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To Sleep, or Not to Sleep, That Is the Question

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Also, I could finally sleep. And this was the real gift, because when you cannot sleep, you cannot get yourself out of the ditch—there's not a chance

– Elizabeth Gilbert from *Eat, Pray, Love*

Not long ago, adequate sleep was generally considered a luxury rather than a health necessity. Indeed, sleeping was often linked to laziness, lack of ambition, and sloth—getting by with inadequate sleep was often considered a “badge of honor,” particularly during medical training (1).

Curtailing sleep does, unfortunately, have adverse consequences. The neurocognitive deficits associated with sleep loss have been recognized for a long time. However, it is only relatively recently that the importance of adequate sleep as one of the pillars of a healthy lifestyle (similar to exercise and a prudent diet) has been recognized. Numerous experimental studies in healthy subjects have shown adverse cardiometabolic effects of even modest durations of sleep loss, including activation of inflammation, sympathetic activation, increased cortisol, and glucose intolerance (2). These findings have complemented the epidemiologic studies that have shown a clear association between habitual short sleep and a variety of long-term health outcomes, including coronary heart disease, diabetes, obesity, hypertension, pneumonia, and death (3, 4). Disorders of sleep fragmentation, such as obstructive sleep apnea, are also linked to poor cardiometabolic outcomes (5).

Although a difficult area to study, the potential role of sleep in the ICU has been receiving increasing attention. Numerous studies have shown that patients in the ICU suffer from poor sleep. Objectively, sleep is more fragmented and characterized by frequent arousals and awakenings, with excessive sleep during the day and less at night (6). Subjectively, patients report that sleep in the ICU is of poorer quality than their sleep at home (7). Given the myriad detrimental effects of sleep loss, it seems likely that these sleep abnormalities would have potential adverse consequences in the ICU.

Multiple factors contribute to sleep disruption in the ICU; for example, noise, light, pain, anxiety, encephalopathy, delirium, medications, and circadian rhythm abnormalities likely

play roles. The role of mechanical ventilation and how we set the ventilator should also be considered. For example, both high levels of pressure support (PS) and minimal levels of PS administered to susceptible patients with high respiratory system gains (e.g., heart failure) can lead to central apneas and sleep disruption (8, 9). High levels of PS may also lead to air trapping and ineffective triggering of the ventilator leading to patient/ventilator dyssynchrony. To make matters more complex, the choice of PS level may be state dependent, that is, dependent on whether the patient is asleep or awake (10). For example, a particular level of PS may be appropriate during wakefulness, but upon transition to sleep, the resultant reduced carbon dioxide production, and blunting of chemosensitivity and loss of behavioral control may lower PS requirements. On the other hand, inadequate unloading of the respiratory muscles due to insufficient PS is not optimal for sleep either. Increased respiratory efforts, characterized by more negative pleural pressure, can trigger arousals from sleep (11); this finding suggests that assisted ventilation should have fewer respiratory-related arousals than spontaneous breathing. Ventilator modes that better match gas delivery to patient effort (such as neurally adjusted or proportional assist modes) (12, 13) may lead to less dyssynchrony and better sleep quality.

In this issue of *Critical Care Medicine*, Roche-Campo et al (14) extend this body of knowledge by addressing the potential impact of mechanical ventilation per se on sleep quality. The authors studied 16 conscious patients with tracheostomy who could breathe spontaneously for at least five consecutive hours. They were studied a median of 23 days after tracheostomy while weaning from mechanical ventilation. In an elegant randomized crossover study, during a single night (10 PM–8 AM), patients were placed on 5 hours of PS ventilation (PSV) or unassisted breathing (UB). PS was set at a level determined by the attending physician (median of 10-cm water). Sleep was assessed by polysomnography, including electroencephalogram recordings, and scored according to standard criteria. During PSV compared with UB, patients experienced significantly more sleep (183 min vs 132 min, $p = 0.04$). Although not statistically significant, amounts of rapid eye movement (REM) and deep sleep were greater in the mechanical ventilation group (11 vs 3 min; 45 vs 28 min); this finding may be important given the association between lack of REM sleep and increased risk of delirium (15). Measurement of esophageal pressure and work of breathing may have helped define the mechanistic basis of the study's findings; such measurements, although unavailable in the present study, do not take much away from the study's important findings. Sleep fragmentation rates were similar in both arms (25 vs 23 arousals and awakenings/hr). Consistent with other studies, overall sleep efficiency (i.e., time asleep/recording time) was small (50%) suggesting a shift from nighttime to daytime sleep from circadian rhythm disruption or other factors.

What do these findings mean for the current practicing critical care clinician? If one believes that improving sleep is an appropriate end in and of itself (which may be reasonable given the myriad adverse effects of sleep loss), the recommendations of the authors appear appropriate. That is, patients should be reconnected to the ventilator at night to promote sleep while being weaned from assisted to UB. However, patients need to be followed closely at night to ensure that PS is not excessive, which could yield central apneas, patient/ventilator dyssynchrony, and sleep fragmentation. Such underlying mechanisms may have contributed to delayed weaning when PS was compared with spontaneous breathing in a recent trial (16).

One interesting overarching question is “What will sleep mean to the future practicing critical care physician?” Fundamentally, will improving sleep lead to better patient outcomes (e.g., delirium, mortality, length of stay, and nosocomial infection)? Will we be able to monitor sleep quantity and quality without the cumbersome use of visually scored electroencephalogram? What will be the best ways to improve sleep (environmental

manipulation, pharmaceuticals, ventilator modifications, and behavioral therapies)? How should we help to ameliorate the circadian abnormalities associated with critical illness?

As physicians, we tend to focus predominately on what our patients are doing in the daytime. Perhaps, the time has come to focus more on what is happening to our patients at night?

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References

1. Peets A, Ayas NT. Restricting resident work hours: The good, the bad, and the ugly. *Crit Care Med*. 2012; 40:960–966. [PubMed: 22297631]
2. Mullington JM, Haack M, Toth M, et al. Cardiovascular, inflammatory, and metabolic consequences of sleep deprivation. *Prog Cardiovasc Dis*. 2009; 51:294–302. [PubMed: 19110131]
3. Al Lawati NM, Patel SR, Ayas NT. Epidemiology, risk factors, and consequences of obstructive sleep apnea and short sleep duration. *Prog Cardiovasc Dis*. 2009; 51:285–293. [PubMed: 19110130]
4. Patel SR, Malhotra A, Gao X, et al. A prospective study of sleep duration and pneumonia risk in women. *Sleep*. 2012; 35:97–101. [PubMed: 22215923]
5. Golbidi S, Badran M, Ayas N, et al. Cardiovascular consequences of sleep apnea. *Lung*. 2012; 190:113–132. [PubMed: 22048845]
6. Weinhouse GL, Schwab RJ. Sleep in the critically ill patient. *Sleep*. 2006; 29:707–716. [PubMed: 16774162]
7. Little A, Ethier C, Ayas N, et al. A patient survey of sleep quality in the intensive care unit. *Minerva Anesthesiol*. 2012; 78:406–414. [PubMed: 22337154]
8. Parthasarathy S, Tobin MJ. Effect of ventilator mode on sleep quality in critically ill patients. *Am J Respir Crit Care Med*. 2002; 166:1423–1429. [PubMed: 12406837]
9. Eckert DJ, Jordan AS, Merchia P, et al. Central sleep apnea: Pathophysiology and treatment. *Chest*. 2007; 131:595–607. [PubMed: 17296668]
10. Williams K, Hinojosa-Kurtzberg M, Parthasarathy S. Control of breathing during mechanical ventilation: Who is the boss? *Respir Care*. 2011; 56:127–136. discussion 136. [PubMed: 21333174]
11. Gleeson K, Zwillich CW, White DP. The influence of increasing ventilatory effort on arousal from sleep. *Am Rev Respir Dis*. 1990; 142:295–300. [PubMed: 2382892]
12. Bosma K, Ferreyra G, Ambrogio C, et al. Patient-ventilator interaction and sleep in mechanically ventilated patients: Pressure support versus proportional assist ventilation. *Crit Care Med*. 2007; 35:1048–1054. [PubMed: 17334259]
13. Delisle S, Ouellet P, Bellemare P, et al. Sleep quality in mechanically ventilated patients: Comparison between NAVA and PSV modes. *Ann Intensive Care*. 2011; 1:42. [PubMed: 21955588]
14. Roche-Campo F, Thille AW, Drouot X, et al. Comparison of Sleep Quality With Mechanical Versus Spontaneous Ventilation During Weaning of Critically-Ill Tracheotomized Patients. *Crit Care Med*. 2013; 41:XXX–XXX.
15. Trompeo AC, Vidi Y, Locane MD, et al. Sleep disturbances in the critically ill patients: Role of delirium and sedative agents. *Minerva Anesthesiol*. 2011; 77:604–612. [PubMed: 21617624]
16. Jubran A, Grant BJ, Duffner LA, et al. Effect of pressure support vs unassisted breathing through a tracheostomy collar on weaning duration in patients requiring prolonged mechanical ventilation: A randomized trial. *JAMA*. 2013; 22:1–7.