Commentary

Measuring sleep in critically ill patients: beware the pitfalls

Paula L Watson

Department of Medicine, Division of Allergy, Pulmonary, and Critical Care, and the Center for Health Services Research Center, Vanderbilt University Medical Center, 21st Ave South, Nashville, Tennessee 37232, USA

Corresponding author: Paula L Watson, paula.l.watson@vanderbilt.edu

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See related review by Bourne *et al*., http://ccforum.com/content/11/4/226

Abstract

Survivors of critical illness frequently report poor sleep while in the intensive care unit (ICU), and sleep deprivation has been hypothesized to lead to emotional distress, ICU delirium and neurocognitive dysfunction, prolongation of mechanical ventilation, and decreased immune function. Thus, the careful study of sleep in the ICU is essential to understanding possible relationships with adverse clinical outcomes. Such research, however, must be conducted using sleep measurement techniques that have important limitations in this unique setting. Polysomnography (PSG) is considered the gold standard but is cumbersome, time consuming, and expensive. As such, alternative methods of sleep measurement such as actigraphy, processed electroencephalography monitors, and subjective observation are often used. Though helpful in some instances, data obtained using these methods can often be inaccurate and misleading. Even PSG itself must be interpreted with caution in this population due to effects of critical illness and associated treatments.

Heralded as the new frontier in critical care medicine, sleep in intensive care unit (ICU) patients is rapidly gaining attention. Researchers now recognize that ICU patients experience poor quality sleep with severely disrupted sleep architecture. The outcomes attributable to poor sleep quality in the ICU are not yet known and are thus the subject of numerous research studies. As in any developing field of investigation, researchers must evaluate the validity and reliability of the methodological tools they employ. The recent article by Bourne and colleagues provides an excellent discussion of the sleep measurement techniques which have been used in the ICU and the problems encountered with each in this specialized setting [1].

As many as 61% of ICU patients report sleep deprivation, placing it among the most common stressors experienced during critical illness [2]. Previous studies used polysomnography (PSG) to demonstrate severe sleep fragmentation, a loss of circadian rhythm, and a decrease or absence of both slow wave sleep and rapid eye movement sleep [3-5]. In addition to causing emotional distress, sleep deprivation in the critically ill has been hypothesized to contribute to ICU delirium and neurocognitive dysfunction, prolongation of mechanical ventilation, and decreased immune function [6]. Little progress has been made, however, toward testing these hypotheses due to the difficulty of accurately measuring sleep in this patient population and setting.

Polysomnography, the gold standard for sleep measurement, is an invaluable tool for the study of sleep in the ICU. But this expensive, labor intensive test requires trained personnel to interpret, and the dispersion of sleep in critically ill patients throughout both day and night means that PSG must be used around the clock to study sleep in the ICU [4]. The expense and labor required for these studies can be prohibitive such that investigators are exploring alternative sleep measurement techniques.

Alternative techniques include actigraphy and processed electroencephalography (EEG) as well as subjective measurements such as nursing observation and patient self reporting. Bourne and colleagues appropriately note that each of these methods has significant limitations when used in the critical care setting [1]. Actigraphy – the use of an electronic device that measures a patient's movement to study sleep – is an attractive alternative to PSG because of its ease of use and ability to collect data over long periods of time. Actigraphs have been successfully used on ICU patients to show loss of circadian rhythm and sleep disruption [7]. They can not, however, be considered an accurate tool to measure sleep time in ICU patients whose movement may be restricted by neuromuscular weakness, sedatives or restraints. Patient self reporting can be unreliable secondary to the high incidence of ICU delirium, and nursing

BIS = bispectral index; EEG = electroencephalography; ICU = intensive care unit; PSG = polysomnography.

observation has been shown to overestimate sleep when compared to PSG in the critically ill [5,8].

Processed EEG devices such as the bispectral index (BIS) and the SEDLine™ may prove to be acceptable alternatives to PSG to measure sleep in certain circumstances. Originally developed to monitor sedation in the operating room, the BIS has been shown to detect sleep in normal volunteers [9]. Of concern is that ICU patients often have EEG changes induced by illness or medication and these changes may significantly affect the ability of processed EEG devices to reliably detect sleep in this population. Currently, there are no published studies directly comparing processed EEG devices to PSG in critically ill patients, and research is needed to determine the validity of these devices in measuring sleep.

Though decidedly the most accurate measurement technique, PSG itself may lead to misleading results if not interpreted with caution. Renal failure, hepatic dysfunction, and sedative and analgesic use, each common among ICU patients, can be associated with significant EEG changes that make PSG interpretation problematic [10,11]. Sedative-induced beta EEG activity, for example, may lead to an overestimation of wake or stage 1 sleep [12]. Also, EEG slowing, which is frequently seen in critically ill patients, may result in the intrusion of delta frequency waves into the wake state, leading to an overestimation of sleep time. Thus, for accurate interpretation the PSG should be read in conjunction with observational measures of sleep.

Sleep measurement in critically ill patients is a complex and challenging endeavor. In their thorough review, Dr. Bourne and colleagues have explained the problems investigators will face as they move forward in this line of research. Currently available techniques for sleep measurement provide at best an imperfect approximation of an ICU patient's sleep. Nevertheless, valuable information can be obtained using these techniques if their limitations are recognized and the most appropriate technique to study sleep is chosen based on the hypotheses being tested.

Competing interests

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