



## Original Article

## The effect of light exposure on insomnia and nocturnal movement in Parkinson's disease: an open label, retrospective, longitudinal study

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## ABSTRACT

Insomnia, hypersomnia and REM Sleep Behavior Disorder (RSBD) during sleep are major problems for patients suffering from Parkinson's disease (PD) but they are also used to predict its onset. While these secondary symptoms detract from the quality of life in PD patients, few treatment options are available due to limited efficacy or risk of complicating the treatment regimen. Light therapy (LT) has been suggested as a strategy for sleep disorders but it has only been implemented recently for use in PD. An open label, retrospective study was undertaken where PD patients had been undergoing LT, using polychromatic light, for four months to 15 years prior. It was found that 1 h exposure to light, just prior to retiring, significantly improved insomnia and reduced RSBD in as little as one month after commencing LT. In addition, the improvement was maintained as long as LT was continued over a four to six year period. The efficacy of LT in alleviating these sleep related conditions was not compromised by time since diagnosis or age of the patient. These results intimate the value of long term application of non-invasive techniques such as LT for treating sleep disorders in PD and justify further controlled trials on the long term efficacy of LT.

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## 1. Introduction

Parkinson's disease (PD) is typically described as a disorder of impaired motor function. First line treatment strategies involve implementation of dopamine (DA) replacement therapy using the aromatic precursor L-Dopa, DA agonists, catabolic DA enzyme inhibitors or anticholinergic drugs and with this, the primary symptoms of bradykinesia, tremor, rigidity and impaired gait improve [1–4]. While this describes the therapeutic overlay which has predominated PD treatment for the past fifty years, the contribution that secondary, non-motor symptoms make toward the imposing morbidity of PD cannot be underestimated. In particular, depression, anxiety, disturbed sleep and REM sleep behavior disorder (RSBD) significantly contribute to morbidity and result in compromised quality of life [5–10]. In recognition of the unique problems that these symptoms pose for PD patients, more novel approaches to treatment have diverged from the traditional lines of DA replacement, thereby implicating the involvement of

other systems in the etiology and treatment of PD [11,12]. The circadian system is one such system hypothesized to be involved and it is receiving an increasing amount of attention in regard to the secondary symptoms of depression and insomnia commonly expressed in PD patients [13–17]. This approach is based on the compellation of four areas of endeavor intimating circadian system involvement: first, that impaired sleep is circadian driven and contributes to the high morbidity of PD [6,8,18–29]; second, that depression is prevalent in 60% of PD patients and often precedes disease onset for two to three decades prior to diagnosis [6,10,30,31]; third, that RSBD itself proceeds and predicts the onset of PD [9,20,32–35] and fourth, that DA replacement interferes with circadian function [1,36–38]. This evidence intimates circadian involvement in PD and provides a strong impetus for examining alternative treatments implementing chronobiotics [5,17,39–41].

When bright light therapy (LT) has been employed as a chronotherapeutic, strategically applied before the onset of the dark or light phase of the light/dark (L/D) cycle, PD patients showed improvement in depression and sleep [5,42–44], and this has been confirmed in controlled trials [41,45]. This approach also serves to alleviate DA replacement overdosing, polypharmacy and adverse side effects which plague long term DA replacement strategies

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[5,42,46]. However, longitudinal studies on the long term efficacy of LT in PD are scarce [8]. While previous reports have demonstrated a beneficial effect of LT on the primary symptoms of PD [5,44], the present retrospective study was undertaken to permit a more detailed examination of sleep, insomnia and RSD in PD patients using LT for extended periods spanning several years.

## 2. Methods

### 2.1. Study design

This was a retrospective, open label study in patients with PD and comorbid states examining changes in RSD and insomnia. Intervention consisted of daily bright light exposure just prior to retiring. The patients had never received LT prior to commencing our study. Patients were clinically assessed using a global rating scale (GRS) to measure the prevalence and severity of primary and secondary symptoms characteristic of PD. It is a comprehensive assessment tool comprised of 21 motor, 25 non-motor and nine items on a daily living items and has been utilised previously [5,44]. This scale was originally developed to provide an easily executed record to enable the medical practitioner and health professional to quickly quantify and record treatment response and disease progression.

### 2.2. Study population

Histories of 140 patients attending the Bronowski Clinic between the years of 1996 and August 2015 were reviewed and those previously diagnosed with idiopathic or suspected drug-induced PD were screened from existing histories for inclusion into the retrospective, open label study. They were either self-referred after assessment by a neurologist or were referred from general practitioners with the final sample consisting of 91 men (65%) and 49 women (35%) (Collective Mean age of 66.0 at study commencement,  $SD = 10.0$ ; Range 31–86 yrs). Patients mean age of PD onset was 60-years-old (Range 25 to 81,  $SD = 11.3$ ), with an average disease duration of six years (Range 1–33 yrs,  $SD = 5.4$  yrs).

### 2.3. Ethics and consent

At the time of admission into the Bronowski Clinic all patients received a detailed explanation of the purpose of the study and the ethical standard underlying access to patient information. A clinical assessment model was employed whereby a carer was present during each assessment when informed consent was obtained from all patients granting researchers permission to access patient data for the purpose of scientific study and publication. The anonymity of patients was maintained with all data stored in accordance with the provisions of Good Clinical Practice, and the accessibility of patient files were limited to authorised personnel only. For the present study ethics approval was granted and monitored by the Cairnmillar Institute Human Research Ethics Committee on the first of September 2014 (Approval Code: 2014/1349-14). Subsequently, patient files were sourced and reviewed, with researchers collaboratively identifying the critical variables for extraction and analysis. Data extracted from patient files dealt primarily with socio-demographics, sleep and related information on motor performance. To minimise error or introduction of experimenter bias, all data was cross checked by each collaborating investigator.

### 2.4. Procedure

Patient files were sourced and reviewed, with patient I.D.s and coded into pseudonyms to ensure confidentiality with gender, age,

age of PD onset (in years), disease duration prior to commencing LT (in years) and the length of time patients remained on LT (in months) recorded. This procedure was similar to those previously employed [5,44]. Compliance, positioning of the light source and tendency to fall asleep during light exposure were reviewed at each assessment to ensure that each patient was experiencing optimal therapeutic value from the LT. Following pre-assessment, patients were exposed to LT as per the instructions discussed above. Patients were then required to attend review assessment sessions at the Bronowski Clinic to monitor therapeutic benefit or side effects one month after their initial consultation as well as at regular intervals thereafter. The times of scheduled assessment were pre-assessment, one month, two months, four months, six months, and every six months thereafter. While there was no formal control group for the present study, none of the patients had ever been exposed to light treatment prior to the initial presentation. This permitted the use of data gathered during the pre-assessment consultation as the baseline, and allowed us to statically compare those values obtained to subsequent visits, after commencing LT. In addition, as a consequence of the ongoing incremental nature of changes observed with PD in previous LT studies [44], statistical comparison were also made for the binned scores for the time periods of 1–2 vs 6–11 months and 6–11 vs 42–60 months after commencing LT. This permitted the evaluation of the gradual nature of any beneficial effect occurring during long term treatment.

### 2.5. Insomnia

To examine sleep patterns and the presence of insomnia three methods of assessment were employed to achieve cross-confirmation. **Sleep Diary:** Sleep diaries were periodically completed by the patient during the course of treatment whereby the number of hours slept each night, the number and duration of awakenings and the number and duration of day naps were mapped on a blank grid. Each diary page consisted of 24 columns over 14 days and these were filled out either during the course of the night after each event transpired, or upon waking in the morning. An example of a completed sleep diary and how the pattern of sleep changed after the application of LT is shown in Fig. 1. **Patient Report:** At a structured time during the course of each clinical assessment, the patients were asked to supply the following information to the clinician: one, the total hours of sleep during the night; two, the number of awakenings during the night; three, whether the patient readily fell back to sleep after awakening; four, the number and duration of day naps; and five, the presence and severity of daytime fatigue. **Circadian Record:** At the conclusion of the clinical assessment a circadian record was completed that depicted when the patient fell asleep, and when they awoke. The total numbers of hours slept in relation to medication were also plotted on a 24 h chart to determine if and how the sleep cycle changed daily for the duration of time between each assessment. The clinical assessment model employed encouraged a spouse, partner, carer or family member to be present during each clinical assessment to provide supplemental feedback to verify the patient's responses. Information from the three sources was then collectively examined to determine the severity of insomnia/hypersomnia on a Likert Scale [5,44,47] ranging from one to ten with ten being the most severe. A score of zero indicated 'normal or an absence of symptoms', a score between one and three indicated 'slight' severity, a score between four and seven indicated 'moderate' severity, and a score between eight and ten indicated 'severe'.

The rationale for developing the assessment scale used in the present study transpired from the necessity to fill a need from

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