Sleep disorders in critical care unit.

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Abstract

Sleep is commonly disrupted in intensive care unit (ICU) patients and usually it is consequence of medical illness itself, ICU environment, psychological stress, and effects of many medications. The purpose of this review is to discuss the relevant literature in this regard.

Keywords: Medications, Injury, Physiology, Respiratory.

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Introduction

Sleep deprivation is common in critically ill patients in ICU. It is not surprising that sleep disturbances and fatigue are among the most common symptoms in critically ill adults. Many factors such as preexisting sleep disorders, pathophysiology of the underlying illness/injury, therapeutic interventions, medications, and ICU environment, play roles in sleep and fatigue symptoms during recovery from acute illness or injury. Sleep disruption is a significant stressor in the ICU that can negatively affect recovery and even survival.

Normal sleep and physiology

In 1968, Rechtchaffen and Kales divided sleep into two types: rapid eye movement (REM) and non-REM, with non-REM further divided into four stages [1]. Stages of sleep are classified on the basis of electroencephalographic patterns (EEG), muscle activity (EMG), and eye movements, in 30 second periods called epochs. During relaxed wakefulness with closed eyes, a normal individual exhibits alpha activity (8-12 Hz) on EEG. During stage 1 non-REM alpha activity disappears, and he/she is in a very light sleep and can easily be awakened. Stage 2 is identified by the appearance of characteristic K-complexes (large, biphasic waves) and sleep spindles (12-14 Hz activity lasting at least 0.5 sec). During stage 3 and 4 sleep, large amplitude waves of 2 Hz or slower appears which are known as delta or slow waves. These stages are mentioned together as delta sleep or slow wave sleep, and make up the deepest sleep in terms of arousal threshold and restorative properties. With aging, the percentage of delta sleep decreases. During REM sleep, muscle activity is greatly reduced but EEG is similar to wakefulness in many ways. Typical very rapid eye movements are seen. REM sleep represents dreaming activity during dreaming muscle hypotonia prevents the dreamer from acting out their dreams. The period of REM sleep is associated with unsteadiness of respiratory and cardiac function during the night. Sleep architecture is the way in which these stages of sleep are put together during the sleep period, and the graphic demonstration of sleep is known as a sleep histogram or hypnogram. Normal subjects will fall asleep within about 20 minutes, and enter deep stages of non-REM sleep, with a REM period occurring in about 90 minutes and every 90-120 minutes thereafter. First half of sleep is associated with deeper non-REM sleep and accompanied by more REM. Brief episodes of wakefulness are seen normally during the sleep period, especially in elderly. However, any condition that causes frequent arousals (brief periods of a few seconds of wake EEG) can lead to daytime sleepiness [2].

In a typical clinical sleep study (polysomnogram), patients are asked to sleep during their normal sleep hours in a comfortable, private room while two channels of EEG, EMG, eye movements, electrocardiogram (ECG), respiratory effort, airflow, and oximetry are measured. Other measurements, such as esophageal pH or pressure monitoring or leg motion sensors, may be added for specific clinical indications. For some patients, daytime sleepiness can also be evaluated by the multiple sleep latency test (MSLT). In this procedure, the patient is monitored to sleep for four to five time at two-hour intervals during the day. The time to sleep onset (sleep latency) during each nap as well as the presence or absence of REM sleep is noted. To objectively measure the quality and quantity of sleep, polysomnography is the gold standard [2]. Because it is difficult to undertake, particularly in patients recovering from critical illness in an acute-care area, other objective (actigraphy and bispectral index) and subjective (nurse or patient assessment) methods, and even wireless polysomnography have been used in other critical care studies [3].

With an increase in parasympathetic tone and a decrease in sympathetic tone, sleep and throughout non- REM sleep starts. During tonic REM sleep (REM sleep without eye movements) parasympathetic activity continues to increase, with further depression in sympathetic activity. In phasic REM (REM sleep with eye movements), increases in sympathetic activity occurs. These autonomic changes result in pupillary constriction during non- REM and tonic REM sleep and dilatation during phasic REM sleep.

Reduction in the thermal set point and body temperature happens. In a cold environment, wake time, sleep latency, movement time are increased and there is a decrease in total sleep time, REM sleep and stage 2 sleep.

Most hormones tend to follow circadian rhythms. Adreno corticotropic hormone (ACTH) and cortisol secretion peaks between 4 AM and 8 AM. Thyroid stimulating Hormone (TSH) is low during the day, increases in the evening and peaks at night prior to sleep.

An increased vagal activity in non REM sleep leads to electrical stability which reduces heart rate, blood pressure, stroke volume, cardiac output and systemic vascular resistance and the risk of arrhythmia. Heart rate is variably tachy cardic and Brady cardic during REM sleep. Transient increases to 35% of baseline may be seen in phasic REM sleep as well as during periods of transient central nervous systems (CNS) activation or arousals. The risk for ventricular arrhythmia increases by Bursts in autonomic activity and heart rate during REM sleep.

There is a progressive decrease in central respiratory drive through stages 1 to 4 of non-REM sleep. Arterial carbon dioxide pressure (PaCO2) increases by 3-7 mmHg and an apnea threshold is revealed. During non REM sleep, respiration is regular and predominantly under metabolic control as opposed to REM sleep when respiration becomes irregular and is more dependent on behavioral factors. During REM sleep ventilatory responses to chemical stimuli and respiratory reflexes are reduced. Arousals are associated with brief increases in ventilation and heart rate [4].

Sleep Disordered Breathing

Obstructive sleep apnea (OSA) is often an undiagnosed cause of daytime sleepiness. It affects between 3 and 7% of the adult population, and the prevalence is expected to rise due to the obesity epidemic and ageing population. OSA is a sleep-related breathing disorder in which the airways completely (apnea) or partly (hypopnea) close during sleep at the end of expiration [5].

Sleep apnea by itself is not generally a cause of respiratory failure, and most patients will have normal arterial blood gases except those with the obesity hypoventilation syndrome. However, this disease decrease respiratory drive, and may worsen respiratory failure from another cause. While patients are monitored in the critical care unit during sleep, cardiac arrhythmias or profound hypoxemia may be seen. Complicated cases may present with right ventricular failure and pulmonary hypertension from chronic nocturnal hypoxemia. Patients with sleep apnea are at risk for complications from any sedation, especially agents that reduce respiratory drive [6-11].

Any patient with a history of snoring and daytime somnolence needs particular attention, especially if obesity and a crowded appearing upper airway are noted. If urgently needed, empiric treatment with Continuous positive airway pressure (CPAP) can often be started in the critical care setting. CPAP is the gold standard treatment for OSA. CPAP masks are worn throughout the night and provide a constant pressure to open the collapsing upper airway. Of course endotracheal intubation will remove obstructive sleep apnea if indicated.

Environmental concerns

Some of this factors may be unavoidable such as need for testing, monitoring, and therapeutic interventions on a 24-hour basis. Other causes may be modifiable. One possible cause is ambient noise [12]. Showed that sound peaks of greater than or equal to 80 dBA were correlated with arousals from sleep in patients in an intermediate respiratory care unit. When sound peaks were recorded in their intensive care units, many were found to be able to influenced by behavior modification, including talking and television [13]. Another study of ambient noise in a surgical care unit and recovery unit appears a continuously high level of noise; despite a substantial contribution from technical equipment, more was caused by the staff [14]. Many detrimental physiological effects can occur from noise including cardiovascular stimulation, increased gastric secretion, pituitary and adrenal stimulation, suppression of immune system and wound healing and possible contribution to delirium and this physician concerned about the true utility of some of these noisy disruptions in the ICU [15,16]. On the other hand others have suggested that noise may not play an important role in sleep disruption. In a study of 22 medical intensive care unit patients that 20 of whom were mechanically ventilated, to determine the effect of environmental noise on sleep disruption, patients were found to have qualitatively and not necessarily quantitavely sleep deprivation and environmental noise was not responsible for the majority of sleep fragmentation [17]. Other studies suggest that noise and patient care activities may be responsible for less than 30% of arousals in the ICU. Additionally, it has also been suggested that it is the change in noise level from baseline that is the main determinant of sleep disruption rather than peak noise [18]. Noise produces physiologic responses analogous to a stress reaction via sympathetic excitation. Such excitation may prevent relaxation and sleep.

Ambient light is another important environmental concern which is the major environmental signal that entrains the circadian system in humans to a 24- hour cycle. This important clue is often ignored in an environment which may be windowless, and in which light levels may be the same day and night. A try to decrease light intensity during night hours may improve sleep. It has also been suggested that secondary to inappropriate light exposure, a dys- synchronization of melatonin secretion with subsequent change in the 'biological clock' may cause to sleep disturbances and delirium in critically ill patients [19].

In a study it is shown that use of melatonin, earplugs and eye masks in healthy subjects in a simulated ICU environment not only improved subjective sleep quality, but also improved the sleep structure, and elevated nocturnal melatonin levels. Their pilot study provides a reasonable basis for promoting the use of oral melatonin, and earplugs and eye masks for ICU patients. However, compared to earplugs and eye masks, melatonin showed better performance in effectiveness and patient tolerability [20].

Medical illness and sleep disorders

a. Chronic obstructive pulmonary disease (COPD): Patients with COPD are more hypoxemic during sleep than during wakefulness. The major cause of hypoxemia in these patients is hypoventilation, although ventilation/ perfusion mismatching appears to also worsen, and decrease in functional residual capacity (FRC) may also presents [21]. As you know ventilation is lower during sleep in both normal subjects and patients with COPD, especially in REM sleep [22]. The decrease in ventilatory drive during sleep makes a concern over the dangers of sedatives or hypnotics during exacerbations of COPD. Benzodiazepine and newer hypnotics appear to be notably safe in these patients. In one study of mild to moderate COPD, it is shown that Triazolam and Zolpidem were not different from placebo in affecting oxygenation or respiratory disturbance

index [23]. Similarly, in another study of 29 patients with mild COPD, Flurazepam and Estazlam had no effect on ventilatory response to carbon dioxide [24].

b. Asthma: Worsening of symptoms commonly occurs during night [25]. Another study presents that more than half of the deaths due to exacerbations of asthma happen between 6 PM and 3 AM [26]. Airway function appears to decrease progressively during the night, whether the subject is asleep or not, although the decline is worsened by sleep [27]. Additionally, sleep related physiologic changes in lung volume, upper airway narrowing, blood pooling, and circadian changes in catecholamines and cytokines may have relation with to nocturnal asthma [28].

c. Congestive heart failure (CHF): Sleep disordered breathing consisting of periodic breathing with periods of central apnea which is called Cheyne-Stokes respiration (CSR) is seen in approximately 40% of the patients with an ejection fraction of less than 40 percent [29]. Treatment should be first focused on treating the underlying heart failure. Supplemental oxygen at high flow rates may make periodic breathing weaker, but success with this modality has been variable at best [30]. Nasal CPAP use during sleep has been shown to improve periodic breathing with CHF and CSR and cardiac function (24). One report suggests that Temazepam can be used in patients with CSR to improve sleep quality without worsening of respiration during sleep [31]. Theophylline has also been shown to decrease the severity of CSA but did not improve cardiac function [32]. In a trial of 12 patients with stable systolic heart failure, a single dose of acetazolamide at bed-time improved CSA, sleep quality, daytime fatigue and feeling rested on morning awakening [33].

d. Sepsis: Freedman et al found that the 5 of their patients who either developed sepsis or positive blood cultures during EEG monitoring had a characteristic EEG pattern of low voltage, mixed-frequency waves with a variable amount of theta and delta activity. Sepsis has also been associated with the loss of normal circadian melatonin secretion. Melatonin has been shown to have a protective effect in animal models of sepsis due to its free-radical scavenging and antioxidant properties and, in fact, has been successfully used to treat septic pediatric patients. sepsis is related with increased non REM sleep, decreased REM sleep and rise in sleep promoting cytokines TNF, IL-1ß.

Pharmacological consideration

it is important to consider drug therapy as a contributing factor in sleep disorders. Sedative and analgesic combinations which are used to facilitate mechanical ventilation are among the most sleep disruptive drugs. Cardiovascular, gastric protection, anti-asthma, anti-infective, antidepressant and anticonvulsant drugs have also been reported to cause a variety of sleep disorders. Withdrawal reactions should also be considered as possible triggers for sleep disruption. Tricyclic antidepressants and benzodiazepines are commonly prescribed in the treatment of sleep disorders, but have problems with decreasing slow wave and REM sleep [34].

Clonazepam has been suggested as the first line treatment option for REM sleep behavior disorder (RBD). Melatonin appears to be beneficial for the management of RBD with reductions in clinical behavioral outcomes and decline in muscle tonicity during REM sleep. Melatonin is safe and tolerable in compare with clonazepam. with limited potential for drug–drug interactions, it would be a suitable drug in elderly individuals with RBD receiving poly pharmacy [35].

Conclusion

The problem of sleep in ICU is generally neglected because of more urgent and life threatening concerns. In addition to various physical and mental illnesses, sleep deprivation is associated with delayed recovery from illness [36]. So prevent or overcome it, would reduce the overall burden of diseases. A combination approach that employs rational drug use, protocols, environmental modification, appropriate treatment of underlying chronic as well as acute illnesses, pertinent use of sedation, scoring systems and vigilance for withdrawal syndromes will minimize sleep disturbances for patients.

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