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Clinical significance of mobile health assessed sleep duration and variability in bipolar disorder

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ABSTRACT

Objective: Sleep disturbances are prevalent, persistent, and impairing features of bipolar disorder. However, the near-term and cumulative impact of the severity and variability of sleep disturbances on symptoms and functioning remains unclear. We examined self-reported daily sleep duration and variability in relation to mood symptoms, medication adherence, cognitive functioning, and concurrent daily affect.

Methods: Forty-one outpatients diagnosed with bipolar disorder were asked to provide daily reports of sleep duration and affect collected via ecological momentary assessment with smartphones over eleven weeks. Measures of depressive and manic symptoms, medication adherence, and cognitive function were collected at baseline and concurrent assessment of affect were collected daily. Analyses examined whether sleep duration or variability were associated with baseline measures and changes in same-day or next-day affect.

Results: Greater sleep duration variability (but not average sleep duration) was associated with greater depressive and manic symptom severity, and lower medication adherence at baseline, and with lower and more variable ratings of positive affect and higher ratings of negative affect. Sleep durations shorter than 7–8 h were associated with lower same-day ratings of positive and higher same-day ratings of negative affect, however this did not extend to next-day affect.

Conclusions: Greater cumulative day-to-day sleep duration variability, but not average sleep duration, was related to more severe mood symptoms, lower self-reported medication adherence and higher levels of negative affect. Bouts of short- or long-duration sleep had transient impact on affect. Day-to-day sleep variability may be important to incorporate into clinical assessment of sleep disturbances in bipolar disorder.

1. Introduction

Disturbances in the quantity of sleep are common among patients diagnosed with bipolar disorder. Between 70 and 99% of bipolar patients experience a reduced need for sleep at some time during the course of their illness (Harvey et al., 2009). Many patients also report difficulties with falling asleep or staying asleep over the course of illness resulting in reduced or variable sleep duration. The influence of sleep duration on mood symptoms in bipolar disorder is complex—some studies show reduced and more variable sleep duration precede manic or depressive episodes (Barbini et al., 1996; Fava and Kellner, 1991; Gruber et al., 2011; Jackson et al., 2003; Perlman et al., 2006), and are evident during mood episodes (Cassidy et al., 1998), suggesting that abnormal sleep duration can be both a risk marker and a concomitant of bipolar episodes.

The majority of studies examining sleep in bipolar disorder have employed retrospective global measures of sleep duration collected over relatively short periods of observation. Some studies have employed prospective designs in which sleep and affect are measured concurrently over periods of one or several weeks (Bauer et al., 2006; Gershon et al., 2012; Gonzalez et al., 2014). These studies suggest that sleep and circadian disruptions are predictive of mood changes among people with bipolar disorder, which, in

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turn, has informed the basis of psychosocial interventions designed to stabilize sleep-wake patterns (Frank et al., 2005). Consistent with the idea that more variable sleep predicts more symptoms in bipolar disorder, Gruber et al. (2011) found in a sample of 196 remitted patients reporting on the maximum and minimum duration of sleep obtained in the previous week, that greater variability in sleep duration was associated with worsening of depression and mania across a one-year follow up period. Seemingly consistent with these data on individuals with bipolar disorder, among healthy individuals, reduced or more variable sleep duration over time is associated with a worsening of mood (Dinges et al., 1997), diminished well-being (Drake et al., 2001) and cognitive impairment (Boland and Alloy, 2013). Poor sleep has also been linked to lower medication adherence in individuals with serious medical conditions (Phillips et al., 2005), although no studies have examined this potential link, to our knowledge, in bipolar disorder. It remains unclear if between person differences in sleep duration variability are adequately captured in brief observation periods and across a range of levels of depressive and manic symptom severity. Additionally, more studies are needed to assess the dimensional components of bipolar disorder (Phillips and Kupfer, 2013). For example, depression has been characterized by low levels of positive affect, rather than high levels of negative affect (Dunn et al., 2004), whereas mania is characterized by high levels of positive affect or irritability, but not necessarily low levels of negative affect. Examining mood symptoms alone may obscure the subtleties of these affective dimensions in bipolar disorder.

Moreover, past studies have not yielded opportunities to examine proximal associations between sleep and mood. Sleep duration and variability has typically been evaluated with cross-sectional surveys (Goossens et al., 2010), and longitudinal studies with time points spaced months, or even years, apart (Gruber et al., 2011; Perlman et al., 2006; Saunders et al., 2015). Studies have employed actigraphy to measure sleep in bipolar patients, but sleep duration in these studies was only measured for one or two weeks (Harvey et al., 2005; Jones et al., 2005; Millar et al., 2004) and concurrent mood ratings were collected at one time point (Harvey et al., 2005; Jones et al., 2005) or by daily mood diary entries (Gershon et al., 2012; Millar et al., 2004). Mobile technology and ecological momentary assessment, the frequent real time and concurrent assessment of naturalistic behavior and affective experience, affords the ability to examine proximal associations between day-to-day sleep duration and variability and concurrent positive and negative affect. In addition, lagged models enable understanding of the potential carryover effects of impaired sleep on affect.

Data from a clinical trial in bipolar disorder with a comprehensive baseline characterization and 11-weeks of daily assessments of sleep and affect via smart phone surveys allowed us to more thoroughly examine the relationship of sleep duration and variability to symptom severity, medication adherence, global cognitive functioning, and longitudinally assessed positive and negative affect. We hypothesized lower average sleep duration would be positively correlated with baseline manic symptom severity and inversely correlated with baseline depressive symptom severity. We also predicted higher day-to-day variability in sleep duration would be associated with greater baseline manic and depressive symptom severity, lower medication adherence, and greater cognitive impairment. Finally, we hypothesized that day-to-day change in sleep duration and in how atypical the day's sleep duration was compared to the person's norm would predict increases in same-day and next-day negative affect and decreases in same-day and next-day positive affect.

2. Materials and methods

2.1. Parent study

Data came from a randomized controlled trial of outpatients with bipolar I and II disorder in San Diego, which compared use of an automated mobile device-delivered intervention following brief psychoeducation with brief psychoeducation alone (Depp et al., 2015, 2012). Only subjects in the active arm (n = 41) were included. This study was carried out in accordance with the Declaration of Helsinki, and informed consent was obtained by all participants. The study was approved by the University of California San Diego (UCSD) Institutional Review Board, and registered in Clinicaltrials.gov (NCT01670123).

2.2. Participants

Participants were recruited through flyers/advertisements, online communities, community treatment settings, bipolar disorder support groups, and community outpatient treatment clinics. Diagnoses (current and lifetime psychiatric and substance use disorders) were determined through structured clinician interview with the Mini-International Neuropsychiatric Interview for DSM-IV (Sheehan et al., 1998) and obtained medical records. Diagnoses were confirmed in consensus conferences. Eligibility requirements included: 1) a bipolar I or II disorder diagnosis; 2) being aged 18+; 3) receiving outpatient medication treatment for bipolar disorder; and 4) free of visual or manual dexterity disabilities precluding operation of a touch screen device. Exclusion criteria included: 1) diagnosis of alcohol/substance use disorder in prior 3 months; 2) psychiatric hospitalization in prior month; or 3) a score of severe depression severity on the Montgomery Åsberg Depression Rating Scale or the Young Mania Rating Scale (defined as a score >32 or >20, respectively). We also excluded participants who were currently experiencing a severe mood state requiring more intense treatment. All participants provided written, informed consent, and were compensated for assessment visits ($25 for each completed assessment with a maximum of $100), but not treatment sessions.

2.3. Data collection

Each participant received an internet-enabled Samsung Fascinate smartphone, and was instructed to respond to study surveys. Surveys were sent twice daily at random times over 3–4 h blocks in the morning and evening for 11-weeks. To ensure that participants' daily activities and habits, as well as sleep/wake patterns, were not disturbed, participants were asked at study entry to indicate the times during which they were available to receive surveys. Participants were asked to fill out a web-based survey at the time it was sent, and if they did not respond, they were sent a reminder after 15 min. If the participant did not respond within 2 h, the survey expired. Individuals did not have to complete the entire survey for the data to be captured. Study staff called participants every two weeks to discuss experiences using the device (including technical difficulties), and to remind them about the next assessment visit. This study reports only on participants who received the mobile device intervention and examines only the morning responses since the sleep survey was only administered in the morning. Available for analyses were 1,882 survey elements—with an average of 45.9 days (range: 8–74) per participant. The average response rate was 63% (SD = 24%).