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Clinical research article

Effect of nocturnal sound reduction on the incidence of delirium in intensive care unit patients: An interrupted time series analysis

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ABSTRACT

Introduction: Delirium in critically-ill patients is a common multifactorial disorder that is associated with various negative outcomes. It is assumed that sleep disturbances can result in an increased risk of delirium. This study hypothesized that implementing a protocol that reduces overall nocturnal sound levels improves quality of sleep and reduces the incidence of delirium in Intensive Care Unit (ICU) patients.
Methods: This interrupted time series study was performed in an adult mixed medical and surgical 24-bed ICU. A pre-intervention group of 211 patients was compared with a post-intervention group of 210 patients after implementation of a nocturnal sound-reduction protocol. Primary outcome measures were incidence of delirium, measured by the Intensive Care Delirium Screening Checklist (ICDSC) and quality of sleep, measured by the Richards-Campbell Sleep Questionnaire (RCSQ). Secondary outcome measures were use of sleep-inducing medication, delirium treatment medication, and patient-perceived nocturnal noise.
Results: A significant difference in slope in the percentage of delirium was observed between the pre- and post-intervention periods (−3.7% per time period, $p = 0.02$). Quality of sleep was unaffected (0.3 per time period, $p = 0.85$). The post-intervention group used significantly less sleep-inducing medication ($p < 0.001$). Nocturnal noise rating improved after intervention (median: 65, IQR: 50–80 versus 70, IQR: 60–80, $p = 0.02$).
Conclusions: The incidence of delirium in ICU patients was significantly reduced after implementation of a nocturnal sound-reduction protocol. However, reported sleep quality did not improve.

Implications for clinical practice

- The current way of thinking is that delirium is inevitable and a part of a critical illness, but this seems only partly true because precipitating factors can be influenced.
- Risk factors such as perceived night-time noise and the use of sleep providing medication were significantly reduced after implementation of a nocturnal sound reduction protocol.
- The implementation of a nocturnal sound-reduction protocol did not improve the reported sleep quality.
- Creating better conditions for ICU patients, such as sound reduction, may reduce the incidence of delirium in critically ill patients.

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Introduction

Delirium in critically-ill patients is a multifactorial disorder often seen after Intensive Care Unit (ICU) admission (Brummel et al., 2013; Cavallazzi et al., 2012; Zaal and Slooter, 2012). The incidence of delirium among ICU patients ranges from 20% in nonmechanically-ventilated patients to 80% in mechanically-ventilated patients (Brummel et al., 2013; Cavallazzi et al., 2012). Delirium is associated with an increase in ICU admission and hospital length of stay (LOS), costs, morbidity and mortality (van den Boogaard et al., 2012a,b; Brummel et al., 2013; Cavallazzi et al., 2012; Johansson et al., 2012; Patel et al., 2014; Zaal and Slooter, 2012). It is generally believed that delirium develops as a result of an interaction between predisposing factors, such as age and cognitive disorders and precipitating factors, such as quality of sleep, exposure to medications and environmental factors (Cavallazzi et al., 2012; Kamdar et al., 2014; Patel et al., 2014; Zaal and Slooter, 2012).

As with delirium, sleep disturbances are common in critically-ill patients (Cavallazzi et al., 2012; Elliott et al., 2013; Hofhuis et al., 2012; Kamdar et al., 2013, 2014; Li et al., 2011; Little et al., 2012; Patel et al., 2014). Disturbed sleep in the ICU is associated with delirium (Cavallazzi et al., 2012; Kamdar et al., 2015; van Rompaey et al., 2012; Salandin et al., 2011). An important modifiable factor involved in sleep disturbance may be that of high sound levels (Elliott et al., 2010; Kamdar et al., 2012a,b; Li et al., 2011; Little et al., 2012; van Rompaey et al., 2012). A review by Xie et al. (2009) reported that between 17% and 57% of arousals and awakenings during sleep are due to noise. Noise in the patient's ICU room disrupts the patient's sleep cycle when noise rises above 30 dB (dB(A)) (Cavallazzi et al., 2012; Johansson et al., 2012; Koch and Noble, 2011; Lawson et al., 2010). Therefore, the World Health Organization (WHO) recommends a mean background noise level of 30 dB(A) and a maximum peak sound level of 4 dB(A) at night (Berglund et al., 2011). Unfortunately, the physical ICU environment is not designed to protect the patient from disturbing sounds (Johansson et al., 2012). On the contrary, ICU background noise has increased during recent decades (Khademi et al., 2011; Konkani et al., 2012; Konkani and Oakley, 2012; Salandin et al., 2011), with acoustic studies measuring mean levels of 50–65 dB(A) and peak sound levels of 70–85 dB(A) at the patient's bedside (Darbyshire and Young, 2013; Elliott et al., 2013; Johansson et al., 2012; Lawson et al., 2010; Macedo et al., 2009). Such sound levels are comparable to those of a busy road. Major contributing factors to background noise are (false) alarms, sounds from medical devices (Hofhuis et al., 2012; Johansson et al., 2012; Kamdar et al., 2012a,b; Konkani et al., 2012, 2014; Lawson et al., 2010; Patel et al., 2014), care-related activities and conversations among clinical personnel (Koch and Noble, 2011; Konkani et al., 2012; Lawson et al., 2010).

Reducing disturbing noise may reduce the incidence of delirium in ICU patients. However, the majority of relevant studies have thus far focused on improving quality of sleep (Elliott et al., 2013; Fontana and Pittiglio, 2010; Johansson et al., 2012; Hofhuis et al., 2012; Kamdar et al., 2014). A study by Kamdar et al. (2013) showed that a multifaceted intervention could reduce the incidence of delirium; however, this intervention did not improve sleep. A study by Patel et al. (2014) showed both a reduction in sleep disturbance and delirium after the introduction of a packet of interventions and increased sleep efficiency was associated with a lower risk of developing delirium. However, the contribution of the separate elements of the packet remained unclear.

Therefore, this study aims to answer the following research question: What is the effect of a nocturnal sound-reduction protocol on the incidence of delirium and the quality of sleep in critically-ill patients admitted to an ICU? It was hypothesized that nocturnal sound reduction results in a reduced incidence of delirium and an improved quality of sleep in critically-ill patients.

Methods

Design

The study had an interrupted time series design. The pre- and post-intervention periods were divided into seven data collection points, with a duration of eight days. The pre-intervention period ran from October 10 to December 10, 2014. During this phase, the staff were unaware of the aim of the study. The post-intervention period ran from February 10 to April 14, 2015. Between December 2014 and February 2015, a nocturnal sound-reduction protocol was implemented. During this phase, the staff were aware of the study, but not of the exact outcome measures. Primary outcome measures were the incidence of delirium and quality of sleep. Secondary outcome measures were the use of sleep-inducing medication and patient-perceived nocturnal noise.

Setting and study population

The study was performed in the ICU of St. Antonius Hospital in Nieuwegein, the Netherlands. This is a level three ICU with 24 beds divided into three units, each with single-patient rooms. Each room has a clock and a window allowing natural daylight. Care from all specialties is provided to patients >18 years of age, with the exception of neurosurgical patients. During the study period, the medical staff consisted of 40 ICU doctors and residents; the nursing staff consisted of 140 ICU nurses and trainees. Most patients were sedated with propofol combined with morphine. In specific cases, patients received midazolam, dexmedetomidine or remifentanil. Sleep-inducing medication (temazepam, midazolam) was only initiated by nursing staff after consulting an ICU doctor.

Patients were included in the study when they met the following criteria (collected from the patient history): (a) no delirium present at time of admission, (b) ability to speak Dutch and (c) adequate hearing. Patients were excluded when they had an ICU LOS <24 hours or a Richmond Agitation-Sedation Scale (RASS) < −3 for more than 50% of their ICU stay (Sessler et al., 2002).

The sample size was estimated using an hypothesized 40% reduction in delirium, based on the study by Patel et al. (2014), who reported a 50% reduction. A conservative estimation was made as the intervention examined here formed only part of the multicomponent packet investigated by Patel et al. A two-tailed test with 80% power and a 5% significance level indicated a necessary sample size of 207 patients in each group.

Ethical considerations

The study protocol was approved by the regional medical ethics committee V.28542/W14.051 (VCMO- Netherlands). The committee waived informed consent. Each patient (or family) was informed by means of a letter containing study information, wherein the research purpose was not explicitly mentioned. All data were analysed and reported anonymously.

Intervention

The nocturnal sound-reduction protocol was designed by dedicated ICU nurses and doctors. The opportunity to be involved was offered to all staff; 16 colleagues displayed professional interest. The new protocol did not compromise patient safety. Most components of the nocturnal sound-reduction protocol were adapted from existing research, resulting in four parts. First, non-patient-related instructions were described, e.g., speaking and laughing