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Comparison of Objective and Subjective Assessments of Sleep Time in Subjects with Bipolar Disorder

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Introduction

Sleep disturbance is believed to be a core feature of bipolar disorder (BD). Bipolar patients exhibit an array of sleep abnormalities, including variations in sleep architecture, disruption of the 24-hour sleep-wake cycle and increased sleep fragmentation (Eidelman et al., 2010, Krystal et al., 2008, Plante and Winkelman, 2008). Somnographic findings in both manic and depressed bipolar subjects include a disruption in sleep continuity, increased time spent in stage 1 sleep, shortened REM latency, and an increase in the density of REM sleep (Hudson et al., 1992). Though commonly associated with affective episodes, sleep disturbance has also been reported in euthymic BD patients (Harvey et al., 2005, Knowles et al., 1986, Millar et al., 2004). Considering that sleep disruptions are associated with a worse course of illness (Eidelman et al., Eidelman et al.), increased symptom severity (Eidelman et al., Gruber et al., 2009), impairments in functioning and quality of life (Eidelman et al., Gruber et al., 2009), and may be initial prodromes (Skjelstad et al., 2009, Duffy, 2009, Duffy et al.), and trait markers (Gruber et al., 2009) for the illness, further research in this area is warranted.

While psychometric rating instruments used to assess symptom severity in disorders of affect contain items that characterize type and degree of sleep disturbances (Hamilton, 1960, Rush et al., 1986, Young et al., 1978, Bowden et al., 2007), to date there are a limited number of studies that compare subjective and objective measures of sleep. Previous studies

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Conflict of Interest - Comparison of Objective and Subjective Assessments of Sleep Time in Subjects with Bipolar Disorder
None of the manuscript authors, listed below, have any conflicts of interest to report in relationship to the research conducted or in preparation of this manuscript.

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in patients with major depression have reported positive correlations between subjective and objective estimates of total sleep time (TST) (Armitage et al., 1997, Rotenberg et al., 2000, Tsuchiyama et al., 2003). Some of these studies in MDD have reported a tendency toward discrepancies between subjective and objective estimates of TST (Rotenberg et al., 2000, Tsuchiyama et al., 2003). Only one study has explored the correlation between the subjective and objective estimations of TST in bipolar disorder. This study noted that euthymic BD patients demonstrated a greater discrepancy between subjective and objective measures of sleep when compared to insomnia and healthy control comparison groups (Harvey et al., 2005).

To our knowledge, there are currently no studies which examine the relationship between subjective and objective sleep variables directly in symptomatic BD patients. Given the significant relationship between sleep disturbance and bipolar disorder, there is considerable clinical benefit to understanding the capability of bipolar patients to accurately record and report sleep quantity. The current study evaluated the relationship between subjective and objective sleep measurements in a BD I population. We also assessed the role of mood state and symptom severity on the impact of the relationship between subjective and objective measures of sleep in BD subjects.

Methods

The primary aim of the study was to assess the correlation between subjective assessment of total sleep time as reported by sleep diaries and the objective assessment of total sleep time as recorded via actigraphy in patients with bipolar disorder. Exploratory study aims examined the influence of mood state on any discrepancies between subjective and objective assessments of total sleep time. We hypothesized that there would be a general discrepancy between the objective and subjective measurements of sleep and that the severity of mood symptomatology would be associated with this discrepancy. Specifically, we hypothesized that there would be an overestimation of sleep with symptoms of mania and an underestimation of sleep duration with depressive symptoms.

Subjects

39 BD I subjects were included in our evaluation. All subjects were participating in a study examining the associations between circadian gene polymorphisms and clinical and course of illness characteristics in BD I subjects at the University of Texas Southwestern Medical Center at Dallas (UTSW). Subjects were recruited from various sources throughout Dallas County and represented a broad sampling of subjects diagnosed with the illness. Patients were recruited from county and community hospitals, the university medical center, community mental health clinics, and psychiatric and clinical research groups at UTSW. Chronobiologically based intermediate phenotype assessments were the focal point of the parent study and, therefore, subjects with a history of shift work or diurnal changes in work schedule four weeks prior to or during the course of the study, travel involving three or more time zones occurring four weeks prior to or during the course of the study, current use of hypnotic agents for sleep, neurological impairment (i.e., history of cerebrovascular accident), decompensated medical illness, mental retardation, traumatic brain injury, and a recent history of substance abuse or dependence were excluded from the study.

Procedure

The study was approved by the institutional review board of UTSW Medical Center and was consistent with standard for the ethical conduct of human research. All study participants provided written informed consent. This observational study was conducted under ambulatory (at home) conditions. Subjects arrived at the research laboratory to be fitted with

the actigraph device and received instruction on how to complete sleep diaries. Subjects wore the actigraph device on their non-dominant wrist for a period of seven continuous days, while maintaining a sleep diary for the same duration of time. Once subjects completed the week of data collection they returned to the research laboratory where a trained clinician administered clinical assessments to assess symptom severity.

Clinical Assessments

DSM-IV Axis I diagnosis of BD I was confirmed by the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I/P). All cases were then subject to a best estimate diagnostic consensus including a minimum of three experienced clinicians in order to confirm the diagnosis of BD I. The Young Mania Rating Scale (YMRS) was used to determine the severity of manic symptoms while the 30-item Inventory of Depressive Symptoms Clinician rating scale (IDS-30-C) was used to determine the severity of depressive symptoms. Symptom rating scales were collected at termination of actiwatch period to assess mood and symptom severity for the study period.

Subjective and Objective Sleep Measure

While some subjects had multiple sleep episodes throughout a single 24 hour period, only primary sleep episodes as defined by subject's record in their sleep diary determined subjective total sleep time (TST). The primary sleep episode reported by the subject was typically the one nocturnal sleep period in a 24-hour time frame. Self-reported sleep diaries were used record participants sleeping and waking times and functioned as the primary subjective sleep measure. Actigraphy was used to collect data concerning physical activity and an objective sleep measure. Basic Motionlogger actigraph units (Ambulatory Monitoring, Inc., Ardsley, NY) were utilized with data sampled in 60s epochs. Total sleep time (TST) as recorded by actigraphy and calculated via the UCSD sleep algorithm was used as the objective sleep measure in the study.

Statistical Analysis

Differences between subjective and objective measures of sleep were calculated by the objective time measured minus the subjective time reported. Pearson's test was conducted to test the correlation between subjective and objective measures of TST. Multivariate regression analysis was conducted to test the impact that mood state had on discrepancy between subjective and objective estimates of TST. A significance value of 0.05 was set for all statistical tests.

Results

Demographic and Clinical Information

Demographic and clinical characteristics are presented in Table 1. The average age was 40.8 $\pm$ 11.1 years and was represented by 64% female and 36% male. 69.2% had a history of psychosis, average age at onset of illness was 16.9 $\pm$ 8.7 years; 69.2% had a history of prior hospitalizations and those hospitalized had a mean of 4.2 $\pm$ 6.9 hospitalizations. The mean symptom severity of subjects participating was YMRS of 14.2 $\pm$ 8.2 and IDS of 20.5 $\pm$ 12.3.

Correlation between Objective and Subjective Total Sleep Time Assessment

Actigraphy recorded an average of 406.53 ($\pm$ 108.90) minutes of TST. Sleep diaries recorded an average of 447.33 ($\pm$ 113.19) minutes of TST. Objective and subjective measures of TST were significantly correlated ($r = 0.5151$, $p = 0.0008$). Results are displayed in figure 1.

Impact of mood on discrepancy of sleep reports

Secondary analysis explored the impact of mood state on discrepancies between objective and subjective estimates of TST. There was a correlation between increased mood severity and a greater discrepancy between objective and subjective assessments of TST ($R^2 = 0.17$; $p = 0.04$). Further analysis indicated that the increased severity of depressive symptoms was associated with the discrepancy in TST estimations ($t = 2.65$, $p = 0.01$) but not for the severity of manic symptoms ($t = 0.03$, $p = 0.98$). Results are displayed in Figures 2&3.

Discussion

The results of the current study support the notion that, by using sleep diaries, symptomatic bipolar patients are able to accurately report TST. Subjects tended to describe their sleep duration with considerable accuracy when compared to the objective measurements of TST. The results of this study also suggest that mood symptomatology may impact the accuracy of TST reported. Contrary to our hypothesis, the degree of manic symptoms had little impact on the accuracy of TST reported while subjects experiencing greater degrees of depression tended to underestimate TST. Previous studies have reported discrepancies between subjective and objective measures of sleep in depressive populations (Rotenberg et al., 2000, Tsuchiyama et al., 2003). Both overestimations and underestimation of TST has been reported in depression (Rotenberg et al., 2000, Tsuchiyama et al., 2003). Existing literature also suggests that depression may be associated with discrepancies between subjective and objective assessments of other qualitative estimates of sleep such as sleep quality and sleep depth (Armitage et al., 1997, Rotenberg et al., 2000). In addition, variability in the reporting of sleep quantity and quality may be associated with variations in sleep architecture (Rotenberg et al., 2000, Tsuchiyama et al., 2003). Future research could also test for correlations between subjective and objective reports of other types of sleep disturbances such as number of awakenings, sleep fragmentation, etc. In the present study, for example, both subjective and objective accounts of sleep estimation recorded rather large standard deviations (± 113.19 and ± 108.90 respectively). Future research might compare the variability in TST between bipolar patients and healthy control subjects to assess whether this variability might be a clinical signature of the disorder.

There are limitations to note in the current study and several pathways for future research. Given the naturalistic study design, pharmacotherapeutic treatments varied greatly in our sample. The impact that medications have on the accuracy of TST reported was not investigated. A medication controlled study would address this concern, however, generalizability of the findings to patients receiving standard clinical care may not be possible.

The naturalistic study design did, however, allow us to assess subjects continuously for 1-week period of time in an ambulatory setting. While polysomnography is considered to be the gold standard in sleep measurement, the controlled conditions under which this testing is conducted would not allow for the assessment of subjective sleep reported in a “real world” setting to capture patients’ habitual sleep-wake patterns.

The use of sleep diaries may have acted to prompt subjects to pay closer attention to their sleep habits and therefore more accurately report TST than in the average clinical setting. A study design testing the correlation between sleep measured objectively via actigraphy vs. subjective recall of TST for a period of time preceding a clinic visit as generally occurs in most clinical settings may more closely reflect the information gathered at most clinical outpatient visits.

To further explore the relationship between mood state and the discrepancy of subjective and objective estimates of TST, it would be interesting to view the results of a similar study that compared individual groups according to specific mood state (e.g., depression, mania, euthymia). The use of mood state as a population divisor may further assess the effect that mood state has on the accuracy of subjective sleep estimation in the BD population. In this same vein, a study further assessing potential relationships between objective sleep measurement and items on mood rating scales relating to sleep may be beneficial in assessing reliability of subjective sleep report in a clinical setting. Also, the patients in our sample had mild to moderate affective symptoms so consideration should be given to the possibility that observed discrepancies may increase with greater severity of symptoms.

Sleep disturbances are a significant component of bipolar disorder. The outcome of this study warrants further examination of the reliability of subjective assessment of sleep factors amongst a BD population in a clinical setting. Additional research centric to understanding the relationship between factors of BD, such as sleep, and subjective clinical reporting of these factors may be of great importance in the assessment of this prominent clinical feature of the illness.

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Figure 1. Graphical representation of the relationship between subjective and objective measures of TST

Objective measurement of TST as recorded via actigraphy and subjective measures of TST as reported via sleep diaries were significantly correlated ($r = 0.5151$, $p = 0.0008$).

YMRS v Discrepancy of Sleep Report

Figure 2. Graphical representation of the relationship between the severity of manic symptoms and the discrepancy between objective and subjective measurements of sleep

The severity of manic symptoms was not significantly associated with the discrepancy between the objective measurement of TST as recorded via actigraphy and subjective measures of TST as reported via sleep diaries ($t = 0.03$, $p = 0.98$). Positive value indicates an underestimation of total sleep time.

Figure 3. Graphical representation of the relationship between the severity of manic symptoms and the discrepancy between objective and subjective measurements of sleep

The severity of depressive symptoms was significantly associated with the discrepancy between the objective measurement of TST as recorded via actigraphy and subjective measures of TST ($t = 2.65$, $p = 0.01$). Positive value indicates an underestimation of total sleep time.

Table 1

Demographic and clinical characteristics of the patient sample.

n=39	Mean
Demographic Variables	
Caucasian (%)	64.1
Hispanic (%)	5.1
African American (%)	30.8
Female (%)	64.1
Age (mean $\pm$ SD)	40.8 $\pm$ 11.1
Clinical Variables	
YMRS (mean $\pm$ SD)	14.21 $\pm$ 8.2
IDS-30-C (mean $\pm$ SD)	20.51 $\pm$ 12.3
Age at first symptoms (mean $\pm$ SD)	16.9 $\pm$ 8.7
History of Psychiatric Hospitalization (%)	69.2
Number of Hospitalizations (mean $\pm$ SD)	4.2 $\pm$ 6.9
History of suicide attempt (%)	51.3
History of Psychosis (%)	69.2