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Filtering out the Noise: Evaluating the Impact of Noise and Sound Reduction Strategies on Sleep Quality for ICU Patients

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Commentary

Filtering out the noise: evaluating the impact of noise and sound reduction strategies on sleep quality for ICU patients

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See related review by Xie *et al*., http://ccforum.com/content/13/2/208

Abstract

The review article by Xie and colleagues examines the impact of noise and noise reduction strategies on sleep quality for critically ill patients. Evaluating the impact of noise on sleep quality is challenging, as it must be measured relative to other factors that may be more or less disruptive to patients' sleep. Such factors may be difficult for patients, observers, and polysomnogram interpreters to identify, due to our limited understanding of the causes of sleep disruption in the critically ill, as well as the challenges in recording and quantifying sleep stages and sleep fragmentation in the intensive care unit. Furthermore, most research in this field has focused on noise level, whereas acousticians typically evaluate additional parameters such as noise spectrum and reverberation time. The authors highlight the disparate results and limitations of existing studies, including the lack of attention to other acoustic parameters besides sound level, and the combined effects of different sleep disturbing factors.

In the previous issue of *Critical Care*, the review by Xie and colleagues aims to answer the following questions [1]. Is noise the most disruptive factor to sleep for intensive care unit (ICU) patients? How effective are noise reduction strategies at decreasing sleep disturbance in ICUs? These are not simple questions to answer. Indeed, the medical literature appears to give conflicting results: of 11 original articles reviewed, five studies assert that noise is the most significant cause of sleep disturbance whereas six other papers suggest that noise is responsible for only a small proportion of sleep disruptions. Similarly, studies examining the effectiveness of noise reduction strategies suggest variable outcomes, with relative improvements in sleep ranging from 10 to 68%. What factors account for such discrepancies amongst studies asking similarly focused questions?

First, the impact of noise must be weighed relative to other factors that may be more or less disruptive to patients' sleep. But how can we determine the relative significance of noise when we do not fully understand or cannot accurately measure all of the factors that may share responsibility for the sleep disturbance? In a seminal work in this field, Gabor and coworkers found that noise and patient-care activities accounted for less than 30% of arousals and awakenings, while the cause of the remaining 70% of sleep disruptions remained unidentified [2].

Second, these studies measured similar outcomes from differing perspectives: those of the patient, of the bedside observer, and of the sleep specialist. Each of these perspectives is different, and subject to its own inherent biases. Questionnaires rely on patients to accurately recall and identify events from their ICU stay. Although it is clearly valuable to obtain information regarding patients' perceptions and experiences, it may be difficult for healthy individuals, let alone critically ill patients, to identify all factors that disrupted their sleep. Furthermore, patients may be more apt to recall experiences that fall within a previously established frame of reference. Most people have experienced sleep disruption due to a noisy environment at some point in their lives; therefore, patients may be more likely to attribute poor-quality sleep to noise in the ICU rather than other factors they might be unaware of, such as patient–ventilator asynchrony or the severity of their illness [3,4].

An alternate approach to surveying patients is to have an independent observer at the bedside to assess and quantify noises and occurrences that arouse the patient from sleep.

ICU = intensive care unit.

Direct observation of sleep, however, has been shown to be unreliable when compared with polysomnography. A recent paper by Beecroft and colleagues demonstrated that nursing assessment underestimated the number of awakenings from sleep, and actigraphy (monitoring of gross motor activity) overestimated total sleep time and sleep efficiency compared with polysomnography [5]. Researcher observation without polysomnography may therefore underestimate the amount of sleep disruption due to noise, or may incorrectly attribute awakenings to noise without identifying other important contributing factors.

Even polysomnography, the gold standard of sleep quantification, may be difficult to interpret for ICU patients using standard Rechtschaffen and Kales methodology [6]. Ambrogio and coworkers demonstrated good intraobserver reliability for identifying individual sleep stages and periods of wakefulness in critically ill patients, but poor interobserver reliability [6]. This finding suggests that even though individual studies utilizing a single sleep expert to score all polysomnograms may have good internal validity, the variability in results across studies may be due in part to disagreement between polysomnographers. This inhomogeneity in outcome assessment compounds the difficulty of arriving at a single conclusion with respect to the impact of noise on sleep disruption in the ICU.

A third factor that may account for the discrepancy in reported results is the breadth and depth of the study question. Investigators typically attribute arousals from sleep to noise when the arousal occurs within 3 seconds of a measurable (>10 decibels) increase in sound level [2,7]. Since both noise peaks and arousals are common in the ICU, some of the arousals may coincidentally occur after a noise peak but not be causally related. If other factors potentially contributing to sleep fragmentation are not systematically examined, investigators may overestimate the effect of noise on patients' sleep.

Additionally, the authors of this review point out that most research in this area has focused purely on noise level, but other acoustic parameters such as spectrum and reverberation time may impact sleep quality [1]. Sound masking appears to be the most effective strategy for improving sleep, but acoustic absorption has not been evaluated in this regard. Comprehensive sound reduction strategies developed by acousticians in collaboration with physicians may yield more impressive results.

In conclusion, the impact of noise and noise reduction on patients' sleep in the ICU is a very complex topic to dissect, due to variability between patients in their perception, recall, and arousal response to noise, due to poor reliability in quantification of sleep by direct observation, and due to suboptimal interobserver agreement in reading polysomnograms of critically ill patients. Furthermore, the significance placed on noise will depend in part on the number of other factors examined as potential contributors to sleep disruption. Nonetheless, this paper lays the groundwork for further research in this area by providing a comprehensive review of the literature published to date and highlighting a broader view of acoustic parameters that have yet to be thoroughly examined in the ICU setting. If noise reduction strategies can improve sleep to any degree, such strategies are worth exploring for our most vulnerable patients.

Competing interests

The authors declare that they have no competing interests.

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