SLEEP QUALITY IN PSYCHIATRIC INPATIENTS

SLEEP QUALITY IN PSYCHIATRIC INPATIENTS: MODERATING EFFECT OF ENVIRONMENT

By RYAN J. L. PYRKE, B.Eng.

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**Abstract**

Inpatients with severe forms of mental illness including: depression and bipolar disorder, anxiety disorders, as well as schizophrenia and related disorders, experience severely disturbed sleep during their stay in hospital. Few interventions exist to treat poor sleep quality and those that do are not very effective in addressing this issue. We examined both objective and subjective sleep quality before and after a move from a ward-style mental health facility to a state-of-the-art integrated psychiatric hospital. Here, we address a major confound in the sleep literature concerning sleep quality in psychiatric inpatients by demonstrating that changes in the environment improve objective sleep quality. In line with previous research, measures of subjective sleep quality do not show this effect. Our results indicate that the redevelopment of psychiatric facilities is warranted and that evidence-based design features such as single-patient bedrooms should be chosen to maximize sleep quality of psychiatric inpatients.

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**Chapter 1**

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**List of Abbreviations**

|  |  |
| --- | --- |
| PSQI | Pittsburgh Sleep Quality Index |
| CBT-i | Cognitive Behavioural Therapy for Insomnia |
| DSM-5 | Diagnostic and Statistical Manual Version 5 |
| RCT | Randomized Controlled trial |
| PTSD | Post-Traumatic Stress Disorder |
| HAM-D | Hamilton Depression Rating Scale |
| MDD | Major Depressive Disorder |
| REM | Rapid Eye Movement (Sleep) |
| SWS | Slow Wave Sleep |
| WASO | Wake After Sleep Onset |
| SD | Standard Deviation |
| SBOT | Sleep Behaviour Observation Tool |
| SSRI | Selective Serotonin Reuptake Inhibitor |
| PRN | Pro Re Nata (as needed) |
| MEQ | Morningness-Eveningness Questionnaire |

**Declaration of Academic Achievement**

This thesis consists of two pieces of original work outlined in two chapters. These two pieces of original work will be submitted for publication in the *Journal of Clinical Psychiatry* and *Psychiatric Services*, respectively, and both have been completed during the duration of my master’s thesis. The study in chapter 2 was conceived and designed by Dr. Peter Bieling, in collaboration with Dr. Margaret McKinnon and the Redevelopment Evaluation Project members. All aspects of recruitment, data analyses, and the first draft of the paper were completed by me. The systematic review presented in chapter 1 was conceptualized by Dr. Margaret McKinnon, Dr. Peter Bieling, and I, and I reviewed all of the articles and composed the first draft of the paper.

**Foreword**

Sleep and circadian rhythm have been of interest since nearly the inception of psychiatry. Sleep disturbance has evolved from being considered a symptom of mental illness (for example, as defined in the DSM-5 (American Psychiatric Association, 2013b)) to a biomarker (Lewy et al., 1985) and presently is thought to dynamically influence symptomology and bi-directionally interact with mental illnesses (Pandi-Perumal et al., 2009). Recently, a paper published in *Science* revealed that one of the many functions of sleep is to provide a neuroprotective effect by opening the brain’s glymphatic system and flushing toxins away (most notably, beta amyloids) after receiving cues initiated by sleep (Xie et al., 2013). It is not surprising, that researchers are realizing that treatments which specifically target mental illness actually have an impact on sleep, which may potentially be responsible for some or all of their effectiveness (Sutton, 2014).

 Interest in harnessing the potential of sleep to influence clinical outcomes of patients with mental disorders has recently peaked in interest and literature developing and evaluating unique sleep interventions had begun to appear. For instance, basic interventions such as sleep hygiene education alone are not considered to be an effective intervention to improve sleep quality and, in fact, are now used to establish a baseline level of sleep knowledge acting as control for other interventions (de Niet, Tiemens, & Hutschemaekers, 2010; Morin, Mimeault, & Gagne, 1999). Currently, the most prominent and exciting intervention for sleep is cognitive behavioural therapy for insomnia (CBT-i) (Taylor & Pruiksma, 2014), which is now being shown to be not only effective in improving sleep in psychiatric populations but also in improving symptomology as a result (Freeman et al., 2013). Despite this, there exists a lack of widespread clinical use of sleep interventions (others include, Stimulus Control, Music Assisted Relaxation, etc.), particularly in inpatient settings where it can be difficult or impossible to effectively implement these interventions (de Niet, Tiemens, van Achterberg, & Hutschemaekers, 2011; John et al., 2007).

 Research pertaining to the sleep quality of psychiatric inpatients has indicated that these populations have severely disturbed sleep when compared with both general hospital populations and controls (Dogan, Ertekin, & Dogan, 2005). Studies done in a variety of different psychiatric inpatient samples all come to the same conclusion that sleep disturbance is widespread and severe. For instance, research in inpatients with addictions using polysomnography revealed that treatments involving abstinence from drugs of abuse resulted in severe deficits in sleep quality, such as reduced slow wave sleep and shorter sleep durations when compared with controls, which may account for the high incidence of relapse in these populations (Angarita et al., 2014; Matuskey, Pittman, Forselius, Malison, & Morgan, 2011; Wallen et al., 2014). A study of forensics inpatients found that 49.1% of 110 participants had disturbed sleep (Kamphuis, Karsten, de Weerd, & Lancel, 2013) according to the Pittsburgh Sleep Quality Index (PSQI), a well validated tool for assessing sleep quality in healthy populations (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). In three studies involving inpatients with mood disorders, unanimously it was found that the prevalence of sleep complaints exceeded 90% (Lemke, Puhl, & Broderick, 1999; Yamahara, Noguchi, Okawa, & Yamada, 2009). Surprisingly, no studies examined the prevalence of sleep disturbance in inpatient populations specifically with schizophrenia or bipolar disorder despite the fact that bipolar disorder, like other mood disorders such as major depressive disorder, has diagnostic criteria involving sleep characteristics (American Psychiatric Association, 2013b; World Health Organization, 1993). In schizophrenia, research in animal models indicates severe sleep and circadian rhythm disruption involved in the biological underpinnings of the illness (Pritchett et al., 2012). It therefore stands to be defined how the sleep quality of these individuals is influenced by the hospital environment and what treatment options for sleep disturbance are available for psychiatric populations as a whole.

The literature investigating potential treatment interventions indicates that interventions in these population are neither feasible nor are they incredibly effective at ameliorating sleep disturbance. For example, certain drugs, such as typical and atypical antipsychotics, have been shown to influence sleep quality as well as sleepiness but the same sources caution that this is not a sufficient intervention for sleep quality for these populations (Waters, Faulkner, Naik, & Rock, 2012). Furthermore, certain drugs may impact clinical features with varying effects (e.g. older adults tend to receive greater benefits from atypical antipsychotics) (Yamashita et al., 2004, 2005). Another class of psychiatric medication, antidepressants have varying side effect profiles (Dolder, Nelson, & Iler, 2012; Staner et al., 1995), which include sleep-related effects but are generally not chosen for these reasons as their impact on other symptoms of illness (e.g., low mood) tends to take precedence. On the other hand, non-pharmacological interventions are often difficult to implement and require substantial training and nursing resources to properly implement (de Niet et al., 2011; John et al., 2007). As a result, interventions such as Music Assisted Relaxation and Stimulus control were shown to be ineffective (Music Assisted Relaxation was only modestly effective) and unfeasible as inpatient sleep interventions (de Niet et al., 2010). A randomized controlled trial (RCT) investigating an exercise intervention for inpatients with PTSD found only a very small significant impact on sleep quality using a modified version of a validated scale (Rosenbaum, Sherrington, & Tiedemann, 2015). Interestingly, all of this research, which is attempting to improve sleep disturbance caused or significantly worsened by the hospital environment, (Reid, 2001) fails to acknowledge and address the underlying issue of the hospital environment itself. To date, no well-designed study (RCT or large sample size) has successfully identified an effective and feasible sleep intervention, independent of clinical improvement, for psychiatric inpatients. Further, no intervention has specifically examined the effect of the environment or the impact that changes in environment can have on psychiatric inpatient sleep quality.

The purpose of this thesis is to investigate the relationship between the environment in which psychiatric inpatients - including patients with severe forms of: i) Depression and Anxiety Disorders; ii) Bipolar Disorder; and iii) Schizophrenia and related disorders - sleep and their subjective and objective sleep quality. Critically, it has been shown that sleep quality in inpatient populations is associated with a variety of symptoms, behaviours, and clinical outcomes. For example, in a population of inpatients with anorexia nervosa, it was found that time to recovery from being severely underweight was associated with baseline sleep quality and, in particular, slow wave sleep (Pieters, Theys, Vandereycken, Leroy, & Peuskens, 2004), which is thought to be associated with growth hormone release (Scacchi et al., 1997). Furthermore, a study performed in a population of inpatients with major depressive disorder found that response to antidepressants plus Quetiapine was found to be predicted by sleep quality (Baune, Caliskan, & Todder, 2006). Kamphuis, Dijk, Spreen, and Lancel (2014) identified behaviours in forensics inpatients, aggression and impulsivity (which are of dire clinical relevance to this specific population), which are correlated with sleep quality. In addition, Lemke et al. (1999) demonstrated, in a population of inpatients with major depressive disorder, that symptom severity correlates with sleep quality. Interestingly, it has been shown in a number of studies that although both subjective and objective sleep quality are clinically relevant and correlated with a number of different clinical outcomes, they are not directly related to each other (Brooks, Krumlauf, Whiting, Clark, & Wallen, 2012; Kung, Chou, Lin, Hsu, & Chung, 2015). It was found that subjective and objective sleep quality measures tend to agree on circadian rhythm related variables but in terms of their effect on more global measures of sleep quality they tend to be uncorrelated (Woodward, Bliwise, Friedman, & Gusman, 1996). It has been proposed that this may be due to objective measurement representing severity of sleep disturbance while subjective measures represent the distress caused by this disturbance (Schwartz & Carney, 2012).

This thesis is composed of two original works concerning sleep quality in inpatient populations. The first, presented in chapter one, is a systematic review with narrative synthesis of the extant literature concerning sleep quality in inpatient psychiatric populations. It highlights the severity of sleep disturbance in these populations with a discussion of existing interventions addressing sleep quality and the relationship between subjective and objective measures in this population. The second chapter is an original experiment that examines the effect of a drastic improvement in environment from a ward-style psychiatric facility to a state-of-the-art integrated psychiatric hospital on sleep quality in psychiatric inpatients. We examined subjective (questionnaires and daily interviews) and objective (actigraphy) sleep quality in the two groups of patients (before and after the move). Following these chapters, the findings of this research are discussed in the afterword section and the thesis concludes with a consideration of future directions.

**Chapter 1**

Running head: Sleep quality in inpatients of psychiatric facilities

A systematic review of sleep quality among inpatients of psychiatric facilities

Ryan Pyrke1,2,3

Margaret C. McKinnon2,3,4

Karen Langstaff5

 Jessica Gillard5

Peter J. Bieling\*2,3

1McMaster Integrative Neuroscience Discovery and Study Program

2Mood Disorders Program, St. Joseph’s Healthcare Hamilton

3Department of Psychiatry and Behavioural Neurosciences, McMaster University

4 Homewood Research Institute

5Redevelopment, St. Joseph’s Healthcare Hamilton

\* Address for correspondence:

Peter J. Bieling
St. Joseph’s Healthcare Hamilton
100 West 5th Street
Hamilton, Ontario
CANADA
E-mail: pbieling@stjoes.ca
Phone: 905-522-1155, ext. 35015

**Abstract**

**Background:** Sleep disturbance is observed across a host of psychiatric illnesses, and represents an important target for therapeutic interventions that aim to restore normal sleeping patterns. Here, we survey the existing literature concerning sleep quality in patients undergoing hospitalization for a psychiatric illness, identifying the extent and severity of sleep disturbance in this population, along with existing therapeutic interventions. Techniques used to assay sleep disturbance in inpatient settings are also discussed.

**Methods:** A systematic literature search was performed to identify studies that assessed sleep quality in psychiatric inpatients. Studies were identified using MEDLINE (1946 to present), CINAHL (1981 to present), PsycINFO (1806 to present), and EMBASE (1974 to present). The search terms were: hospitals, psychiatric hospitals, hospitalization, hospitalized patients, hospitalized psychiatric patients, inpatients, mental disorders, sleep quality, and quality of sleep\*. Articles were independently rated by two reviewers for fit with inclusion criteria.

**Results:** Twenty-five articles were identified that addressed inpatient sleep quality through experimental analysis or review. Taken together, these papers suggest that sleep quality is disturbed among inpatients with psychiatric illness relative to other inpatient hospital populations, outpatients with psychiatric disorders, and healthy individuals. Articles defining interventions targeted at improving sleep quality in inpatients failed to provide evidence of improved sleep quality or were conducted at a low level of scientific evidence (non-RCT).

**Conclusion:** Despite overwhelming evidence of sleep disturbance in psychiatric inpatient populations, to date, few interventions have been implemented that target directly sleep quality in this population. Moreover, the efficacy of existing interventions is poorly established. Environmental factors may contribute significantly to poor sleep quality in inpatient settings, representing an important target for future intervention efforts. Additional research is also required to identify optimal methods of measuring sleep disturbance in inpatient settings as data obtained from subjective report often differ from those obtained by objective measurement.

**Introduction**

Disturbed sleep is a hallmark of almost all major psychiatric disorders (American Psychiatric Association, 2013b), and individuals with the most acute psychiatric illnesses often require hospitalization over the course of illness to manage safety and stabilize symptoms (Abas et al., 2003). Ironically, however, creating a sleep supportive environment is a challenge within these same hospital settings; noise, altered routines and increased anxiety all interfere with good sleep (Monti & Monti, 2005; Reid, 2001). An inpatient environment is often unpredictable, involving a myriad of auditory and light stimuli. The aggregate experience of this environment may undermine patients’ sense of security, and contribute further to sleep disruption. Moreover, disruptions of sleep due to an inability to accommodate unconventional social rhythms, sleep-interfering symptoms, and social needs are likely the norm rather than the exception in this environment. Conversely, restoration of normal sleep is a hallmark of clinical improvement, and itself often a target of treatment through pharmacological and non-pharmacological means (Sutton, 2014).

In this review, we summarize the published literature on the impact of inpatient hospital environments on sleep and mental illness. We set two main objectives. We sought first to provide a critical systematic review of the extant literature concerning the sleep quality of individuals in hospital for psychiatric illness. Below we review the methods of our search strategy and offer our critical analysis of the amassed literature. Our secondary aim was to review current treatment approaches aimed at ameliorating sleep deficiencies in inpatient psychiatric populations. Limitations of existing assays of sleep quality are also discussed. We conclude by identifying gaps in the research literature and by contemplating possible directions for further investigation.

**Methods**

 In order to perform a comprehensive search of the literature, an expert in the field of sleep research at Brock University in Ontario, Canada was consulted in conjunction with a professional Librarian at McMaster University to determine the appropriate keywords and databases to search. Following consultation, the literature search was performed in the databases: MEDLINE (1946 to present), CINAHL (1981 to present), PsycINFO (1806 to present), and EMBASE (1974 to present) combining the subject headings “Inpatients”, “Mental Disorders”, and “Sleep Quality” (an abstract and title search of “sleep quality or quality of sleep\*” was used in place of the subject heading “Sleep Quality” when it was not available and “Hospitals or Hospitalization or Hospitalized Patients or Psychiatric Patients/ or Psychiatric Hospitals or abstract/title search for inpatient” in place of the subject heading “Inpatient” when it was not available). This yielded 154 results (Fig. 1). Subsequently, two raters (RP and JG) independently determined whether or not to include each article based on the title and abstract meeting four criteria.

1. Topic – The article or some aspect of the article must specifically measure sleep.
2. Population – The article must deal with sleep in psychiatric inpatients.
3. Article Type – The article must be a published manuscript of an experiment or review.
4. Language – The article must be published or available in English.

In the event of a discrepancy, the paper was read and each rater again independently made an inclusion decision. Following this secondary step, no discrepancies remained. One additional article was found via reference in an included article. In total, twenty-four papers detailing original experiments and 1 review article met inclusion criteria (n = 25 in total). We identified two overarching themes in these articles (Table 1 outlines the design and main themes of the 24 articles): i) characterization of sleep characteristics of psychiatric inpatients, including specific subpopulations and the limitations of current sleep measurement tools in these populations and ii) analysis of available treatment interventions. Articles addressing sleep quality focused primarily on characterization of sleep disturbance in specific populations (e.g., mood disorders). The second theme, involving treatment strategies, arose from studies that examined the feasibility and effectiveness of either pharmacological or non-pharmacological treatment interventions. These studies included psychiatric inpatients with sleep treated as a primary or secondary outcome variable. A final set of articles examined the methodological limitations of sleep measurement strategies used by researchers in psychiatric hospital settings.

**Discussion**

*Characterization of Sleep in Psychiatric Inpatients*

As noted, fifteen articles focused specifically on sleep characteristics, the majority in specific subpopulations.

Mood Disorders

Four articles concerning sleep quality in psychiatric inpatients focused specifically on patients with mood disorders. This is unsurprising given that sleep disturbances are a diagnostic symptom of these disorders, ranging from hypersomnia in atypical depression to profound insomnia in bipolar disorder (American Psychiatric Association, 2013b; World Health Organization, 1993). Within the mood disorders spectrum, investigating sleep may shed light on mechanisms of illness in a way that is probably unique in psychiatry. For example, Lemke et al. (1999) examined the relation between an objective and non-invasive measure of sleep, *actigraphy*, subjective sleep quality (self-report Pittsburgh Sleep Quality Index (PSQI) and daily sleep logs), and severity of depressive symptoms (clinician-rated Hamilton Depression Rating Scale (HAM-D) score) in a sample of 52 inpatients with major depressive disorder (MDD). The majority of inpatients reported disturbed sleep (n=47 with PSQI > 5) that correlated with objectively measured disruptions in nocturnal activity, as measured by actigraphy. Moreover, participants with more severe depressive symptoms also had significantly higher nocturnal activity counts. In a related study, Baune et al. (2006) investigated actigraphy and subjective sleep quality (PSQI) in a population of 10 inpatients with treatment-resistant MDD and bipolar depression. By grouping individuals into those that showed improvement (≥30% improvement on HAM-D) and those that did not, they found that treatment response to antidepressants plus Quetiapine (an atypical antipsychotic) at four weeks could be predicted by sleep efficiency measured by both actigraphy and the PSQI during the first week of admission.

Ferentinos et al. (2009) examined the association between depression severity (clinician-rated HAM-D score), sleep quality (self-report Athens Insomnia Scale; self-report Epworth Sleepiness Scale), and fatigue (self-report Fatigue Severity Scale) in a mixed sample of 40 inpatients and 41 outpatients with MDD. They found that insomnia and daytime sleepiness were independent predictors of fatigue in a multiple regression analysis. In addition, the authors noted a high prevalence of not only fatigue (87.5% of participants) but also insomnia (91.4%) and daytime sleepiness (24.7%) within the population. Noting the strong association between measures of sleep quality and fatigue, the authors conclude that further work is required to establish independent measures of these constructs, where significant collinearity may exist in current self-report measures.

Finally, one study compared subjective daily sleep logs with actigraphy in a sample of 30 inpatients with depression (Kung et al., 2015). Here, patients reported worse sleep latency and efficiency on a subjective sleep log than was captured objectively through actigraphy. Interestingly, however, actigraphy indicated greater sleep disturbance throughout the night and longer times in bed than did subjective report.

 Taken together, these findings suggest that although sleep disturbance is characteristic of patients with mood disorders undergoing hospitalization, sleep quality and illness severity may interact dynamically with one another over the course of treatment. Although inpatient sleep quality is likely to be influenced by medication administration (e.g. use of Quetiapine/Seroquel), to date this issue has received relatively scant attention (see below). Finally, this literature points towards the need for sophisticated and standardized measures of self-reported and objective sleep quality in this population (e.g. a revised PSQI tailored to mood disorders inpatients), where subjective and objective report may be at odds.

Post-traumatic stress disorder (PTSD)

 Woodward et al. (1996) investigated the relation between PSQI sleep scores at admission and Polysomnography measured between one and two months on the unit in a population of 25 inpatients with combat-related PTSD. In a pattern similar to that observed in patients with mood disorders, they found that the subjective PSQI scores were in line with objective polysomnography measurements of schedule-related variables such as bed times (although the magnitude of these variables differed significantly) but at odds with global sleep quality variables.

Addictions

Sleep has also been studied in sub-populations with addictions issues, including individuals recovering from cocaine and alcohol dependence. Abstinence from these drugs is associated with a variety of disruptions in sleep patterns that relate characteristically to the drug of abuse (American Psychiatric Association, 2013b). In a series of three separate experiments involving 28 participants undergoing inpatient treatment for cocaine dependence, Matuskey et al. (2011) found that subjective sleep quality (PSQI) improved after two weeks of cocaine abstinence but objectively-measured sleep quality (assessed by polysomnography) did not. Specifically, comparing the first and third weeks of withdrawal revealed a significant decrease in Rapid Eye Movement (REM) sleep, stages 1 and 2 sleep, total sleep time, and sleep efficiency along with increased sleep onset and REM latencies, all of which indicate a decrease in sleep quality. Interestingly, slow wave sleep increased slightly (although not to the level seen in healthy individuals) providing a potential account for the increase in subjective sleep quality observed at week two of withdrawal; it is unclear whether these effects persisted over the course of admission. The authors also reported that years of cocaine abuse (chronicity) but not measures of current use (acute withdrawal) were predictive of decreased sleep duration and that recent alcohol use increased sleep duration. Finally, increased age was associated with decreased slow wave sleep, with female participants (N=5) having longer total sleep and REM sleep times than did males (N=23).

Angarita et al. (2014) also examined sleep quality in 20 inpatient participants from the placebo arm of a larger, drug-assisted cocaine abstinence clinical trial. Following two weeks of abstinence, the study identified characteristic sleep changes similar to those identified in Matuskey et al’s report but, in contrast, found that slow wave sleep decreased at two weeks and was substantially reduced compared with control data (~50% reduction). In addition, a small subset of participants (N=3) saw mean total sleep time increase above seven hours 28 to 54 days into abstinence, providing very preliminary evidence of sleep restoration. Here, it is probable that individual (e.g., medical status; psychiatric co-morbidity), as yet unidentified, characteristics may influence patterns of sleep restoration among inpatients undergoing treatment for substance use, as seen in this subset of participants.

An additional study examined sleep quality in a population of 164 individuals undergoing inpatient treatment for alcohol dependence (Wallen et al., 2014). Using both subjective (PSQI) and objective (actigraphy) measurement, the authors found that sleep quality was poor early in abstinence and improves by a small amount at four weeks. The authors comment that the clinical relevance of a small improvement in sleep efficiency (increase from 75.78 % (SD: 14.15) to 77.43 % (SD: 11.26); > 85% is considered normal) is not well understood and may represent the beginning of a trend in sleep recovery over continued abstinence. Finally, Brooks et al. (2012) reported that, in a sample of 22 abstaining alcohol-dependent inpatients, both the subjective PSQI and objective actigraphy measures indicated a high prevalence of sleep disturbance (79% with PSQI > 5 and mean actigraphy sleep efficiency of 75.89%). Actigraphy found that participants slept longer with increased wake after sleep onset than reported on the PSQI. These two variables have opposing effects on sleep efficiency and, as a result, there was no significant difference in sleep efficiency between the two measures.

As noted by Arnedt, Conroy, and Brower (2007), sleep quality may serve as an important prognostic factor in risk for relapse, pointing towards the urgent need for pharmacological and non-pharmacological interventions (e.g., environmental modification) that may lessen the deleterious impact of poor sleep on recovery in populations undergoing treatment for addictions. Taken together, the studies reviewed here further suggest that although subjective data may indicate an improvement in sleep, objective measurements of sleep quality point towards a worsening in the early stages of abstinence.

Forensics Inpatients

Two studies have examined sleep quality among psychiatric inpatients undergoing admission for legal reasons. Kamphuis et al. (2013) investigated sleep quality and contributing factors in a sample of 110 forensic inpatients. They used the PSQI, the Sleep Diagnosis List, and chart information to determine that sleep in this population is severely disturbed. Sleep disorders were present in 29.1% of participants (N=32) and roughly half of participants had a PSQI score greater than 5 (the threshold between “good” and “poor” sleep; N=54; mean = 7.1 ± 4.6). They report that 37.2 % of participants (N=32) with either sleep disorders (according to the Sleep Diagnosis List) or disturbed sleep (according to the PSQI) were taking hypnotics specifically for their sleep problems. Additionally, it was found that antisocial traits or personality disorder significantly predicted sleep disturbance on the PSQI, specifically the duration and sleep efficiency components.

In a follow-up study, Kamphuis et al. (2014) investigated the interaction between sleep (PSQI and self-report Sleep Diagnosis List), impulsivity (self-report Barratt Impulsiveness Scale - 11), and aggression (self-report Aggression Questionnaire and the Historical Clinical Future - 30, a validated Dutch instrument completed yearly by the participants’ clinicians) in a population of 96 forensic psychiatry inpatients with heterogeneous psychiatric diagnoses. Variables impacting impulsivity and aggressiveness are of particular relevance to these individuals, who may require long-term psychiatric treatments in hospital. The authors noted a high prevalence of disturbed sleep with 50 % (N = 48) of the sample reporting PSQI scores above 5. Using a multiple regression analysis, the authors found that sleep quality was a significant predictor of patients’ self-perceived level of aggression and impulsivity while substance abuse was not. Logistic regression indicated further that sleep quality was a significant predictor of clinicians’ perceptions of patient aggression with each point increase on the PSQI being associated with a 12-percent increase in the odds of being rated severely hostile. The authors conclude that poor sleep is a predictor of aggressive incidents (recorded 6 months prior to and after filling out questionnaires) but temper this conclusion by noting that the overall rate of aggressive incidents among their sample was relatively low compared to studies using alternate scales to assess aggression on a spectrum.It is further unclear whether the aggressive acts recorded would have met institutional thresholds for an “incident”, reducing the generalizability of these findings to clinical practice for aggressive behaviour. Despite limitations, including the timing of assessments (5.1 ± 4.6 months between assessments), the authors cautiously suggest that the poor sleep quality of this population may increase over time, thereby increasing risk of aggression.

It is clear from these studies that sleep disturbance is also highly prevalent among inpatient forensic psychiatry populations and may be associated with critical behavioural implications on impulsivity and aggression. There were no studies that incorporated objective measures of sleep in this population but, nonetheless, the results presented again point towards the need for effective methods of screening and management of sleep disruptions in these populations.

Anorexia Nervosa

Pieters et al. (2004) studied sleep quality in 34 individuals diagnosed with anorexia nervosa at admission when severely underweight and again after weight restoration. In a pattern similar to that reported in addictions, mood and PTSD, whereas subjective sleep quality (PSQI) improved, objective measurement (polysomnography) failed to show any evidence of improvement following weight gain, a marker of clinical improvement. Interestingly, however, time to recovery of normal weight was inversely related to amount of slow wave sleep after controlling for the initial percentage underweight at baseline. The authors note this finding supports previous suggestions that growth hormone release is stimulated by slow wave sleep and that this system becomes dysregulated in Anorexia Nervosa, highlighting the importance of interventions to address sleep quality for this population (Born, Muth, & Fehm, 1988; Scacchi et al., 1997).

Heterogeneous samples

A number of studies have examined heterogeneous samples of inpatients at psychiatric facilities. Two studies attempted to characterize sleep disturbance during hospitalization for broadly defined psychiatric reasons. Using the PSQI, Dogan et al. (2005) assessed the sleep quality of equal samples of 50 inpatients from psychiatry, and diverse medical specialties including orthopedic, general surgery, cardiovascular surgery, urology, internal medicine, chest diseases, infectious diseases, physical therapy and rehabilitation. Sleep quality of inpatients was compared to that of 50 healthy controls. Taken together, hospital inpatients experienced worse sleep than did controls. Critically, psychiatric patients exhibited significantly worse sleep quality than did controls *and* the other hospital patient groups, pointing towards the urgent need for interventions aimed specifically at improving sleep quality in this population.

In a related study, John et al. (2007) found that 83 nurse participants were unable to appropriately identify sleep disturbance in many of their sample of 183 newly admitted psychiatric inpatients. Here, there was a very low agreement between nurses’ qualitative observations of sleep disturbance and self-report during early (nurses – 25.1 % vs. self-report – 79.2 %) and late (nurses – 11.8 % vs. self-report – 46.1%) hospitalization. Interestingly, the researchers found a high rate of agreement between their observations (using a sleep behaviour observation tool (SBOT)) of sleep disturbance and patient self-report (72.6 % and 48.3 % for early and late hospitalization respectively), with observed (using the SBOT) and self-reported (modified PSQI) sleep disturbance decreasing by one week of hospitalization. Low rates of agreement between clinician perceptions of inpatient sleep quality and patient report/objective measurement may stem, in part, from the typically busy inpatient psychiatry setting combined with the degree of vigilance necessary to record observations through structured tools such as the SBOT. This high prevalence of sleep disturbance in inpatients, and the Dogan et al. (2005) study suggests, importantly but not surprisingly, that psychiatric patients have more disturbed sleep than other patient populations.

One final study used complex Fractal Dimension mathematics to analyze the complexity of actigraphy data within a 24-hour period in a sample of 20 inpatients with psychiatric disorders (Yamahara et al., 2009). The authors used the subjective PSQI to compare with the Fractal Dimension of the actigraphy data. According to the PSQI, the sample had severely disturbed sleep (95 % with PSQI > 5) and the complexity of the actigraphy data correlated with a number of PSQI domains, including sleep quality, sleep duration, sleep disturbance, daytime dysfunction, and total PSQI score.

Measurement techniques

It is worth noting here that, to date, few researchers have considered specifically the quality of measurement tools used to assess sleep quality in psychiatric inpatient settings, with even less consideration given to what these measurements mean clinically for patients. Despite the discordance between objective measurement and subjective report of sleep disturbance across disorders seen among the patient populations reviewed here, it appears probable that these two measurement techniques may play complementary roles in an inpatient psychiatric setting. Specifically, whereas objective report may be an effective diagnostic tool to identify sleep disturbance, subjective report may be equally valuable in indexing patient distress over its disruption. Notably, cognitive behavioural therapy techniques for the reduction of insomnia focus on identification of this discrepancy between subjective report and objective measurement, providing a valuable clinical tool for treatment of sleep disorder (Schwartz & Carney, 2012). It will also be critical for researchers and clinicians to identify measurement tools that balance precision of measurement with the invasiveness of the method used.

*Conclusions*

Overall, the studies reviewed here point strongly towards the presence of disturbed sleep in hospitalized psychiatric patients that may not be adequately screened for and treated during routine psychiatric care. The absence of sleep quality studies involving patients with schizophrenia, a frequent diagnosis in psychiatric inpatient settings (Weiss & Heslin, 2015), is notable. Moreover, few studies compare different psychiatric diagnostic groups to one another in an attempt to compare and contrast degree and type of sleep disruption among inpatient populations. Nonetheless, the broad finding that sleep is disrupted in hospitalized psychiatric inpatients points directly to the need for targeted intervention strategies. This treatment literature can be broadly divided into two approaches, non-pharmacological and pharmacological. We begin with the latter.

*Sleep Disturbance Amelioration: Pharmacological*

Understandably, one area of interest for researchers is the impact that medications typically prescribed as treatment for psychiatric illness have on sleep quality. A medication that treats both the underlying psychiatric condition and aids sleep would obviously have significant advantages. For example, Dolder et al. (2012) conducted a review on the effects of Mirtazapine (a dual-action antidepressant) on sleep in various populations of patients with depression. They concluded, based on 23 studies (of which 5 examined an inpatient population and of those only one included sophisticated sleep measurement), that Mirtazapine benefits sleep more than other antidepressants even when accounting for sleep benefits that result from clinical improvement. In addition, depressive symptoms improve with mirtazapine comparable to other antidepressants and in some cases at an increased rate. In an article by Staner et al. (1995), the effects of the antidepressant Paroxetine were examined before administration, during administration (at 2 days and 4 weeks), and after withdrawal in a trial of 40 inpatients with depression. In this study, sleep effects measured by polysomnography were found to be comparable between Paroxetine (n=21) and another drug of the SSRI class, Amitriptyline (n=19). They found that, although these medications resulted in reductions in REM sleep (reduction in sleep quality), they also resulted in increased sleep time and sleep efficiency (improvement in sleep quality). However, there was no significant difference in subjective sleep quality measured by the HAM-D before and after administration of the drugs and no difference between responders and non-responders. The only difference between the drugs was that the normalization of sleep parameters that occurs after the discontinuation of medication in Amitriptyline does not occur with Paroxetine. It is clear that antidepressants have the potential to impact both clinical outcomes as well as sleep characteristics. Importantly, it has been noted that certain antidepressants (for example, Mirtazapine) can increase sleep quality beyond that of other antidepressants and that of untreated clinical improvement. This could be an indication that these types of antidepressants should be considered as first-line or as an adjunctive medication in the case of patients with complaints of sleep disturbance and in those requiring longer-term pharmacological treatment.

 The impact of antipsychotic medications on inpatient sleep quality has been examined in three similar research paradigms. Two of these papers, by Yamashita et al. (2004, 2005) focused on samples of 92 and 86 inpatients, respectively, with schizophrenia that were being switched from typical antipsychotics to one of four randomly assigned atypical antipsychotics. Sleep was measured using the PSQI before and after adjustment to this switch in medication and it was found that subjective sleep quality improved. This effect, in addition to a reduction in negative symptoms as measured by the Positive and Negative Syndrome Scale, was exaggerated in elderly inpatients with schizophrenia compared to middle-aged inpatients with the same illness. The third article examined the relation between anti-psychotic medication load in 83 psychiatric inpatients and subjective sleep quality measured by the PSQI (Waters et al., 2012). Notably, there was a high prevalence of sleep disturbance (70% with PSQI>5) and of sleep problems like obstructive sleep apnea (OSA; >50%) in this sample. The researchers converted various antipsychotic medications to “standardized” chlorpromazine equivalents and examined correlations between these equivalents and PSQI domains. They found that as antipsychotic medications increased, three domains on the PSQI significantly improved by a small amount (sleep disturbances, sleep quality, and daytime dysfunction). Therefore, the authors conclude that in this high-risk population for sleep problems, a high antipsychotic load does have an effect on sleep but caution that this is not a replacement for more targeted sleep interventions. This conclusion is in line with current “Choosing Wisely” treatment guidelines set out by the American Board of Internal Medicine that caution against polypharmacy and the overzealous application of antipsychotic medications in treating sleep disturbance (American Psychiatric Association, 2013a).

 Although this literature is small and no large high-quality studies (e.g., double-blind RCTS) across medications or diagnoses are available, it appears probable that medications prescribed primarily to treat psychiatric symptoms or syndromes could be considered sufficient to aid sleep in inpatient settings. There is a notable absence of studies examining pharmacological interventions intended to target sleep restoration specifically; this is particularly surprising given the frequent use of PRN medication ostensibly used to aid sleep. In contrast, we found more targeted studies of non-pharmacological approaches that did have the specific goal of sleep restoration. These are reviewed next.

*Sleep Disturbance Amelioration: Non-Pharmacological*

A number of non-pharmacological interventions have been shown to be effective in improving sleep independent of or more often in addition to other salutary clinical outcomes. In a case study of a 59-year-old hospital patient with severe anxiety, suicidal ideation, and comorbid insomnia, effective application of sleep restriction and cognitive behavioural therapy for insomnia (CBT-i) resulted in the recovery from her severe insomnia as well as an antidepressant effect (Breitstein, Penix, Roth, Baxter, & Mysliwiec, 2014). Two other papers examined the efficacy of different non-pharmacological interventions. First, in inpatients with post-traumatic stress disorder (PTSD), Rosenbaum et al. (2015) investigated the effectiveness of exercise augmentation on PTSD symptoms and sleep. In this randomized controlled trial, sleep was measured by the PSQI in a sample of 81 inpatients with PTSD and compared between the exercise augmentation group (n=39) and control group (n=42) receiving usual care. The researchers found that regardless of intervention group, sleep remained severely disturbed (post PSQI mean score = 11.14 and 13.2 for intervention and control groups respectively) despite a statistically significantly improvement in the exercise augmentation group only when measured by a version of the PSQI (the PSQI-A) developed specifically for PTSD populations. The second paper introduced a novel device to administer rose odorants during sleep (Vitinius et al., 2014). Over three nights, the odorant was applied during sleep directly into the noses of 27 inpatients with depression. Although no significant results emerged compared with placebo and washout, there was a trend towards a decrease in mood symptoms and an increase in sleep quality according to scales custom designed for the study. The authors suggest that this result may be enhanced by longer trials over increased numbers of nights using the device.

 Two final papers dealing with non-pharmacological sleep interventions focused on the efficacy (de Niet et al., 2010) and feasibility (de Niet et al., 2011) of two sleep treatments implemented by nurses. Using a brief assessment of insomnia questionnaire, 54 participants were determined to be eligible for the study because they indicated insomnia symptoms and absence of sleep apnea and/or restless leg syndrome. The Richards-Campbell Sleep Questionnaire, and more specifically the sleep quality item on it, was the main outcome variable used to determine if Stimulus Control or Music Assisted Relaxation were effective interventions compared to usual care as control. The results indicated that only Music Assisted Relaxation was effective at reducing insomnia symptoms with only a modest effect observed. A subsequent study by de Niet et al. (2011) identified, qualitatively, barriers to effective implementation of the two non-pharmacological sleep interventions. Here, 28 participating nurses indicated through questionnaires that their ability to apply the intervention and their perception of its effectiveness were primarily responsible for preventing effective implementation of the two sleep interventions (Stimulus Control and Music Assisted Relaxation).

 In sum, these studies point towards promising non-pharmacological treatments for sleep disturbance in psychiatric hospitalized patients. However, to date, there are no large well-designed RCTs, despite the promise of potential benefits. Certainly, an effective non-pharmacological intervention to aid sleep would be an important step forward, and would also avoid polypharmacy that can result from using multiple pharmacological sleep aids.

**Conclusion**

It is clear that disturbed sleep is a significant issue, regardless of diagnosis, for inpatients undergoing psychiatric hospitalization. Studies examining psychiatric populations as a whole or comparing psychiatric inpatients’ sleep quality to other populations unanimously found disturbed sleep to be significantly more severe in psychiatric populations when compared to general hospital patients and controls. Among patients with mood disorders, illness severity and sleep disturbance interact dynamically, and appear interrelated. Critically, across diagnostic groups, subjective and objective measures of sleep were frequently at odds. For example, inpatients undergoing treatment for substance abuse often report that in contrast to objective measures, their sleep is improving during abstinence and this effect may have implications for relapse in these populations. Finally, sleep disturbance was present in a high proportion of psychiatric patients hospitalized for legal reasons and sleep disturbance may predict behavioural outcomes in this population.

Despite overwhelming evidence of sleep disturbance in psychiatric inpatient populations, it is surprising that so few interventions have been implemented that target directly sleep quality in this population. Here, pharmacological studies involving psychiatric inpatients appear limited primarily to observational studies examining the ancillary effects of common psychopharmacological interventions on sleep quality. Studies examining non-pharmacological treatments that target directly sleep disturbance point towards promising new approaches that will need to be validated in better designed studies involving double-blind RCTS and larger samples.

Optimal methods of measuring sleep disturbance in inpatient settings using methods that balance precision of measurement with the invasiveness of the method implemented need to be identified for specific psychiatric populations. It appears probable that both subjective and objective measurement techniques may play complementary roles in these inpatient psychiatric settings. Specifically, whereas objective report may be effective diagnostically, subjective report may be equally valuable in indexing patient distress. Environmental factors may contribute significantly to the poor sleep quality observed in inpatient settings, representing an important target for future intervention efforts. By identifying environmental factors in hospital that impact sleep in patients with mental health conditions, it will be possible to recommend intervention efforts (e.g., private rooms) aimed at reducing sleep disturbance. Currently, our laboratory has been working to systematically address the issue of hospitalization’s detrimental effect on sleep using both objective and subjective measures. Overwhelmingly, there is an urgent need for high-quality studies that address systematically the characteristic features of sleep disturbance in inpatient psychiatric settings and that target directly its remediation.

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\* Two raters came to a consensus on the appropriateness to include each article based on inclusion criteria of topic, population, article type, and language.

Figure 1 - Flowchart of the Literature Review

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| Table 1: Categorization of Review Articles |
| **Author - Year** | **Study Design** | **Sample** | **Intervention / Observation** | **Comparator Group** | **Sleep Measurement** | **Randomization / Blinding** |
| *Sleep in Inpatients with Mood Disorders* |
| Lemke 1999 | Cross-sectional study (n=52) | Inpatients with depression | Nocturnal Activity, Depression severity, and Sleep | Clinical Improvement, Sleep Quality | PSQI, Actigraphy, DSL | Clinician completing HAM-D was blind to subjective scales |
| Baune 2006 | Case series (n=10) | Uni- (n=8) and Bi-Polar Type II (n=2) Depressive inpatients taking antidepressants + Quetiapine | Sleep, Depression severity | Clinical Improvement | PSQI, Actigraphy, HAM-D, BDI | None |
| Ferentinos 2009 | Cross-sectional study (n=81) | Inpatients (n=40) and outpatients (n=41) with depression | Sleep and Fatigue (FSS) | None | PSQI, AIS, ESS | N/A |
| Kung 2015 | Cross-sectional study (n=30) | Inpatients with depression | Objective and Subjective Sleep | Depression Severity | HAM-D, SHPS, DSL, Actigraphy | N/A |
| *Sleep in Inpatients with Post Traumatic Stress Disorder (PTSD)* |
| Woodward 1996 | Cross-sectional study (n=25) | Inpatients with PTSD | Objective and Subjective Sleep | None | PSG, SHQ | N/A |
| *Sleep in Inpatients with Addictions* |
| Matuskey 2011 | 3 Uncontrolled Trials (n=28) | Admitted community dwelling cocaine-dependent individuals | Cocaine abstinence | None | PSG variables, SQQ | N/A |
| Angarita 2014 | Uncontrolled Trial (n=20) | Placebo arm of a larger RCT on drug assisted cocaine abstinence | Cocaine abstinence | Cocaine (+) at admission | PSG variables | None |
| Wallen 2014 | Uncontrolled Trial (n=164) | Adults admitted to an alcohol treatment facility | Alcohol abstinence | None | PSQI, Actigraphy, ESS | N/A |
| Brooks 2012 | Uncontrolled Trial (n=22) | Adults admitted to an alcohol treatment facility | Alcohol abstinence | None | Actigraphy, PSQI, and ESS | N/A |
| *Sleep in Forensics Inpatients* |
| Kamphuis 2013 | Cross-sectional study (n=110) | Forensic psychiatry inpatients | Subjective Sleep Quality | Antisocial Traits / Personality Disorder | PSQI, SDL, interviews, chart information | N/A |
| Kamphuis 2014 | Cross-sectional study (n=96) | Forensic psychiatry inpatients | Sleep, impulsivity (BIS-11), and aggression (AQ) | Observational (HCF-30, Aggressive Incidents) | PSQI, SDL | N/A |
| *Sleep in Inpatients with Anorexia Nervosa* |
| Pieters 2004 | Uncontrolled Trial (n=34) | Inpatients with Anorexia Nervosa, restrictive subtype | Weight Restoration | None | PSQI, Actigraphy | N/A |
| *Sleep in Heterogeneous Inpatients* |
| Dogan 2005 | Cross-sectional controlled study (n=200) | psychiatry = 50; Medical = 50; rehabilitation = 50; and 50 healthy controls | Sleep and Socio-demographics | Healthy Sleepers in hospital | PSQI | N/A |
| John 2007 | Qualitative cross-sectional study (n=263) | Participants were from two hospitals and consisted of 183 patients and 80 nurses | Patient subjective sleep | Nurse and researcher observation of sleep | Observation and self-report | N/A |
| Yamahara 2009 | Cross-sectional study (n=20) | Inpatients with psychiatric disorders (schizophrenia (13), schizoaffective(1), affective (5), and delusional (1)) | Objective and Subjective Sleep | None | PSQI, Actigraphy | N/A |
| *Sleep Disturbance Amelioration - Pharmacological* |
| Dolder 2012 | Review | Major Depressive Disorder | Mirtazapine | N/A | Ham-D, MADRS, PSG | N/A |
| Staner 1995 | Randomized Uncontrolled Trial (n=40) | Major Depressive inpatients | Paroxetine (30 mg) (n=16) | Amitriptyline (150 mg) (n=14) | PSG, HAM-D | Double-blind, randomized |
| Yamashita 2004 | Randomized Uncontrolled Trial (n=92) | Schizophrenia inpatients taking typical antipsychotics | Atypical Antipsychotics | Typical antipsychotics | PSQI | Randomized, not blinded |
| Yamashita 2005 | Uncontrolled Trial (n=86) | Schizophrenia inpatients taking typical antipsychotics | Atypical Antipsychotics | Age, typical antipsychotics | PSQI | Randomized to one of four antipsychotics and grouped by age |
| Waters 2012 | Cross-sectional study (n=83) | Long-stay inpatients with severe mental disorders | Sleep and Medication Load | None | PSQI | N/A |
| *Sleep Disturbance Amelioration - Non-Pharmacological* |
| Breitstein 2014 | Case Study (n=1) | Hospital patient with pharmacotherapy refractory insomnia | Sleep Deprivation and CBT-i | None | ISI, ESS, and self-report | N/A |
| Rosenbaum 2014 | Randomized Controlled Trial (n=81) | Inpatients with PTSD | Exercise Augmentation (n=39) | Usual care (n=42) | PSQIA | Assessor-blind, randomized |
| de Niet 2010 | Controlled trial (n=54) | Psychiatric hospital inpatients at three different hospitals (n=14 control / 29 in intervention 1 / 11 in intervention 2 corresponding to each of the three hospitals) | Stimulus Control and Music Assisted Relaxation | Usual care | Brief Assessment of Insomnia, RCSQ | None |
| de Niet 2011 | Qualitative cross-sectional study (n=28) | Nurses implementing two evidence based and one control sleep intervention | Feasibility of interventions | None | Questionnaire, interviews | N/A |
| Vitinius 2014 | Randomized Crossover Controlled trial (n=27) | Normosmic female depressed inpatients | Rose odorant | Placebo | Sleep (SF-A, SF-B) and dream questionnaires | patient-blind, randomized crossover |

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| --- | --- |
| PSQI – Pittsburgh Sleep Quality Index (PSQIA – PTSD version)HAM-D – Hamilton Depression Rating ScaleESS – Epworth Sleepiness ScalePSG – PolysomnographySQQ – Sleep Quality QuestionnaireSHQ – Sleep History QuestionnaireSHPS – Sleep Hygiene Practice Scale | RCSQ – Richard Campbell Sleep QuestionnaireMADRS – Montgomery Asberg Depression Rating ScaleBDI – Beck Depression InventoryAIS – Athens Insomnia ScaleISI – Insomnia Severity IndexSDL – Sleep Diagnosis ListDSL – Daily Sleep Logs |

**Chapter 2**

Running head: sleep quality in psychiatric inpatients

Evidence-based design features improve sleep quality among psychiatric inpatients

Ryan Pyrke1,2,4

Margaret C. McKinnon2,4,5

Heather McNeely3,4,6

Catherine Ahern6

Karen Langstaff6

Peter J. Bieling\*2,4

1McMaster Integrative Neuroscience Discovery and Study Program

2Mood Disorders Program, St. Joseph’s Healthcare Hamilton

3Neuropsychology Program, St. Joseph’s Healthcare Hamilton

4Department of Psychiatry and Behavioural Neurosciences, McMaster University

5Homewood Research Institute

6Redevelopment, St. Joseph’s Healthcare Hamilton

\* Address for correspondence:
Peter J. Bieling
St. Joseph’s Healthcare Hamilton
100 West 5th Street
Hamilton, Ontario
CANADA
E-mail: pbieling@stjoes.ca
Phone: 905-522-1155, ext. 35015

**Abstract**

**Objective:** Significant evidence points towards sleep disruption among psychiatric inpatients. It is unclear, however, how environment factors (e.g., dorm-style rooms) impact sleep quality in this population. Hence, the primary aim of the present study was to compare sleep characteristics pre- and post-move into a state-of-the-art mental health facility, which offered private sleeping quarters.

**Methods:** To assess sleep quality, a novel objective technology, actigraphy, was used before and after a facility move. Subjective daily interviews were also administered, along with the Horne-Ostberg Morningness-Eveningness Questionnaire and the Pittsburgh Sleep Quality Index.

**Results:** Actigraphy revealed significant improvements in objective sleep quality following the facility move. Interestingly, subjective report of sleep quality did not correlate with the objective measures. Circadian sleep type appeared to play a role in influencing subjective attitudes toward sleep quality.

**Conclusions:** Built environment has a significant effect on the sleep quality of psychiatric inpatients. Given well-documented disruptions in sleep quality present among psychiatric patients undergoing hospitalization, design elements like single patient bedrooms are highly desirable.

**Introduction**

It is well established that sleep and mental illness share a bidirectional relationship where sleep and circadian rhythm disruptions worsen mental illness and vice versa (Pandi-Perumal et al., 2009). Indeed, sleep disturbances are a diagnostic criterion of mental illnesses (for example, depression) (American Psychiatric Association, 2013b; World Health Organization, 1993) and are often the target of therapeutic interventions (Luca, Luca, & Calandra, 2013). Just as disturbed sleep is a marker of illness and its severity, restoration of regular sleeping patterns is a hallmark of clinical recovery (Baune et al., 2006; Breitstein et al., 2014; Dolder et al., 2012; Pieters et al., 2004). Despite the obvious importance of sleep, sleep disturbances that accompany mental illness are often dismissed as a symptom of the illness or are not effectively screened for during hospital treatment despite a variety of environmental factors (e.g., shared sleeping quarters, artificial light, high ambient noise levels) in hospital that may create sleeping problems (Reid, 2001).

The over-arching goal of the present study was to examine the impact of a new facility on the sleep quality of hospitalized psychiatric patients. Here, we examine sleep characteristics and circadian rhythms of a population of psychiatric inpatients with heterogeneous diagnoses in order to determine whether sleep characteristics, particularly nightly disturbance, could be significantly impacted by hospital environment factors, including natural light exposure, improvements in unit layouts and amenities, but primarily by each patient having an individual bedroom that included control of light and noise. We were uniquely positioned to conduct this study, given our recent move to an upgraded hospital facility that focused heavily on the introduction of design elements that might influence sleep, including a transition from dorm-style rooms to private sleeping quarters, allowing us to assess sleep quality pre- and post- move.

Numerous studies point towards severe sleep disturbance across a heterogeneous range of inpatient psychiatric populations. Critically, these studies indicate that the severity of this sleep disturbance is associated with the severity of participants’ illness (Baune et al., 2006; Lemke et al., 1999) and other clinical variables, including agression and impulsivity (Kamphuis et al., 2014), pointing towards the central role that sleep plays in mental illness and recovery. For example, withdrawal from either cocaine or alcohol (a common direct consequence of hospitalization in these individuals) results in marked and distinct disruption of sleep, particularly its duration (Angarita et al., 2014; Matuskey et al., 2011; Wallen et al., 2014). Similarly, among hospitalized patients with mood disorders, sleep disturbance is commonly reported (Ferentinos et al., 2009; Lemke et al., 1999), and its disruption may represent a prognostic factor for recovery on the unit (Baune et al., 2006; Pieters et al., 2004). Interestingly, however, to date, no robust study has objectively examined sleep in patients with schizophrenia who were in hospital as a result of the disorder, perhaps due to the difficulty of diagnosing sleep disorders in severely mentally ill patients (de Niet et al., 2010; de Niet et al., 2011), and the perceived inadequacy of treatments for sleep disruption in hospital (de Niet et al., 2010; Rosenbaum et al., 2015; Vitinius et al., 2014).

The study of sleep quality in psychiatric inpatients is further confounded by the use of traditional polysomnographic techniques. These techniques involve a variety of potentially disruptive conditions (anxiety from attachment of electrodes, drastic change in sleeping environment, etc.) pointing towards the need for alternative, less invasive, methods of measuring sleep quality. Recently, it has been shown that actigraphy provides a comparable index of sleep quality to polysomnography while maintaining patients’ natural social rhythms within a hospital setting (Marino et al., 2013). To our knowledge, this new technology has not been applied in a large heterogeneous psychiatric inpatient sample and could be a significant advance for sleep research in such populations.

The relation between environmental design characteristics and sleep quality in psychiatric populations, however, remains surprisingly unexplored, where, for example, no study has explored specifically the impact of built hospital environment on sleep characteristics and circadian rhythm among psychiatric inpatients undergoing hospitalization. Given the current lack of knowledge concerning the impact of evidence-based hospital design on sleep in hospitalized patients and the availability of actigraphy which allows for an in situ exploration of these issues, the redevelopment of a large hospital in south-western Ontario provided an unprecedented opportunity. The new building was constructed on the same grounds as the old facility controlling for a variety of confounding environmental factors including: proximity to social services; the landscape and grounds; and the culture of the surrounding neighbourhood. This redevelopment marked a transformation from an “asylum” style mental health facility to a state-of-the-art “evidence-based design” informed hospital that included a variety of improvements over the old facility. One of the most notable features which was hypothesized from the time of initial design to potentially impact sleep quality was the switch to single patient rooms from dorm-style rooms on the old units. This allowed patients to sleep alone, with nearly complete control over access to their room, control of natural and artificial light, and an ensuite bathroom.

In the present study, we sought to both objectively and subjectively assess the impact of innovative environmental design features on the sleep characteristics among a heterogeneous sample of inpatients with severe mental illness pre- and post-move. As part of a larger evaluation project, this study was a priority because single patient bedrooms are increasingly the norm for hospital design, and improving sleep quality could potentially be an important justification for this design feature. Therefore, a cross-section of participants filled out subjective questionnaires and were followed over the course of 7 days each with actigraphy and daily sleep interviews both before and after our move from a 1950s era building with dorm-style bedrooms (either 2 or 4 sharing) to a facility that is approximately 850 thousand square feet, features single bedrooms, larger wards with access to more amenities, and enhanced exposure to natural light in the ward milieu. With so few relevant studies to draw from, and considering the prevalence and severity of sleep disturbance in this population, we cautiously hypothesized that we would nonetheless find some evidence of improvement in sleep quality in the new facility.

**Methods**

**Participants**

The design was a pre-post cross sectional survey consisting of two patient samples with minimal overlap of participants between the two time points. From September 2013 to February 2014, N = 47 adult participants (Mean age = 37.3 (SD: 15.0); 22 Male: 25 Female) were recruited into the study prior to the reconstruction of the mental health facility (see Table 1 for a description of the demographic and clinical characteristics of the study sample). Following the redevelopment, in September 2014 to February 2015, an additional N = 47 adult participants (Mean age = 39.4 (SD: 14.3); 25 Male: 22 Female) were recruited. Inclusion criteria for study participation included patients currently undergoing treatment for a mental illness and admitted to the Margaret and Charles Juravinski Centre for Integrated Healthcare’s psychiatric inpatient units. Exclusion criteria were history of acquired brain injury, developmental delay (e.g. documented IQ < 70), and presence of neurological/neurodegenerative disease.

The study was approved by the Hamilton Integrated Research Ethics Board. Signed informed consent was obtained for each participant. In addition, consent was obtained to obtain medical and psychiatric chart information for each participant.

**Primary Outcomes**

At study onset, participants completed two subjective scales related to their sleep and sleep cycle, the Pittsburgh Sleep Quality Index (Buysse et al., 1989) and Horne-Ostberg Morningness-Eveningness Questionnaire (Horne & Ostberg, 1976). Over a subsequent 7-day period, participants wore an actigraph, (Littner et al., 2003) a wristwatch-like sleep monitoring device at night (a minimum of 5 nights of full data were required to be considered complete data) and completed daily sleep diaries.

***Pittsburgh Sleep Quality Index (PSQI*)**

The PSQI is a ten-item self-report instrument used to measure the quality and patterns of sleep. It differentiates “poor” from “good” sleep by measuring seven domains: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction over the last month. Scoring of the answers is based on a 0 to 3 scale, where a rating of 3 reflects the negative extreme on the Likert Scale. The PSQI has a reliability coefficient (Cronbach’s alpha) of 0.83 for its seven components. To avoid comprehension issues, the scale was administered as an interview upon initiation into the study.

***Actigraphy***

Actigraphy is a method used to study sleep-wake patterns by assessing movement, most commonly of the wrist using a watch-like device. Actigraphy is reliable and valid for detecting sleep in normal, healthy populations and has the advantage of being able to measure multiday human rest-activity patterns, and the estimation of sleep-wake patterns (Littner et al., 2003). It has been recommended as an alternative to traditional sleep studies, including in situations where more traditional laboratory methods are incompatible with the milieu or population (Littner et al., 2003). For the present study, the ActiLife 6 analysis software was used with ActiSleep+ wristbands from ActiGraph Corp. to objectively measure sleep. The Cole-Kripke sleep scoring algorithm in ActiLife 6.10.4 was used to score sleep variables of participants. In order to account for the highly irregular sleeping patterns observed in this sample, adjustments to sleep periods were made according to observational rounds from participant charts. Day-time naps and short nightly sleep periods (e.g. < 3 hours) were frequently present in our sample and overlooked by automatic sleep scoring and as a result all sleep periods (including any night and day-time sleep periods which met a 1-hour threshold length) were identified by verifying actigraphy with observational rounds data, summed over 24-hour periods, and averaged for the week.

***Sleep Diary***

A sleep diary was used to collect daily data on sleep and other variables that affect sleep quality (e.g., caffeine, napping; as well as subjective measures of sleepiness, fatigue, mood, etc.). Each morning, the sleep diary was collected via interview with each enrolled patient concerning their sleep experiences and patterns including sleep schedules, quality and quantity of sleep, sleep disturbances, sleep hygiene and daytime sleepiness.

**Secondary Outcomes**

***Horne-Ostberg Morningness-Eveningness Questionnaire (MEQ)***

This scale assesses an individual’s tendency towards being a “morning” or “evening” type, and represented an important demographic specifier in relation to changing sleep quality in a new environment. The MEQ produces a total score between 16 and 78 where lower scores indicate an evening type and higher scores indicate a morning type. It has a reliability coefficient (Cronbach alpha) of 0.83. In order to facilitate comprehension, the scale was also administered as an interview upon initiation into the study.

***Chart***

Chart information was used to reliably and efficiently capture demographic characteristics of participants. We extracted participants’ basic demographic (e.g. age, sex), clinical (e.g. diagnosis, length of stay, medications), and observational rounds information from their charts.

**Results**

**Statistical Analysis**

 To examine group differences in age, questionnaire, and actigraphy variables, independent samples t-tests or Mann-Whitney U tests were conducted, depending on normality of data (assessed with the Shapiro-Wilk test). For the calculation of correlations, depending on normality of data, Pearson or Spearman correlations were used. Significance was set at alpha = 0.05 for all analyses. All sample data except for the actigraphy autocorrelation scores were non-normal and as a result an independent sample t-test and Pearson correlation was used for actigraphy autocorrelation scores and U tests and Spearman correlations for all others. Proportions of categorical variables pre- and post-move were compared using chi-square analysis. Analyses were conducted with SPSS 21 (IBM, Armonk, NY, USA) and R 3.0 statistical software (R Foundation for Statistical Computing, Vienna, Austria).

**Demographic Characteristics**

Participants’ demographic and clinical data are presented in Table 1. Chi-square analyses indicated that the proportion of male and female patients did not differ significantly in the pre- and post-move samples (χ(1) = 0.383; *p* = 0.536; V = 0.064), nor did the proportion of patients with a primary diagnosis of: i) Depression and Anxiety Disorders; ii) Bipolar Disorder; and iii) Schizophrenia and related disorders (χ(2) = 1.481; *p* = 0.477; V = 0.133). The average age of participants across all diagnoses did not differ between the two time points (t = -0.404; *p* = 0.687; d = 0.083). Additionally, the amount of each of three major classes of psychiatric medications: i) Antipsychotics ii) Antidepressants and iii) Benzodiazepines being taken by participants during the study did not significantly differ between the two groups (i: Z = -0.49; *p* = 0.624; r = 0.051, ii: Z = -1.42; *p* = 0.156; r = 0.146, and iii: Z = -1.253; *p* = 0.210; r = 0.129).

**Pittsburgh Sleep Quality Index**

There were no significant differences in any of the seven domains of the PSQI or its global score pre- and post-move (*ps* > 0.05; see Table 2). The number of participants who fell in the categories of “good” or “poor” sleepers did not change (*p* > 0.05) Although, the mean global score decreased, it was still above the threshold for disturbed sleep (PSQI > 5) in both time points. Finally, a large proportion of individual participants’ global scores (77 %) across both time points were above the threshold.

**Sleep Diary**

Participants’ subjective ratings of sleep quality improved slightly at the second time point (see Table 2); this result trended towards significance (Z = -1.75; *p* = 0.08; r = 0.074).

**Actigraphy**

Actigraphy data were averaged across the examination period and summarized into indices of: i) sleep efficiency, the ratio of time spent sleeping to time in bed presented as a percentage; ii) total sleep time, the number of minutes spent sleeping per night; iii) wake after sleep onset, the number of minutes the participant spent awake each night; iv) total time in bed, the number of minutes the participant spent in bed each night; v) latency, the number of minutes it takes to fall asleep each night; vi) number of awakenings per night; and vii) autocorrelation which reveals how well this set of data, when shifted a certain number of hours (in this case 24 hours), correlates with itself.

 Sleep efficiency (Z = -2.67; *p* = 0.008; r = 0.276) significantly increased while wake after sleep onset (Z = -3.43; *p* = 0.001; r = 0.354), total time in bed (Z = -2.545; *p* = 0.011; r = 0.262), latency (Z = -3.125; *p* = 0.002; r = 0.322), number of awakenings (Z = 2.03; *p* = 0.042; r = 0.210), and autocorrelation (t = 2.852; *p* = 0.005; d = 0.59) all significantly decreased following the move; total sleep time did not differ significantly.

**Horne-Ostberg Morningness-Eveningness Questionnaire**

There were no significant correlations between the score on the MEQ and the actigraphy indices, however, the MEQ did correlate significantly with sleep quality (two sided; ρ = -0.320; *p* = 0.003) and latency (two sided; ρ = -0.276; *p* = 0.012) scores of the PSQI, and was trending towards a significant correlation with the global score (two sided; ρ = -0.212; *p* = 0.056). Here, lower scores on the MEQ indicate an evening type and higher scores indicate a morning type.

**Discussion**

This study is the first to reveal a significant impact of evidence-based hospital design features on sleep quality among psychiatric inpatients. Specifically, there was a significant improvement in objective measures of sleep quality following a move from an older hospital environment with dorm-style rooms to a new hospital that incorporated many evidence-based design features, including private sleeping quarters. Here, the collection of actigraphy data illustrated a significant decline in the amount of nightly sleep disturbance in the sample from the new facility. Sleep efficiency, a global measure of sleep quality, increased significantly while the number of minutes of wake time after sleep onset, a key indicator of nightly sleep disturbance, decreased significantly, showing the largest decrease (i.e., effect size) among all of the actigraphy measures. Finally, patients experienced a significant decrease in the number of awakenings each night. By assessing sleep quality pre- and post-move to a new facility, we were able to illustrate directly the positive impact that evidence-based design features, most prominently, single bedrooms, had on mitigating the deleterious impact of environmental stimuli on sleep quality in among psychiatric inpatients (roommates, noise from the unit, etc.).

Interestingly, although these objective data pointed strongly towards the positive impact of the rebuilt environment on sleep quality, there was no difference in subjective sleep quality between the two groups. This finding is in line with a wide body of evidence pointing towards discrepancies in objective measurements of sleep quality in inpatient psychiatric settings (e.g., mood disorders, addictions, eating disorders) and patients’ subjective report (see Pyrke et al., submitted, for a review). Factors that may contribute to this discrepancy include cognitive limitations that may impact responding on complex scales that rely upon recall of past events, and the relative sensitivity of objective and subjective measures of sleep quality. The PSQI requires participants to consider their past month of sleep which may be not only cognitively difficult for this population but also may be confounded by reports of sleep at home if the participant has not been in hospital for one full month. Furthermore, the sleep medication subscale of the PSQI may have been inflated due to the timing of psychiatric medication dosing and metabolic load being used as a sleep aid. Indeed, previous reports indicate that subjective report may exaggerate the severity of schedule-related measures of sleep quality (e.g. sleep duration, latency, etc.) resulting in a lack of correlation with more complex sleep quality variables (e.g. sleep efficiency, wake after sleep onset, etc.) (Baune et al., 2006; Brooks et al., 2012; Kung et al., 2015; Lemke et al., 1999; Matuskey et al., 2011; Staner et al., 1995; Wallen et al., 2014; Woodward et al., 1996; Yamahara et al., 2009). Here, it is probable that whereas objective measurement techniques may represent key diagnostic tools for assessing sleep quality, subjective report may be equally crucial in indexing patient perceptions regarding sleep quality. Notably, patients who reported being more of an evening type tended to report more severely disturbed sleep on the PSQI. From a clinical standpoint, the hospital environment may be less accommodating of this sleeping pattern raising the possibility that the PSQI may capture some aspect of attitudes regarding difficulties attaining an individual’s ideal sleeping pattern (e.g., late morning awakening) in this subpopulation.

It is further notable that the actigraphy analysis revealed relatively high durations of time spent in bed in our patient sample (mean between 9 and 10 hours for both groups) as compared to studies in other populations (Matuskey et al., 2011) (Wallen et al., 2014). In contrast to previous studies, our sample included patients with schizophrenia, which may have increased sleep duration. Notably, this increased duration resulted in sleep efficiency levels above 85 % (a value which is thought to be within the “normal range” for shorter durations of sleep) despite patients’ subjective reports of disturbed subjective sleep quality. Unfortunately, it was not possible to accurately link patient sleep logs to the actigraphy data and instead observational nursing rounds were used to adjust bed times when screening autoscored sleep periods. Here, patient sleep logs may have suffered inaccuracies due to difficulty recalling the duration of sleep period (exacerbated by burden of illness among some participants). Many participants also napped frequently and for an extended period throughout the day, an activity that was difficult for participants to chart accurately. Finally, although there was a significant reduction in the latency to fall asleep after the move, the autoscore function appears to underestimate the latency in general as the values are comparatively small when considering previous findings in smaller samples which control more carefully for latency (Baune et al., 2006).

 Interestingly patients’ circadian rhythms within the new building were less regular (autocorrelation value at a cycle period of 24 hours decreased) than in the old facility. Apparent “irregularities” in circadian rhythm may have been influenced by the privacy provided by single patient bedrooms where patients were free to follow their own rhythms independent of potential disturbances caused by roommates and the hospital routine. Notably, severe mental illness may further cause disruptions in neurological circadian timings and result in highly irregular, but metabolically cued, sleeping patterns (Pritchett et al., 2012). Indeed, forcing a sleep rhythm onto an individual might have the counter therapeutic effect of decreasing sleep quality despite the appearance of a more regular sleeping pattern by increasing sensitivity to night time disturbances.

**Conclusion**

The recent move of our hospital from an older building with dorm-style rooms to a new facility with private sleeping quarters provided an unprecedented opportunity to systematically address, with a high level of ecological validity, a key methodological confound within the hospital-related sleep literature. Here, we found that a novel, objective measure of sleep quality (actigraphy) revealed a significant improvement in sleep quality among psychiatric patients undergoing hospitalization following the move from largely dorm-style rooms to private sleeping quarters. Additional, design-related features that may have contributed to this improvement included an increase in natural light exposure and improvements in unit layouts and amenities, such as recreational spaces that were not as elaborate in the older facility. These findings have important implications both for clinical treatment and for decisions concerning the design of healthcare facilities. Specifically, these results provide clear support for continued efforts to redevelop existing healthcare facilities following evidence-based design principles, including the introduction of private rooms that yield clear therapeutic benefit in terms of improved sleep quality. This study further illustrates the merits of using a non-invasive, objective measure of sleep quality, actigraphy, to gauge sleep quality in inpatient settings.

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Table 1 – Demographic and clinical characteristics of participants before and after the facility move

|  |  |  |
| --- | --- | --- |
| **Characteristics** | **Pre-Move** | **Post-Move** |
| Number of Participants | 47 | 47 |
| *Primary Diagnosis – N (%)* |  |  |
| Depression & Anxiety Disorders | 12 (26 %) | 13 (28 %) |
| Bi-Polar Disorder | 8 (17 %) | 12 (26 %) |
| Schizophrenia & related disorders | 22 (47 %) | 17 (36 %) |
| Post-Traumatic Stress Disorder | 1 (2 %) | 1 (2 %) |
| Personality Disorder | 1 (2 %) | 2 (4 %) |
| Mood Disorder NOS | 1 (2 %) | 1 (2 %) |
| Psychosis NOS | 1 (2 %) | 1 (2 %) |
| Delusional Disorder | 1 (2 %) | - |
| Age – mean in years (SD) | 38.11 (15.79) | 39.36 (14.30) |
| *Age Group – N (%)* |  |  |
| 18-29 | 20 (43 %) | 17 (36 %) |
| 30-39 | 9 (19 %) | 6 (13 %) |
| 40-49 | 7 (15 %) | 10 (21 %) |
| 50+ | 11 (23 %) | 14 (30 %) |
| *Gender – N (%)* |  |  |
| Male | 22 (47 %) | 25 (53 %) |
| Female | 25 (53 %) | 22 (47 %) |
| *Medication* |  |  |
| Antipsychotics (Chlorpromazine equivalents1) – mean(SD) | 322.5 (389.3) | 392.4 (592.6) |
| Antidepressant Potency2 – mean (SD) | 2.15 (2.21) | 2.89 (2.62) |
| Benzodiazepines (Lorazepam equivalents3) – mean (SD) | 1.35 (2.37) | 1.72 (2.23) |

1 Using calculations by Sackeim (2001) and Leucht et al. (2015).

2 Using calculations by Sackeim (2001).

3 Using calculations by Miller and Gold (1998), Sostmann, Sostmann, Crevoisier, and Bircher (1989), Ng, Dahri, Chow, and Legal (2011), and Quan (2011).

Table 2 – PSQI and Sleep Diary Results

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|   | **Pre-Move** | **Post-Move** | **Statistical Value** | **p-value** | **Effect Size** |
| N | 42 | 45 |  |  |  |
| Sleep Disturbed (5 < Global PSQI < 10) – N (%) | 20 (48 %) | 18 (40 %) |  |  |  |
| Sleep Severely Disturbed (Global PSQI >10) – N (%) | 15 (36 %) | 14 (31 %) |  |  |  |
| Sleep Not Disturbed (Global PSQI ≤ 5) – N (%) | 7 (17 %) | 13 (29 %) | χ(2) = 1.84 | 0.399 | V = 0.145 |
| Sleep Onset Latency – minutes (SD) | 46.5 (46.7) | 44.5 (45.0) | Z = -0.37 | 0.712 | r = 0.040 |
| Sleep Efficiency – percent (SD) | 83.2 % (20.7) | 79.9 % (19.9) | Z = -0.56 | 0.572 | r = 0.061 |
| Total Sleep Time – hours (SD) | 7.68 (2.30) | 7.45 (2.16) | t = 0.47 | 0.642 | d = 0.100 |
| *Sub-domain Scores – mean (SD)* |  |  |  |  |  |
| Duration of Sleep | 0.88 (1.09) | 0.64 (1.09) | Z = -1.32 | 0.186 | r = 0.142 |
| Sleep Disturbance | 1.38 (0.54) | 1.22 (0.52) | Z = -1.40 | 0.161 | r = 0.150 |
| Sleep Latency | 1.74 (1.04) | 1.62 (1.15) | Z = -0.45 | 0.653 | r = 0.048 |
| Daytime Dysfunction | 1.12 (1.11) | 1.20 (1.01) | Z = -0.46 | 0.648 | r = 0.049 |
| Sleep Efficiency | 0.90 (1.14) | 1.16 (1.30) | Z = -0.76 | 0.446 | r = 0.082 |
| Sleep Quality | 1.12 (0.92) | 1.13 (0.63) | Z = -0.58 | 0.563 | r = 0.062 |
| Use of Sleep Medications | 2.05 (1.36) | 1.84 (1.40) | Z = -0.74 | 0.461 | r = 0.079 |
| Global Score | 9.19 (3.91) | 8.82 (4.73) | Z = -0.64 | 0.526 | r = 0.068 |
| Sleep Diary – N | 275 | 291 |  |  |  |
| Sleep Diary Sleep Quality | 1.77 (0.84) | 1.52 (0.50) | Z = -1.75 | 0.080 | r = 0.074 |

Table 3 – Actigraphy Results

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|   | **Pre-Move** | **Post-Move** | **Statistical Value** | **p-value** | **Effect Size** |
| N | 47 | 47 | - | - | - |
| Sleep Efficiency – percent (SD) | 88.57 (4.83) | 91.06 (4.49) | Z = -2.67 | 0.008 \* | r = 0.276 |
| Total Sleep Time – minutes (SD) | 529 (108) | 494 (103) | Z = -1.84 | 0.065 | r = 0.190 |
| Wake After Sleep Onset – minutes (SD) | 64.34 (31.66) | 45.67 (26.42) | Z = -3.43 | 0.003 \*\* | r = 0.354 |
| Total Time in Bed – minutes (SD) | 597 (116) | 542 (107) | Z = -2.54 | 0.011 \* | r = 0.262 |
| Latency – minutes (SD) | 3.13 (1.85) | 1.94 (1.24) | Z = -3.12 | 0.002 \*\* | r = 0.322 |
| Number of Awakenings – N (SD) | 18.07 (10.12) | 14.06 (7.72) | Z = -2.03 | 0.042 \* | r = 0.210 |
| 24-hour Autocorrelation – R (SD) | 0.179 (0.086) | 0.135 (0.060) | t = 2.85 | 0.005 \*\* | d = 0.588 |

\* P < 0.05

\*\* P < 0.01

**Afterword**

 This thesis represents a contribution to a growing body of research concerning sleep in psychiatric illness and, in particular, systematically addresses the confounding factor of the environment in influencing the quality of psychiatric inpatient sleep. We sought to examine the impact of a non-pharmacological environmental intervention on a heterogeneous sample of psychiatric inpatients. An environmental intervention has the benefits of requiring relatively few clinical resources to implement, potentially applying to all psychiatric inpatients regardless of diagnosis or symptom profile, and providing a variety of other clinical benefits such as patient autonomy and sense of security. Our goal was to examine aspects of both sleep quality and circadian rhythm by both subjective and objective means comparing between a cross-sectional sample of inpatients before and after the move. Furthermore, we investigated the relationship between objective and subjective measures of sleep quality. Participants in the post-move group had significantly increased objective sleep quality as measured by actigraphy compared to the pre-move group. This difference was primarily mediated by the change in a variable called Wake After Sleep Onset (WASO) which is the average number of minutes during sleep periods that the individual was detected as being awake. Additionally, the total sleep time between the two groups was not significantly different[[1]](#footnote-1). This was an expected result if the two groups were representative of the same overall population of psychiatric inpatients because we did not select participants based on any kind of sleep criteria. As a result, the increase seen in sleep efficiency, a measure of global sleep quality can be attributed primarily to WASO and not to a change in sleep duration.

Interestingly, subjective sleep quality did not differ between the two groups including on both the PSQI and the daily sleep diaries, although sleep quality measured by the daily sleep diaries was trending towards significantly improving in the post-move group. While this may seem to be a peculiar result, it is actually in line with previous findings that indicate an incongruence between subjective and objective sleep quality (Kung et al., 2015). We hypothesize that whereas subjective measures capture some form of distress caused by sleep, objective measures represent the severity of sleep disturbance. Additionally, while the PSQI is the most common and widely accepted tool used to measure subjective sleep quality, it has a number of limitations when applied in this population. First, the scale measures sleep quality over the past month and requires participants to: i) recall one month of sleep-related factors such as night time disturbances and daytime sleepiness which is difficult or impossible for participants with impaired cognitive functioning commonplace with severe forms of mental illness; and ii) it requires participants’ sleep characteristics to have been stable over the past month. For example, if a participant was hospitalized two weeks prior to the PSQI being administered, certain aspects that might have otherwise been less intrusive after a longer time spent in hospital may be overrepresented in the participants’ responses. Second, one of the scale’s domains has to do with sleep medication and asks the participant if they use any kind of medication to help with sleep. Many patients and clinicians will schedule psychiatric medication dose timings to have a sleep inducing side effect and this would in turn drive the response for this item up. A score of 5 out of a possible 21 points on the PSQI constitutes a poor sleeper of which a possible 3 points can come solely from the medication domain[[2]](#footnote-2). A final limitation of the PSQI was that two of the domains on the PSQI significantly correlated with the Horne-Ostberg Morningness-Eveningness Questionnaire’s rating of a person’s circadian rhythm type (morning or evening person), which again agrees with the idea that subjective sleep quality is a measure of distress caused by sleeping problems (for example, not being able to go to bed and wake up when you want to).

Following the move, the autocorrelation of participants’ actigraphy data actually decreased, indicating increased deviation from a 24-hour circadian rhythm. Although typically in healthy populations, having a consistent 24-hour rhythm is considered to be representative of healthy sleeping patterns, it may be the case that disturbed biological rhythms (Lewy et al., 1985; Partonen & Lonnqvist, 1998), particularly those identified in schizophrenia models (Pritchett et al., 2012), cues for a less consistent, almost free running circadian rhythm. The changes made in the environment encourage patient autonomy and increase their ability to control their sleeping patterns (e.g. being free of room-mates’ rhythms, control of lighting in the room, etc.) and could explain why the autocorrelation value decreased. But, the increase in objective sleep quality indicates that allowing an individual to follow their natural circadian rhythm may be more beneficial than attempting to force a “healthy” rhythm upon them.

*Limitations and Future Directions*

 These results indicate that there is a sleep-related justification for the redevelopment of psychiatric healthcare facilities, particularly with design features that benefit sleep such as single-patient bedrooms. Probably the largest limitation of the research presented in this thesis would be the fact that our sample was of heterogeneous psychiatric disorders. Although this choice of sample makes our results more translatable to other psychiatric facilities, it is not as methodologically sound as would be the case if we performed strict diagnostic interviews and recruited large sample sizes for each demographic. Though, given the severity of illness in this population and the burden of the current study protocol, this approach would not have been feasible and would have excluded many of the participants we were able to recruit otherwise. As a result, our sample would be representative of a subset of the psychiatric hospital population who were cognitively well enough to endure lengthy assessment batteries. Another way to address this issue would have been to have paired samples between the two time points but this was an impossibility given the average length of stay of psychiatric patients, some of whom are discharged shortly after participation in the study. A second limitation was the disconnect between subjective and objective results. Although our findings are supported by previous literature identifying a difference between the two, ideally we would have observed improvements in both measures or observed some sort of correlation between the two.

 Subsequent research needs to be focused on identifying unique sleep characteristics and factors associated with samples of each disorder and specific environmental design elements. For example, the most drastic change in the environment for our research was the change to single patient rooms but there were a variety of other changes that might have impacted sleep such as natural light exposure or the building acoustics. Furthermore, the unique clinical applications of novel objective measures of sleep quality such as actigraphy need to be thoroughly explored. Given the divide between subjective sleep quality (potentially measuring distress from sleep) and objective sleep quality (potentially measuring degree of sleep disturbance), the clinical relevance of each of these measures needs to be examined for psychiatric inpatients in general as well as for each specific psychiatric illness. The development of different subjective measures that more clearly and specifically measure aspects of sleep are warranted in psychiatric populations with severe forms of mental illness where cognitive abilities impacting comprehension and recall may be impaired and sleep quality may vary more rapidly than is possible to capture with current tools.

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1. There was, however, a significant difference in the total sleep times of those with schizophrenia and those with bipolar disorder and depression and anxiety disorders. Whereas participants with schizophrenia slept for longer periods of time, patients with bipolar disorder or depression and anxiety disorders slept significantly less. [↑](#footnote-ref-1)
2. Average score on the medication domain before was 2.05 and after 1.84 [↑](#footnote-ref-2)