Can We Improve Sleep Quality by Changing the Way We Ventilate Patients?

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Sleep is an integral part of daily life. Both disrupted and restricted sleep adversely affect well-being and predispose to chronic medical problems [1]. For example, in epidemiologic studies, women reporting 5 or fewer hours of sleep per night are at significantly increased risk of incident cardiovascular disease and diabetes over a 10-year time period [2, 3].

Critically ill mechanically ventilated patients have long been known to have poor sleep quality [4], but the potential importance of sleep disturbance in these patients is only now starting to be recognized [5, 6]. Sleep deprivation may adversely affect respiratory, cognitive, cardiovascular, endocrine, and immune function in normal subjects [7–9]; altered sleep architecture may be associated with an increased incidence of delirium in ICU patients [10]. Furthermore, in the case of long-term positive-pressure therapy, adherence to the treatment may be influenced by how it affects sleep [11].

There are numerous factors that adversely affect sleep quality in critically ill patients. Noise, nursing care, circadian rhythm disruption, and light exposure have all been implicated [12, 13], as have severity of illness and

medications [14]. Interest, however, has recently turned toward the mode and settings of mechanical ventilation as a cause of sleep disturbance [15].

Major causes of sleep disturbance associated with mechanical ventilation include patient-ventilator asynchronies [16], central apneas due to overventilation [17], and inadequate ventilatory support due to improper settings or air leaks leading to increased respiratory effort [18]. Therefore, there is a renewed interest in finding novel ways of adequately ventilating patients while minimizing sleep disturbance.

In a previous issue of *Lung*, Crisafulli et al. [19] presented the findings of a pilot study comparing a newer mode of noninvasive ventilation, average volume assured pressure support (AVAPS), to noninvasive pressure support (NIV-PS) therapy in nine stable hypercapnic COPD patients. AVAPS differs from NIV-PS in its ability to ensure more consistent minute ventilation by slowly adjusting inspiratory positive airway pressure (IPAP) to achieve a preset tidal volume. Therefore, there is a theoretical benefit in that this mode of ventilation could improve nocturnal ventilation in hypercapnic patients, leading to improvements in CO₂ retention and sleep efficiency. Specifically, they looked at differences in nocturnal ventilation, sleep efficiency, and compliance with therapy in patients randomized to 5 days of one mode of ventilation, who then crossed over to 5 days of the other mode. They found that AVAPS resulted in a trend toward improved nocturnal minute ventilation as well as a statistically significant improvement in subjective sleep quality as measured by a questionnaire. Although two previous studies demonstrated an increase in nocturnal minute ventilation with AVAPS in patients with chronic respiratory failure [20] and obesity hypoventilation [21], neither study was able to show an improvement in sleep efficiency

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as measured by polysomnography. While there are numerous possible explanations for this discrepancy, there is one in particular that bears mentioning. Whereas the previous studies used polysomnography to assess sleep efficiency, Crisafulli's study employed a diurnal hypersomnia questionnaire. It is thus possible that the previous studies on AVAPS using polysomnography were not able to detect subtle changes in sleep architecture that patients may nevertheless subjectively feel over the long term.

It is crucial that future studies looking at the effects of mechanical ventilation on sleep efficiency use sleep questionnaires that have demonstrated acceptable levels of reliability and validity, while also using objective measures such as polysomnography, continuous oxygen saturation, or end-tidal CO₂ monitoring that may help determine the mechanism by which sleep efficiency is improved.

Recent developments such as the renewed interest of esophageal balloons [22] may help clinicians and researchers titrate their nocturnal ventilation in a more physiologic fashion that benefits sleep [23]. Also, neurally adjusted ventilatory assist (NAVA) mode of ventilation [24] may allow one to minimize asynchronies [25] and overventilation [26], while ensuring adequate ventilation during sleep, though this remains speculative.

Finally, more work will be needed to determine whether an improvement in sleep quality will have an impact on meaningful patient outcomes. For example, will improving sleep quality improve compliance with treatment, reduce delirium, decrease susceptibility to infections, reduce time to extubation, and improve patient mortality? Nevertheless, papers such as the one by Crisafulli et al. may awaken clinicians and researchers to a potentially important field of study in the critical care unit.

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