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Lighting, sleep and circadian rhythm: An intervention study in the intensive care unit

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Summary Patients in an intensive care unit (ICU) may risk disruption of their circadian rhythm. In an intervention research project a cycled lighting system was set up in an ICU room to support patients' circadian rhythm. Part I aimed to compare experiences of the lighting environment in two rooms with different lighting environments by lighting experiences questionnaire. The results indicated differences in advantage for the patients in the intervention room ($n = 48$), in perception of daytime brightness ($p = 0.004$). In nighttime, greater lighting variation ($p = 0.005$) was found in the ordinary room ($n = 52$). Part II aimed to describe experiences of lighting in the room equipped with the cycled lighting environment. Patients ($n = 19$) were interviewed and the results were presented in categories: ''A dynamic lighting environment'', ''Impact of lighting on patients' sleep'', ''The impact of lighting/lights on circadian rhythm'' and ''The lighting calms''. Most had experiences from sleep disorders and half had nightmares/sights and circadian rhythm disruption. Nearly all were pleased with the cycled lighting environment, which together with daylight supported their circadian rhythm. In night's actual lighting levels helped patients and staff to connect which engendered feelings of calm.

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Implications for Clinical Practice

- Most patients are aware of the lighting environment, indicating the importance of adapting lighting to patients' preferences.
- Light and lighting which follow a natural rhythm support patients' circadian rhythm.
- Lighting experiences are highly individual. Light at night can be both disturbing and provide a feeling of security.

Background

This study focuses on patients' experiences and reports of being cared for in an intensive care unit (ICU) patient room, provided with a cycled lighting intervention that aims to support the patients' circadian rhythm and health. The circadian rhythm is constituted of regular day and night over approximately 24 hours and light and darkness is important for the human health in supporting the body's circadian rhythm (Gaggioni et al., 2014; LeGates et al., 2014). As early as 1912 Nightingale described light and the rhythm of night and day as two important factors in supporting and restoring patient health. Sleep and wakefulness is the most obvious circadian rhythm in humans (Germain and Kupfer, 2008) and both states have been described as basic human needs by Henderson (1966). The circadian rhythms are driven by the circadian pacemaker in the anterior hypothalamus which functions as the person's inner clock (Saper et al., 2004). Exogenous stimuli such as light are able to set the circadian rhythm in motion (Veitch et al., 2004). Furthermore, light stimulates the immune system by regulating the pineal neurohormone melatonin (Maestroni, 2001), it initiates the absorption of Vitamin D (Mason et al., 2011) and has been reported to reduce the number of days in hospital for patients with bipolar depression (Benedetti et al., 2001).

It is also important to emphasise that light, circadian rhythm and sleep are interrelated and interdependent (Dijk and Archer, 2009). The presence of nighttime light suppresses the melatonin level, which is normally highest at night (Duffy and Wright, 2005). The level of melatonin is widely accepted as an indicator for the circadian rhythm (Benloucif et al., 2005). There are indications that the constant variations in circadian rhythms, due to the changing hormone levels, experienced by night workers have increased the risk of cancer, as well as infectious and autoimmune diseases (Lockley et al., 2003).

Critically illness, light and circadian rhythm

As the most critically ill and vulnerable patients are cared for in the ICU it is most important for their survival and health that the environment supports patient restorative processes. Unfortunately the ordinary indoor light environment in ICUs does not always support patients' circadian rhythms. Lighting is sometimes used at high levels at night, during treatments, examinations and nursing activities and this may risk disrupting the circadian rhythm (Dunn et al., 2010). Mean illumination levels measured in four different ICUs ranged at night from 2.4 to 145 lx and in the day from 55.3 to 165 lx (Dennis et al., 2010; Frisk et al., 2004; Meriläinen et al., 2010; Verceles et al., 2012). These measurements highlight two main problems, a pattern of low illumination levels by day and high levels by night.

The ICU patients' nighttime sleep is described as abnormal and fragmented with reduced periods of REM sleep (Elliott et al., 2013). Light in the night is one known factor for sleep disruption when it impairs melatonin secretion (Kamdar et al., 2012). Circadian rhythms are temporally disturbed in most ICU patients; some develop temporal disorganisation and the circadian pacemaker may become effectively free-running (Frisk et al., 2004; Gehlbach et al., 2012; Perras et al., 2007). Furthermore, sleep deprivation is one important risk factor for ICU delirium (Girard et al., 2008). Patients' vulnerability increases with lack of sleep and are characterised by increased sensitivity to light, noise and activity (McKinley et al., 2002). The health, wellbeing and recovery of patients are dependent upon their ability to get a normal sleep and circadian rhythm. Most research into light environments affecting the circadian rhythm in an ICU context has been done with infants (Engwall et al., 2014; Morag and Ohlsson, 2011). Based on the knowledge concerning light and its importance to the circadian rhythm it would seem important to measure and then evaluate and report patients' experiences.

Aims

This study consisted of two parts: in Part I, the aim was to evaluate and compare patients' experiences of lighting environments in two ICU rooms with different lighting environments; in Part II, the aim was to describe patients' experiences of an ICU room equipped with a cycled lighting environment.

Method

This study was a part of a larger study concerning patient experiences of the ICU environment with regard to sleep, rest and circadian rhythms (Engwall et al., 2014; Johansson et al., 2012). Part I was a comparative, descriptive study which included data from a questionnaire used to compare two patient groups, one exposed to a cycled lighting system and the other to an ordinary lighting system. Part II had an explorative and descriptive design based on data derived from nineteen interviews, subjected to qualitative and quantitative content analysis (Krippendorff, 2004).

Setting

The study was conducted in an eight-bed general ICU in a regional hospital in Sweden in which a new cycled lighting intervention designed to promote circadian rhythm and