% (n = 4) were using both a benzodiazepine and zopiclone. There were no participants taking antipsychotics. Of the sample, 25.4% (n = 30) reported symptoms suggestive of alternative sleep disorders, and a number of participants reported having a sleep disorder as diagnosed by a respiratory physician (Table 1). Of the participants, 66.9% (n = 79) had a medical or psychiatric condition or were using a medication with stimulant properties and 28% (n = 33) had primary insomnia. No information was collected regarding participant ethnicity or income. All participants were English-speaking.

Primary End Point Measures

A standard sleep diary[24] collected information pertaining to SQ, TST, SOL, SE, NOW, and WASO, as well as frequency of medication use. SQ was assessed by taking the average of two items: "How well do you feel this morning?" And "How enjoyable was your sleep last night?" (0 = not at all, 4 = very). Sleep diary measures were scored for each night and then averaged across the recording period. Although not perfectly correlated, sleep diary ratings have been shown to correlate significantly with results obtained using polysomnographic monitoring.[25,26] Sleep diaries tend to provide overestimates of SOL and WASO, and underestimates of TST, relative to PSG,[27-30] but diaries are widely used as measures of insomnia. The Insomnia Severity Index (ISI)[31] measured the degree of dissatisfaction and daytime impairment associated with insomnia. The ISI has been found to have acceptable reliability and construct validity.[32,33] Scores range from 0 to 28, with higher scores indicating more impairment. Scores > 14 are thought to indicate the presence of clinical insomnia. The Multi-Dimensional Fatigue Inventory (MFI)[34] measured general levels of fatigue. The MFI consists of 5 subscales, and the authors recommend using the general fatigue subscale for investigations of overall levels of fatigue. The general fatigue (GF) subscale has been found to have good internal consistency (ranging from 0.83–0.90), and GF subscale scores have been shown to positively and significantly correlate with other self-report measures of fatigue.[34] Scores on the subscale range from 4 to 20, with higher scores indicating greater fatigue. GF scores from a middle-aged, mostly female, hospital staff sample (M = 10.8, SD = 4.4), outpatients with heart disease (M = 11.0, SD = 4.7), and a palliative cancer care sample (M = 16.8, SD = 3.7) have been reported.[35]

Process Measures

The Dysfunctional Beliefs and Attitudes about Sleep Scale (DBAS-10)[36] is a 10-item self-report measure of maladaptive

Table 1—Participant Characteristics

	Treatment (n = 59)		Control (n = 59)	
Variable	**%**	***n***	**%**	***n***
Referred by Physician	52.54	31	54.20	32
Female Gender	67.80	40	66.10	39
Post-Secondary Education	79.66	47	78.00	46
Employed	62.71	37	64.40	38
Married	59.32	35	66.10	39
Psychiatric Comorbidity	47.46	28	50.80	30
Depressive disorder	22.03	13	28.80	17
Generalized anxiety disorder	32.20	19	25.40	15
Posttraumatic stress disorder	6.78	4	6.80	4
Panic disorder	13.56	8	11.90	7
Social phobia	10.17	6	3.40	2
Obsessive compulsive disorder	6.78	4	3.40	2
Sleep				
Apnea	10.17	6	11.90	7
Restless legs syndrome	8.47	5	15.30	9
Periodic limb movement syndrome	11.87	7	10.20	6
Parasomnia	0	0	3.40	2

beliefs about sleep (e.g., beliefs about the immediate and long-term negative consequences of insomnia, beliefs about the need for control over insomnia). Although developed as an analogue scale, it was transformed into a Likert-type scale with responses ranging from 1 (strongly disagree) to 6 (strongly agree). Thus, possible scores ranged from 10 to 60, with higher scores indicating more maladaptive cognitions regarding sleep. The DBAS has moderate reliability and validity.[37] The cognitive subscale of the Pre-Sleep Arousal Scale (PSAS)[38] is an 8-item measure of cognitive hyperarousal associated with insomnia. The subscale score can range from 8 to 40, with higher scores indicating more hyperarousal. Evidence of the internal consistency, test-retest reliability, and convergent validity have been reported by the authors in their initial publication.

The Clinical Global Improvement Scale-self-report version (CGI)[39] assessed patients' perceived global improvement. The CGI asked patients to report the overall change in their sleep and in sleep-related effects as a result of participation in their treatment. Participants were asked to rate the change in their sleep and not in any other problem such as chronic pain, depression, or anxiety. Response choices ranged from very much improved (1) to very much worse (7). Evidence of the construct validity of the CGI-self-report version comes from the demonstration that CGI scores are significantly and positively associated with treatment-related changes in sleep parameters (e.g., TST, SE).[40]

Online Treatment

The online treatment was developed by the first author and organized into 5 modules. The main teaching component was present in an audiovisual mode with occasional text material appearing in the background to highlight particular points. The decision regarding the sequence of treatment components in the modules was made so as to mirror the sequence of treatment component delivery offered in a 6-week in-person group at the same site. This resulted in the compression of time allowed for the provision of cognitive therapy, sleep restriction, and relaxation training, each of which would normally be allotted 3 weeks in the in-person group. The online treatment was abbreviated due to anticipated concerns about poor adherence to this medium. Module 1 included psychoeducation about insomnia (e.g., information about normal sleep, types of sleep disorders) and presented the cognitive behavioral model of insomnia as described in Morin.[31] Homework for the week was to avoid clock-watching to reduce hyperarousal in the bedroom. Module 2 included information regarding sleep hygiene (e.g., implication of daytime napping for sleep, information regarding effects of alcohol consumption on sleep) and stimulus control (e.g., encouragement to avoid engendering arousal in the bedroom environment, removing of oneself from bed if unable to sleep, going to bed only when sleepy). Homework was assigned in each of these areas. Module 3 presented relaxation training and provided MP3 files for paced breathing, progressive muscle relaxation, imagery-induced relaxation, and self-hypnosis. Homework was assigned in form of daily practice of relaxation strategies, as well as continued practice in areas of sleep hygiene and stimulus control. Participants were asked to choose the relaxation exercises that they most liked and to practice with those. There was no demand to work on all 4 relaxation exercises concurrently. Module 4 introduced the concept of sleep restriction,[26] and discussed how to gradually taper off hypnotic medications only under the direction of a physician. Participants were advised against tapering if they had comorbid medical conditions as a safety precaution. For SRT, participants were informed about how to calculate a sleep window but were discouraged from using this strategy if currently sleeping < 4 hours per night. Module 5 introduced cognitive therapy, including instruction and modeling regarding the identification and correction of automatic thoughts that may increase arousal,[31] instruction regarding scheduled problem solving,[41] and instruction and modeling regarding the downward arrow technique.[42] Participants had the opportunity to listen to audio files of cognitive therapy between actors portraying patients with insomnia and the first author acting as cognitive therapist. Homework for the week was to monitor thoughts and attempt to replace anxiety-provoking thoughts with more realistic alternatives.

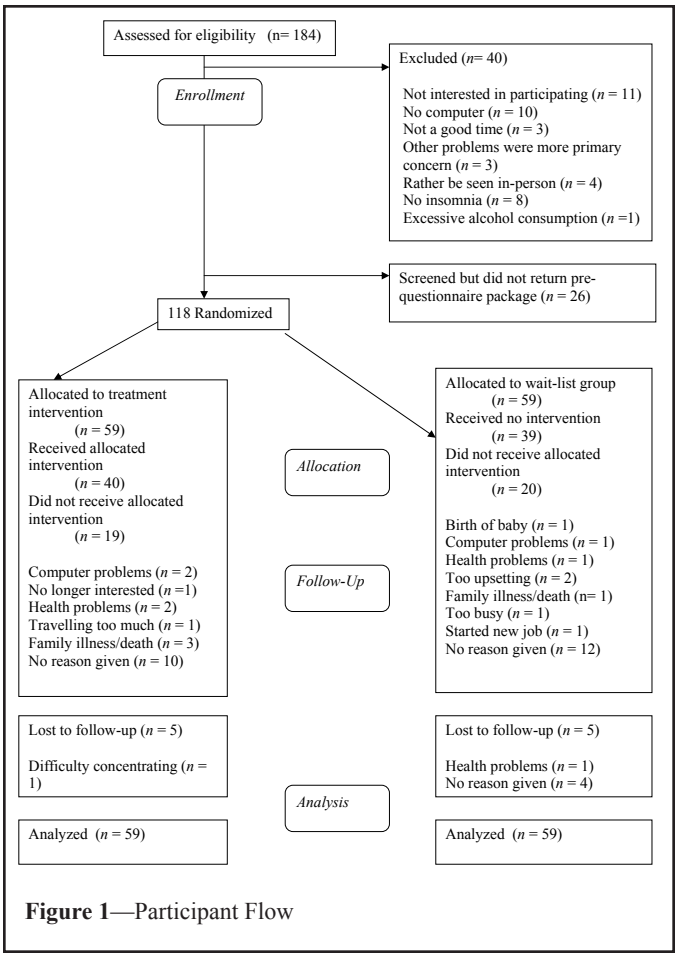

Figure 1—Participant Flow

Procedure

See Figure 1 for an illustration of the flow of participants through the study. Upon either referral to a teaching hospital behavioral medicine sleep clinic or response to a newspaper advertisement, participants were phone screened to determine whether they met inclusion and exclusion criteria for the study and whether they were interested in participating. Informed consent was obtained at this time. Next, information was collected regarding symptoms of sleep disorders, as well as medical history and current medications (for sleep and any other problem). Additionally, the Mini-International Neuropsychiatric Interview (MINI),[43] a structured clinical interview for DSM-IV[44]axis I disorders was administered by the study coordinator. All participants completed a pre-treatment questionnaire package consisting of 7 days worth of sleep diaries, the DBAS-10, MFI, PSAS, and ISI. Initially, pre-treatment questionnaires were placed on the website, but we ran into difficulties with multiple submissions of identical data by a few individuals. As a result, we later revised the procedure to have participants complete measures using paper and pencil format (either by coming to our center or through the mail). Thus, participants completed the pre- and post-treatment questionnaires in a variety of ways: 25.4% (n = 30) on the website, 43.2% (n = 51) at home (sent through the mail), and 31.4% (n = 37) came in to complete the package. There were no significant differences between the treatment and control groups for each of these methods; pre- and post-treatment data were collected using the same method for individual participants. Upon receipt of the pre-treatment package, 50% were randomly assigned by the study coordinator to receive the Internet treatment or to remain on a waiting list. Participants were not blind to study condition, and a random numbers table was used for assignment. Those in receipt of Internet treatment were provided with the web site address and with a password. Control participants were advised that they would receive access to the treatment modules once their follow-up data was received and they were also asked to refrain from treatment-seeking during the course of the study (including Internet surfing for sleep-related information). Participants in the treatment arm were instructed to log on at a consistent time each week, view the module, complete homework associated with the module, and answer questions pertaining to the prior week's homework. Participants in the treatment arm were contacted electronically at week 3 to determine whether they were having any difficulties with using the site. There was no extended patient contact (electronically or otherwise). Participants in both treatment and control groups were contacted to complete the post-treatment questionnaire package and sleep diaries at the end of the 5-week period, and then again at a 4-week follow-up. At the post-treatment period only, participants were administered the CGI and were queried regarding a retrospective estimate of the amount of time spent surfing for insomnia-related information during the study. The study was conducted between September 2006 and April 2008 and was approved by an institutional ethical review board. The trial was registered on clinicaltrials.gov.

RESULTS

As can be observed in Figure 1, 33.0% (n = 39) dropped out prior to returning their post-treatment questionnaires and diaries, and 8.5% (n = 10) dropped out at follow-up. As we were most interested in those who dropped out during the course of the 5-week treatment program, we focused on this group for drop-out analyses. There were equivalent numbers of drop-outs between the 2 conditions; treatment group (n = 19), control group (n = 20), χ^2 (1, N = 118) = 0.10, P > 0.05. Using a series of t-tests, we determined that there were no significant differences between dropouts and completers on any of the pre-treatment sleep diary variables or sleep disorder diagnoses. Although there were a number of significant differences between dropouts and completers on demographic variables, comorbidities, and referral patterns, only referral status emerged as a significant difference after adjusting alpha for repeated tests. Drop-outs were more likely to have been referred by a physician (75.0% vs 42.9%) χ^2 (1, N = 118) = 12.18, P = 0.002.

Treatment Integrity

Treatment integrity was assessed using weekly adherence questionnaires and by asking participants to self-report the amount of time spent surfing on the Internet for sleep related information during the course of the study. Successful adherence was arbitrarily defined as the practice of homework > 4 nights per week. Not all participants completed the homework checks, and homework adherence was not assessed for week 5. The number of participants completing adherence checks for each week was as follows: week 1 (n = 46 of 59), week 2 (n = 24 of 59), week 3 (n = 37 of 59), week 4 (n = 31 of 59). Results

Table 2-Effect of Group, Time, and the Group*Time Interaction on Sleep Parameters

Variable	df_1	df_2	*F*	*P*
TST				
Group	1	85.9	0.94	0.34
Time	2	62.9	11.73	0.0001
Group* Time	2	62.9	0.96	0.39
SOL				
Group	1	86.2	7.15	0.009
Time	2	56.8	9.09	0.0001
Group* Time	2	56.8	2.39	0.10
NOW				
Group	1	80.16	9.98	0.002
Time	2	55.28	3.44	0.04
Group* Time	2	55.28	1.86	0.17
WASO				
Group	1	81.2	.83	0.37
Time	2	61.9	6.43	0.003
Group* Time	2	61.9	1.32	0.27
SE				
Group	1	82.4	1.86	0.18
Time	2	60.6	22.9	0.0001
Group* Time	2	60.6	2.16	0.12
SQ				
Group	1	97.4	2.44	0.12
Time	2	58.5	1.20	0.31
Group* Time	2	58.5	7.12	0.002
MFI				
Group	1	97	6.65	0.01
Time	2	63.6	0.12	0.89
Group* Time	2	64	3.78	0.03
ISI				
Group	1	102	12.09	0.001
Time	2	66.6	25.26	0.0001
Group* Time	2	66.6	10.19	0.0001

Note. TST = total sleep time; SOL = sleep onset latency; NOW = number of nocturnal awakenings; WASO = wake time after sleep onset; SE = sleep efficiency (total time asleep/total time in bed x 100); SQ = sleep quality; MFI = Multi-Dimensional Fatigue Inventory; ISI = Insomnia Severity Index. Variables SOL, NOW, and WASO had a non-normal distribution of residuals, and so appropriate transformations were conducted. There was a violation of the sphericity assumption for the TST variable, so a Greenhouse-Geisser correction was applied to the *F* test. The reported *F* values are based on transformed data. Prior to analysis, univariate and residual outliers were removed resulting in varying degrees of freedom for each of the dependent measures.

from *t*-tests and χ^2 analyses revealed that those who did not respond to weekly adherence questionnaires did not differ from responders in terms of pre-treatment variables.

Adherence for treatment components was as follows: week 1 avoidance of clock-watching (73.9%), week 2 sleep hygiene (76.8%), week 2 stimulus control (64.2%), week 3 relaxation training (67.6%), week 4 sleep restriction (51.6%) and week 4 hypnotic tapering (22.6%). Of the relaxation exercises taught during week 3, more participants completed paced breathing exercises (*n* = 18 of 37), than PMR (*n* = 8 of 37), hypnosis (*n* = 8 of 37), or imagery-induced relaxation (*n* = 8 of 37). The adherence rate for hypnotic tapering was based on the part of the sample that was using a hypnotic. Due to experimenter error, the question regarding how many hours spent surfing for insomnia related information was not administered to the control group. Using a mixed model analysis of variance (ANOVA) procedure, there was no significant group, time, or interactive effect on medication use frequency. Those in the online group did not use significantly more medication from pre- to post-treatment.

Effect of Online Treatment on Primary Variables

We used a mixed-model analysis of variance to analyze findings to allow for serial correlation of residuals and also to accommodate missing data at some of the time points. Prior to analysis, all of the assumptions of the approach were evaluated. Results in Table 2 indicate that there was a significant interaction between group and time for SQ, MFI, and ISI, and a trend in this direction for SOL, SE, and NOW. Results in Table 3 show the nature of this effect. For the online group but not control group, SQ and ISI improved significantly between pre- and post-treatment ($P < 0.0001$), and between pre-treatment and follow-up ($P < 0.0001$). For the online but not control group, MFI ratings improved significantly between pre- and post-treatment ($P < 0.01$). There were significant main effects of time for all variables, with the exception of SQ and MFI. In all cases, sleep improved over time. Effect sizes ranged from small (WASO) to medium (TST, SQ, SOL, NOW, SE, MFI) to large (ISI).

Effect of Online Treatment on Process Variables

We used 2 mixed-model ANOVAs to analyze the impact of treatment on the process variables of pre-sleep arousal and dysfunctional beliefs and attitudes about sleep. Results showed that there was a significant group $F_{1, 96} = 19.25$, $P = 0.0001$, time $F_{2, 65} = 22.44$, $P = 0.0001$, and interactive effect $F_{2, 65} = 6.03$, $P = 0.004$ for the DBAS variable (Table 4). For the online but not control group, DBAS scores improved significantly from pre to post-treatment ($P < 0.0001$) and from pre-treatment to follow-up ($P < 0.0001$). There was a significant time $F_{2, 67} = 6.44$, $P = 0.003$, and interactive effect $F_{2, 67} = 7.08$, $P = 0.002$ for the PSAS variable. For the online but not control group, PSAS scores improved significantly from pre to post-treatment ($P < 0.0001$) and from pre-treatment to follow-up ($P < 0.0001$). The effect sizes ranged from medium (PSAS) to large (DBAS).

Clinical Significance of Findings

Of the sample, 92.5% (*n* = 37 of 40) of the treatment group and 59.0% (*n* = 23 of 39) of the control group completed the CGI. Of treated participants, 35.1% (*n* = 13 of 37) rated themselves much or very much improved, 45.9% (n = 17 of 37) rated themselves minimally improved, 16.2% (*n* = 6 of 37) rated themselves unchanged, and one participant self-rated as minimally worse. Of control participants, 60.9% (*n* = 14 of 23) rated themselves unchanged, 30.4% (*n* = 7 of 23) rated themselves minimally improved, one participant self-rated as much improved, and one participant self-rated as much worse. Of treatment group completers, 40% (*n* = 16 of 40) had ≥ 10% improvement in sleep efficiency, and 30% (*n* = 12 of 40) were receiving an additional hour of sleep at the end of the program. Of treated participants, none

Table 3-Effect of Online Treatment on Sleep Parameters

Variable	Group	Pre-Treatment		Post-Treatment		Follow-up	
		M	*SE*	*M*	*SE*	*M*	*SE*
TST (h)							
	Online	5.71	0.18	6.48	0.20	6.49	0.24
	WL	5.68	0.19	6.1	0.21	6.2	0.26
SOL (min)							
	Online	33.1	4.0	21.7	3.54	21.3	4.0
	WL	41.6	4.2	35.5	3.6	33.7	4.1
NOW							
	Online	1.96	0.16	1.49	0.17	1.69	0.21
	WL	2.54	0.17	2.40	0.18	2.31	0.22
WASO (min)							
	Online	70.8	6.4	53.5	6.8	43.0	6.1
	WL	70.2	7.0	60.78	7.6	53.6	6.7
SE (%)							
	Online	75.5	1.7	82.7	1.8	86.7	1.4
	WL	75.8	1.9	79.3	2.1	81.7	1.6
SQ							
	Online	1.83	0.11	2.18	0.13	2.28	0.13
	WL	1.99	0.12	1.77	0.14	1.83	0.15
MFI							
	Online	13.15	0.40	12.35	0.51	12.51	0.62
	WL	13.77	0.41	14.71	0.52	14.21	0.69
ISI							
	Online	18.08	0.59	12.43	0.72	12.89	0.78
	WL	18.11	0.59	16.95	0.72	16.74	0.84

TST = total sleep time; SOL = sleep onset latency; NOW = number of nocturnal awakenings; WASO = wake time after sleep onset; SE = sleep efficiency (total time asleep/total time in bed x 100); SQ = sleep quality; MFI = Multi-Dimensional Fatigue Inventory; ISI = Insomnia Severity Index.

Table 4-Effect of Online Treatment on Process Variables

Variable	Group	Pre-Treatment		Post-Treatment		Follow-up	
		M	*SE*	*M*	*SE*	*M*	SE
PSAS							
	Online	26.32	0.99	22.42	1.08	22.06	1.1
	WL	25.29	1.03	25.46	1.1	25.17	1.18
DBAS-10							
	Online	39.56	0.94	33.07	1.1	32.58	1.1
	WL	42.13	0.94	40.48	1.09	38.92	1.21

Note. PSAS = Pre-sleep Arousal Scale (cognitive subscale); DBAS-10 = Dysfunctional Beliefs and Attitudes about Sleep Scale.

had sleep in the normative range at the pre-treatment period, and 27.5% experienced sleep in the normative range by post-treatment as defined by TST > 6.5 hours, SOL ≤ 30 minutes, WASO ≤ 30 minutes, and SE ≥ 85%. Results in Table 5 showed the proportion of treated patients experiencing post-treatment sleep in the normative range and/or reliable change. This definition of "recovery" and "improvement" is offered tentatively as there is no consensus regarding how best to define these terms.

DISCUSSION

The main findings of this study were that online CBT for chronic insomnia resulted in significant improvements in insomnia severity, general fatigue, and sleep quality. Online treatment also resulted in a reduction in erroneous beliefs about sleep and pre-sleep mental activity. Of participants, 35% of those in receipt of online treatment rated themselves as much or very much improved; this compares to 50% who receive in-person group therapy at the same site.[47] Unfortunately, we do not know whether some of these improvements were due to changes in medication use patterns, or whether social desirability and/or increased attention associated with being part of a research study contributed to these outcomes. Our data showed that there was no significant change in medication use frequency as a function of time, group assignment, or an interaction of the two. We do not know whether there was fluctuation in medication use during the interim period of the study; however, it is unlikely that such fluctuation could explain these results as periods of

Table 5-Clinical Significance of Online Treatment

Variable	% Normal Sleep[a]		Reliable Change Index					
			% Improved[b]		% Recovered[c]		% Unimproved or deteriorated[d]	
	Post	FU	Post	FU	Post	FU	Post	FU
TST	50.0	53.9	22.5	30.8	20.0	26.9	47.5	42.3
SOL	57.5	61.5	22.5	19.2	10.0	15.4	30.0	34.6
WASO	42.5	44.4	32.5	37.0	20.0	33.3	42.5	37.0
SE	47.5	59.3	37.5	40.7	27.5	40.7	42.5	22.2

Note. FU = follow-up. The reliable change index (RCI)[45] was used to determine whether the observed changes from pre to post-treatment in the sleep diary variables were beyond the limits of chance variation, given the reliability of the sleep diary instrument. RCI = *M*post-*M*pre/$[2(SE)^2]^{1/2}$. Test-retest reliabilities for the sleep parameters were taken from Currie, Wilson, and Curran.[46] Reliabilities were as follows: TST (0.86), SOL (0.85), WASO (0.87), and SE (0.88).

[a]TST > 6.5 hours, SOL < 30 minutes, WASO < 30 minutes, SE > 85%. [b]RCI > 1.96. [c]Both RCI > 1.96 and criteria for normal sleep met. [d]RCI < 1.96 and criteria for normal sleep unmet.

increased usage followed by medication withdrawal, typically produce rebound insomnia which would lead to the opposite pattern of findings than those obtained in the current study. Our findings are based on self-reported sleep data; objectively collected data would likely show less pronounced improvement. The percentage of persons experiencing sleep in the normative range at post-treatment was 27% and 0 at pre-treatment. Past studies in the insomnia area have shown that 18% to 50% of persons have been found to sleep normally at post-treatment.[3] When considering both normative functioning and reliable change, our "recovery rates" ranged from 10% to 28% at post-treatment, and from 15% to 40% at follow-up. A lowered rate of recovery may occur if individuals have a smaller magnitude of change but end with normal sleep at the conclusion of treatment. Thus, with the reliable change computation, a spurious conclusion of no recovery may be made in samples with less pre-treatment severity. Our sample had a relatively high level of pre-treatment sleep efficiency, and this may have affected the degree to which participants could be viewed as recovered. Additionally, the relatively good sleep efficiency of this sample places some limitation on the degree to which these findings can be generalized to samples of greater sleep severity.

Self-Administered Treatments: The Role of Contact

Various forms of self-administered treatment for insomnia have been developed and a smaller number evaluated.[19] One recent online treatment study, directed at 109 media-recruited adults with primary insomnia, showed that both SE and TST, but not SQ, improved significantly with treatment.[18] The effect sizes of their primary sleep variables ranged from 0.03 to 0.35. This compares with the effect sizes of the primary sleep variables in the current study which ranged from 0.14 to 0.75. Research in other areas has found that supportive contact with participants who use self-help materials enhances outcome for problems such as chronic pain[48] and panic disorder.[49] If future experimental manipulation shows that additional experimenter contact enhances the outcome of online treatment for insomnia, it may be because such contact motivates individuals to attempt sleep restriction which is often crucial in improving WASO and SE. Previous work at this site has shown that sleep restriction is one of the least-liked treatment components of in-person group CBT.[5] Indeed, in this study, only 52% of individuals practiced with sleep restriction > 4 nights of the treatment week; this may be an overestimate, as not all participants responded to this adherence check.

A second main finding of the study was that community-recruited participants, compared to physician-referred participants, were significantly less likely to drop-out. Indeed, the rate of attrition of community-recruited individuals (18.2%, 10 of 55) was much lower than that of referred participants (46.7%, 29 of 62). Most investigations of self-administered treatments in the area of insomnia have employed media-recruited individuals;[19] and it is possible that these individuals have higher levels of pre-treatment motivation, are more comfortable with technology, and/or have different expectations about appropriate treatment of their sleep disorder. Within the referred subsample, the rate of attrition (47%) is higher than that reported from in-person studies in clinical settings. In-person studies have shown attrition rates from 9% to 40%.[5,55-61] Ong et al.[58] reported that the best predictors of early attrition from a group CBT program for insomnia were short sleep duration coupled with depressive symptoms. Neither Strom et al.[18] or findings from the current study found that TST predicted attrition from online treatment, although Strom speculated that those with better sleep quality at pre-treatment were more likely to drop-out. Other investigations have found mixed results regarding whether pre-treatment sleep severity predicts attrition in in-person treatments.[57,60] It could be that a second variable, perhaps mood, moderates the effect of sleep on attrition.

Future Online Treatment Research Considerations

There are numerous research questions awaiting exploration in this area some of which are: what is the best online treatment package for chronic insomnia? Given the low rates of adherence for our later modules, and given that sleep restriction, relaxation and cognitive therapies, require time for practice, it may be advisable to have these occur early on in the treatment sequence. What are the challenges to engaging referred patients to online treatment? A previous investigation in our laboratory showed that achieving a gain of at least 1

hour of sleep per night and an improvement in sleep efficiency of at least 10% are some of the most sensitive indicators of patient-rated perceived improvement.[47] Our results showed that approximately one-third of online participants experienced these types of gains. Online treatment is clearly not inert and may be an appropriate choice for a smaller number of individuals with chronic insomnia.

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