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Editorial

EDITORIAL

Natural light exposure and circadian rhythm: a potential therapeutic approach for disorders of consciousness

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Circadian rhythms are internal timetables that exist in every cell of our bodies, including the brain, which has its own clock. These clocks work together to provide us with daily sleep, temperature, metabolism, mood, and gut microbiome rhythms. Inappropriate circadian rhythm entrainment can cause the sleep–wake cycle to be rather unstable, with many transitions between sleep and wakefulness happening during the 24-h cycle. Circadian rhythm disorders, such as temperature [1], heart rate variation [2], and sleep [3], are common in severely brain-injured patients and are not favorable to wakefulness and awareness. Angerer et al. [4] mimicked dynamic daylight to entrain and stabilize the circadian cycles of disorders of consciousness (DOC). This firstly emphasizes the necessity of natural room lighting as an auxiliary therapy technique for normalizing circadian rhythms in patients with DOC.

Light, as the primary zeitgeber, is an important mediator in generating the body clock of the hypothalamic suprachiasmatic nucleus (SCN). The property of light that resets the clock is very different. To be specific, melanopsin, which is found in intrinsically photosensitive retinal ganglion cells and is particularly sensitive to blue light (wavelengths of 460–480 nm), is hard-wired to our brain clock to entrain the circadian rhythm with the outside day [5–7]. Blue light that is rich in the daylight stimulates melanopsin, resets and synchronizes the brain clock, improves alertness and mood, and reduces tiredness and depression [8, 9].

A healthy individual needs more bright natural light during the daytime and less light at nighttime. Moreover, it frequently blurred the distinction between day and night for patient in long-term care facilities or intensive care units. Angerer et al. [4] manipulated the patient room lighting to mimic natural daylight (i.e. changes in photopic and melanopic illuminance and color temperature). It exposed patients to a continual modification of the intensity and spectrum of patient room illumination throughout the day, with lower light intensity in the morning and evening.

Angerer et al. [4] showed that the body temperature cycle of 11/17 DOC patients were close to 24 h following exposure to daylight, and the intensity of the patient's rhythm increased. Furthermore, better daytime stability indicated stronger 24-h rhythm entrainment in these individuals. This is the first research to highlight the role of daylight for circadian entrainment in DOC patients during the recovery process scientifically.

Lighting systems that mimic the natural daylight spectrum will promote visual comfort, subjective alertness, and mood in healthy people. It is being employed as an adjuvant or even primary therapy in a variety of disciplines, such as treating circadian sleep abnormalities. These rhythm actions in bodies enable us to prevent sickness and increase our immune function so that we can fight infectious diseases more effectively. It also speeds up healing mechanisms, allowing us to recover from injuries faster, and they optimize brain function, improving our emotional and intellectual health.

In ordinary life, natural light has a positive impact on people's moods and sleep. Circadian rhythm disorders, on the other hand, are abnormal in severely injured patients, and some researchers believe they may impede recovery. Therefore, research into the effects of natural light fluctuations in DOC patients will be critical.

Furthermore, many studies have discovered that DOC patients with a better clinical diagnosis had more complete circadian rhythms of melatonin and body temperature [10, 11], stronger circadian components of wrist activity [12], and better sleep–wake cycles. Even investigations of DOC patients' circadian rhythms have gotten a lot of attention in recent years. No research has shown that resetting circadian rhythms improves patients' consciousness, which is a shortcoming in the Angerer et al.'s study. Mimicking daylight exposure only increases behaviors, not clinical diagnosis [4]. That means that more research is needed to explore the therapeutic value of natural light for DOC patients.

An earlier study from Blume et al. [11] used blue light glasses three times per day for 1 h over the period of 1 week, and two patients improved from unconsciousness to minimal consciousness. In addition, another preliminary research suggested that improved sleep and sleep–wake cycles may also boost recovery in DOC patients [13]. The integrated information theory (IIT), a most popular conscious theory, demonstrated that consciousness is related to a system's ability to integrate information [14, 15], and that sleep deprivation substantially reduced this ability [16–18]. In DOC patients, dysregulation of excitatory arousal and inhibitory sleep promotion neurotransmitters may play a role in maintaining effective connections between higher-order cortical and subcortical regions [19]. Therefore, as the result of the mechanism of circadian rhythm and these research foundations, it is hypothesized that based on the neuroimaging brain function in DOC patients [20, 21], longer natural light exposure may better entrain circadian rhythm, which may promote DOC patients' recovery and provide a scientific basis for natural light therapy.

A quote from Florence Nightingale might better illustrate the importance of natural light to these patients [22]: "It is the unqualified result of all my experience with the sick that, second only to their need of fresh air, is their need of light; that, after a close room, what hurts them most is a dark room and that it is not only light but direct sunlight they want." Therefore, it is crucial to expose these patients to natural daylight, which will boost their health and speed up their recovery. In addition to encouraging patients to get outside in the natural light if they are available, it could also try changing the hospitals' illumination patterns to mimic bright daylight and dark night to get the patients' circadian rhythm back in gear.

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