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ORIGINAL RESEARCH

Evaluation of Sleep Disorders in Patients With Severe Traumatic Brain Injury During Rehabilitation

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Abstract

Objective: To explore the presence and types of sleep disorders in chronic patients with severe traumatic brain injury (TBI) undergoing inpatient rehabilitation using formal diagnostic criteria based on the *International Classification of Sleep Disorders, 2nd edition*.

Design: Cross-sectional study.

Setting: Inpatient brain injury rehabilitation units.

Participants: Chronic inpatients with severe TBI (N = 30) were evaluated during rehabilitation.

Interventions: Not applicable.

Main Outcome Measures: Participants wore an actiwatch for 7 days and completed self-report measures on sleep, mood, fatigue, pain, and daytime sleepiness.

Results: Twenty participants (67%) had a sleep-wake cycle disturbance, of which 15 (50%) met diagnostic criteria for a sleep disorder. Diagnosed sleep disorders in the sample were insomnia (26.7%), posttraumatic hypersomnia (6.7%), delayed sleep phase syndrome (10%), irregular sleep-wake pattern disorder (3.3%), and periodic limb movement disorder (3.3%). Sleep quality was estimated by senior clinical staff as interfering with rehabilitation in 36.6% of the sample. Poor sleep quality was associated with greater anxiety, fatigue, and daytime sleepiness.

Conclusions: Consistent with previous studies, the present study showed high levels of sleep-wake cycle disturbances in patients with severe TBI undergoing rehabilitation, which were associated with anxiety, fatigue, and daytime sleepiness. These findings highlight the importance of assessing and treating sleep problems in patients with TBI undergoing rehabilitation.

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Sleep problems are reported in up to 70% of patients after traumatic brain injury (TBI) and insomnia symptoms in up to 30%.[1] These rates are significantly higher than those found in the general population.[1] On most occasions, sleep difficulties appear to develop or worsen postinjury[2,3] and frequently progress into chronic difficulties.[4] Sleep problems in this population may be attributed to neuropathology in systems associated with sleep-wake regulation[3] or to secondary consequences of the TBI such as anxiety, depression,[2,5-7] fatigue,[7,8] or pain.[7,9]

Although it is recognized by sleep researchers and rehabilitation clinicians that patients with TBI may experience disturbed sleep-wake patterns,[10] few studies have evaluated the presence of sleep-wake disturbances in inpatient rehabilitation cohorts. In a questionnaire-based investigation of sleep complaints, Cohen et al[11] found that 16 of 22 patients (73%) with TBI reported sleep problems during rehabilitation. In this study, inpatients with TBI reported more difficulties initiating and maintaining sleep, whereas discharged patients with TBI mostly experienced excessive somnolence. Makley et al[12] reported disrupted sleep in up to 21 of 31 consecutive TBI admissions to a rehabilitation unit (68%). Recently, Nakase-Richardson et al[13] found that 136 of patients undergoing neurorehabilitation (n = 205) (66%) had a sleep-wake cycle disturbance (SWCD) 1 month postinjury.

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However, these studies recorded the presence or absence of sleep difficulties on the basis of patients' self-reports and observations by staff without a diagnosis of sleep disorder using formal criteria. In addition, these studies evaluated SWCDs during the acute phase postinjury.

The rehabilitation period is a critical time after the TBI when a coordinated multidisciplinary approach attempts to enable patients to reach optimal recovery. Inpatients with TBI with disrupted sleep-wake patterns can have longer durations of rehabilitation,[12] poorer long-term vocational outcomes,[8] and exacerbated cognitive dysfunction.[14,15] It is important to evaluate the presence of sleep disorders during the postacute and chronic rehabilitation period, to investigate whether sleep difficulties affect the rehabilitation process, and if there are implications for assessment and treatment at an earlier stage. The present study is the first to use formal diagnostic criteria based on the *International Classification of Sleep Disorders, 2nd edition* (*ICSD-2*) to assess the occurrence of sleep disorders in patients with severe TBI undergoing inpatient rehabilitation. The present study aims to explore the presence and types of sleep disorders in chronic patients with severe TBI undergoing inpatient rehabilitation by using formal diagnostic criteria based on the *ICSD-2*.[16]

Methods

Participants and rehabilitation setting

The sample population comprised chronic individuals with severe TBI recruited from 2 brain injury rehabilitation units. The study sites were 2 independent units (25 beds and 20 beds, respectively) delivering inpatient rehabilitation to persons with cognitive impairment, complex needs, and challenging behavior after brain injury. The units receive subacute and chronic TBI referrals from all the National Health Service regions in Scotland, United Kingdom. Subacute admissions follow acute neurosurgical and medical TBI care (modal time since injury to admission of 2 months) for rehabilitation of basic functional impairments (eg, communication, self-care, and mobility) as well as functional abilities (eg, domestic life and major life areas). Chronic TBI admissions occur because of difficulties in interpersonal interactions, forensic and/or substance misuse issues, on average 5 years postinjury. The multidisciplinary team uses a goal setting approach and is composed of clinical psychology, general practice, occupational therapy, neuropsychology, nursing, physiotherapy, psychiatry, rehabilitation support workers, and speech and language therapy. The initial assessment over 4 weeks precedes a goal planning meeting, and progress is reviewed every 8 weeks to discharge. All suitable inpatients in both units were eligible to take part in the study at the start of the recruitment phase (January 2013). Subsequently, consecutive admissions at both rehabilitation centers were invited to take part until the end of the study (December 2013). Inclusion criteria for patients were admission after the TBI, aged ≥18 years, have received rehabilitation for >2 weeks (to allow for settling in the units as most would have been admitted from hospital wards), speak English fluently, and have no recent history or ongoing treatment of severe mental health problems. Potential participants were excluded if they had a preinjury learning disability.

List of abbreviations:

ESS	**Epworth Sleepiness Scale**
GODS	**Glasgow Outcome at Discharge Scale**
ICSD-2	***International Classification of Sleep Disorders, 2nd edition***
PSQI	**Pittsburgh Sleep Quality Index**
SE	**sleep efficiency**
SWCD	**sleep-wake cycle disturbance**
TBI	**traumatic brain injury**

Measures

Demographic characteristics

Demographic (age, sex, postcode, employment status preinjury), history of brain injury, and medical information were collected from rehabilitation case notes.

Disability outcome measure

The Glasgow Outcome at Discharge Scale (GODS) was used to assess inpatient disability.[17] The GODS is an inpatient version of the Glasgow Outcome Scale-Extended[18] that is recommended for the predischarge assessment of disability in a rehabilitation setting for patients with TBI.

Pain

The Brief Pain Inventory Short Form[19] is a 9-item self-administered questionnaire used to evaluate the pain intensity (severity) and the impact of this pain on the patient's daily functioning (interference). The patient is asked to rate their worst, least, average, and current pain intensity, list current treatments and their perceived effectiveness, and rate the degree that pain interferes with general activity, mood, walking ability, normal work, relations with other persons, sleep, and enjoyment of life on a 10-point scale.

Mood

The Hospital Anxiety and Depression Scale[20] is a brief 14-item self-report measure used to assess anxiety and depression and has been used widely in individuals with TBI.[21]

Sleep-wake assessment measures

A semi-structured clinical interview based on the *ICSD-2*[16] and the published interview schedules to assess insomnia and screen for additional sleep disorders[22] was used in the study (given in supplemental appendix S1, available online only at http://www.archives-pmr.org/). The interview consisted of 3 parts: (1) evaluating the present sleep routine of patients with TBI and their subjective sleep complaint and gathering information about any history of sleep difficulties; (2) screening of patients for sleep disorders, including insomnia, hypersomnia, narcolepsy, sleep-related breathing disorders, periodic limb movement disorder, parasomnia, circadian rhythm disorders, and restless legs syndrome; and (3) enquiring about how their sleep complaint affected their daily functioning.

Actigraphy data: Participants were asked to wear an actiwatch (Actiwatch 4[a]) continuously on their nondominant hand (except when showering or swimming) for 7 consecutive days. Actigraphy is a valid objective measure of sleep-wake patterns[23] that has been used in patients with TBI.[24] An actiwatch is a wrist-worn device that detects and records activity data. Activity counts in this study were stored at 0.5-minute epochs that were downloaded to a computer for the analysis of sleep measures including sleep efficiency (SE), sleep onset latency, total sleep time, and wake after sleep onset. The analysis was done using the Actiwatch Sleep