Mini Review

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Journal of Intensive and Critical Care
ISSN 2471-8505

2017
Vol. 3 No. 4: 39

DOI: 10.21767/2471-8505.100098

Sleep Disturbances and Critical Illness

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Abstract

Patients in the intensive care unit are at risk for developing sleep disturbances. This article describes the etiologic factors associated with sleep disturbances in the intensive care setting, effects of sleep disturbances for the patient, sleep measurement and strategies to mitigate sleep disturbances.

Keywords: Sleep disturbances; Critical care; Intensive care unit; Sleep

Received: September 13, 2017; **Accepted:** September 19, 2017; **Published:** September 26, 2017

Citation: Kaplow R (2017) Sleep Disturbances and Critical Illness. J Inftensfive & Crfift Care Vol. 3 No. 4: 39

Introduction

Sleep is required for its healing, defensive, and energy preserving functions [1]. Despite its importance, critically ill patients in the ICU report inferior sleep quality. Poor sleep quality is associated with apprehension and distress, which affect patients' quality of life. Altered sleep architecture, quantity and quality increase the risk for delirium and other complications, ICU length of stay and mortality [2]. Sleep disturbances can also significantly affect patients' recovery from critical illness [3]. A multitude of factors contribute to sleep disturbances in the ICU, many of which are difficult to avoid.As far back as the early 2000s, patients have been reporting that inadequate sleep was among the most stressful aspects of their ICU admission [4-6]. It is also important for emotional well-being and adequate cognitive, immunologic and muscle function and healing [1,7,8]. Adequate restorative sleep is also associated with decreased morbidity and with restoring health [9,10].

Types of Sleep Disturbances

Patients in the ICU may obtain an adequate number of hours of sleep while being treated. However, the sleep architecture is altered [1,9]. Patients' sleep in the ICU is interrupted, resulting in sleep deprivation. Patients may experience a decrease in total sleep time caused by several ICU environmental factors. In addition to a decrease in total sleep time, sleep is reported as fragmented, there is excessive light sleep and decreases in slow wave and REM sleep, abnormal or loss of circadian rhythms, and frequent arousals and awakenings [10,12]. Poor sleep efficiency and sleep latency also occur [11] and result in disproportionate daytime sleepiness. Patients also report poor sleep quality [13].

Patients in the ICU may receive sedation to help decrease work of breathing or otherwise tolerate required treatment modalities. Although it may seem that patients are asleep while receiving sedation, the type of sleep experienced is clinically and physiologically different from the sleep achieved without the use of sedative agents. Although patients appear to be asleep, they are experiencing poor sleep quality [14].

Causes of sleep disturbances in the intensive care unit

The cause of sleep deprivation in the ICU is multifactorial. Patients are increasingly vulnerable for sleep deprivation because of ICU environmental factors, treatment modalities, patient demographics, and medical conditions.

Environmental factors

Noise: Several sources of noise have been implicated in the development of sleep disturbances in the ICU. These sources include alarms from monitoring devices infusion pumps, ventilators and normal function of the ventilator, telephones, beepers, overhead paging and health care providers having conversations at patients' bedsides [7-9,12,15-16].

Light: Exposure to artificial light in the ICU 24 h a day can lead to altered sleep patterns [1,8,9,11,12,15-17]. Exposure to artificial light is reported to stifle secretion of melatonin, which controls circadian rhythms.

Treatment Modalities

Frequent monitoring

Frequent interruptions in sleep can result during monitoring and other patient care activities that are required around-the-clock in the ICU [8,17,18]. The need to obtain laboratory specimens, radiologic procedures, and other diagnostic studies further contributes to sleep disturbances [1]. Patient care activities identified to contribute to sleep disruption in the ICU include performing patient assessments, wound care, bathing, and monitoring vital signs. Data from Kamdar et al. [11] suggest that patients' sleep may be disrupted as often as up to 60 times per night.

Medications

Medications administered in the ICU can alter sleep architecture [9]. For example, opioids and benzodiazepines result in interrupted REM sleep [3,17]. Other classes of medications that reportedly cause sleep disturbances are those used for cardiovascular conditions, asthma, infections, depression and seizures [1]. Medications used to regulate blood pressure, increase urinary output or cardiac output, or increase oxygen delivery are associated with changes in the activation of cortisol.

Mechanical ventilation

The mode of mechanical ventilation used may affect sleep architecture and circadian rhythms. Specifically, high and low levels of pressure support can lead to sleep disruption in some patient groups (e.g. patients with heart failure). Mechanical ventilation and high levels of pressure support can lead to patient/ventilator dyssynchrony, increased ventilatory effort, alterations in gas exchange, and air trapping. All of these can impact sleep quality [1,9,11,15,17,19-21].

Data suggest that patients on mechanical ventilation experience increased levels of daytime sleepiness [9]. Aspects of mechanical ventilation that can cause sleep disturbances are alarms, suctioning, increased ventilatory effort, and alterations in gas exchange [11]. In addition, discomfort from the endotracheal tube may affect sleep architecture [1,11,21,22].

Noninvasive ventilation

Patients who receive noninvasive ventilation for more than 24 h are reported to have sleep disturbances. Noninvasive ventilation causes disruption of circadian rhythms and decreased REM sleep [9].

Patient Factors

Patient demographics

A significant percentage of patients admitted to the ICU are older than 65 years [23]. The amounts of REM and deep sleep decrease with age [1]. Older patients also have increased sleep latency, less total sleep time, decreased sleep efficiency and they are more likely to awaken than younger patients [1].

Patient conditions

Sleep disturbances are implicated with the symptomatology of respiratory, cardiac, renal, endocrine and neurologic conditions. Diagnoses that result in ICU admission are associated with physiologic, emotional and functional alterations and associated symptoms. These symptoms can result in sleep deprivation [9]. For example, patients with pulmonary conditions may experience oxygen desaturation during REM sleep. Similarly, presence of dyspnea, cough or wheezing in patients with COPD may cause a decrease in REM sleep and sleep duration. Patients with COPD also have prolonged sleep latency, decreased total sleep time and more frequent arousals from sleep caused by hypoxia and hypoventilation [11].

Patients with diabetes experience neuropathic pain and awakening during the night to urinate; both can result in reduced and fragmented sleep. Patients with renal disease may develop sleep apnea or restless legs syndrome. Further, presence of renal disease-associated uremia, itching, pain or nausea can result in fragmented sleep [11].

A variety of other multisystem complications can disrupt normal sleep. For example, sepsis causes alterations in melatonin secretion, increase in NREM sleep and decrease in REM sleep. All of these can contribute to poor sleep quality [3,9]. Patients with heart failure or who have experienced a stroke have altered breathing patterns, which are associated with disruptions in sleep [9]. Psychological problems and cognitive dysfunction can lead to sleep disruption. Anxiety, depression, and personality disorders can occur as a result of altered sleep patterns [1].

Effects of Sleep Deprivation on Physiologic Processes

Negative consequences of sleep disturbances related to admission to the ICU have been well documented for many years [5]. Several organ systems are affected by sleep disturbances. These body system consequences can impact, extend ICU length of stay, and increase mortality [1,8-10,13,16,26]. Complications of sleep disturbances by body system are shown in **Table 1**.

Changes in temperature regulation

Sleep helps with temperature regulation. Thermoregulation follows a circadian pattern; core body temperature is highest in the later part of the day and is lower just before sleep onset. There is a decrease in temperature sensitivity during NREM sleep, whereas REM sleep is associated with loss in ability to shiver or sweat [11]. Body temperature is lowest in the later part of sleep and temperature begins to increase just before awakening [9]. Alterations in sleep result in disruption of this circadian pattern.

Changes in respiratory function

There are changes in breathing associated with each stage of sleep. Specifically, minute volume, tidal volume, and respiratory rate decrease as the body shifts to N1 from being awake. As patients progress through NREM sleep, arterial carbon dioxide levels increase by 3 to 7 mm Hg. While sleeping, patients lose some of their hypoxic and hypercarbia drives to breathe; this is more pronounced during REM sleep [11].

Changes in cardiovascular function

Changes in blood flow and electrical activity occur when patients are sleeping. These changes contribute to ischemia and dysrhythmias in patients with a history of cardiac disease. During NREM sleep, blood pressure, heart rate and systemic vascular resistance decrease because of increases in parasympathetic tone and decreases in sympathetic tone. During REM sleep, heart

Table 1 Complications of sleep disturbances by body system [1-3,8-10,12-16].

Body System	Complications
Cardiac	Heart disease, hypertension (from increased catecholamine levels), increased sympathetic tone, decreased parasympathetic tone, increased risk for AMI (from endothelial disruption).
Respiratory	Variability in respiratory rate, pneumonia, delayed weaning from mechanical ventilation, impaired lung mechanics, increased oxygen consumption, increased CO_2 production, decreased respiratory drive, decreased inspiratory muscle endurance.
Endocrine	Diabetes, altered endocrine responses; increased cortisol levels, increased T3, T4 and TSH levels; increased growth hormone and prolactin levels (may lead to muscle wasting and impaired immunity); hormonal effects; hyperglycemia; insulin resistance; altered glucose metabolism.
Neurologic	Alterations in thermoregulation, fatigue, irritability, disorientation, hallucinations.
Gastrointestinal	Alterations in metabolism, altered nitrogen balance, altered carbohydrate metabolism, catabolism, decreased glucagon levels.
Psychiatric/ cognitive	ICU psychosis, delirium, increased stress, psychological aberrancies, cognitive impairment, mood instability, depression, anxiety, decreased memory, decreased ability to concentrate, perceptual distortions.
Hematologic/ immunologic	Increased risk of cancer, production of proinflammatory mediators, impaired immune function, decreased natural killer cells, decreased T-helper cells, decreased phagocytosis activity, decreased leukocyte function.
Other	Obesity, decreased quality of life, increased intensity of pain, excessive daytime sleepiness, decreased energy, reproductive changes.

Abbreviations: AMI: Acute Myocardial Infarction; TSH: Thyroid-Stimulating Hormone

rate and venous return increase when patients inhale; these parameters decrease when patients exhale [11].

Changes in gastrointestinal function

When patients are sleeping, there is a reduction in esophageal motility, swallowing and saliva production. Also, gastric acid secretion intensifies early in the sleep cycle [11]

Changes in endocrine function

Growth hormone production typically intensifies during the early phase of N3 and is secreted during SWS. This leads to DNA and protein synthesis. Prolactin levels intensify during the second half of sleep. Both growth hormone and prolactin are required for cell differentiation and proliferation. These processes contribute to tissue healing and physical restoration. Growth hormone and prolactin levels increase with critical illness; however, the beneficial effects may be countered by sleeplessness in the ICU, which augments catabolism. Catabolism may lead to muscle wasting and impaired immunity [9,11]. The lowest cortisol level occurs at the onset of sleep [11]. Thyroid-Stimulating Hormone (TSH) has a similar pattern to cortisol, with the lowest level at the onset of sleep and inhibited by N3 sleep; levels of both hormones increase with sleep deprivation [11].

The development of delirium is proposed to be related to changes in melatonin release and circadian rhythms [17]. Hallucinations and perceptual distortions associated with sleep deprivation in the ICU have also been implicated in delirium development [12].

Sleep measurement tools

There are a number of methods available to measure sleep. These methods include polysomnography (PSG), actigraphy, Bispectral Index (BIS) and patient self-report.

Polysomnography

Polysomnography is considered the gold standard for measurement of sleep. It is the only tool that is reliable for measuring sleep, especially when evaluating patients with sleep disturbances [12]. This technology uses simultaneous recordings of EEG, electromyogram and recording of eye movement (electro-oculography).

Actigraphy

Actigraphy uses a small automated device that is worn on the wrist or leg. It documents motion/gross motor activity [1,11]. The actigraph measures sleep efficiency and sleep-wake periods. Data on total sleep time, wake time, and sleep fragmentation are conveyed [12].

Bispectral index (BIS)

BIS uses EEG leads and a foam sensor. It incorporates EEG data on a scale of 0 to 100. Higher numbers equate to higher levels of consciousness [9]. Used primarily to assess the effect of anesthesia, the use of BIS to evaluate sleep in general or in the ICU has limited data [12].

Patient self-report

A number of scales are available for patients to assess their quality and quantity of sleep. In addition to the Richards-Campbell Sleep Questionnaire (RCSQ), there is the Pittsburgh Sleep Quality Index and the Verran and Snyder-Halpern (VSH) Sleep Scale. Each of the tools can quantify sleep quality, disturbance, time, and latency. In addition, the VSH Sleep Scale quantifies sleep fragmentation, length, latency and depth. With the RCSQ, patients quantify the number of hours of sleep they experienced the previous night and the quality of their sleep [14] Another instrument that has been used to evaluate sleep in critically ill patients is the Epworth Sleepiness Scale, which measures degree of sleepiness [14]. Patient self-report of sleep has some degree of validity because patients are able to compare quality of sleep before, during, and after critical illness. Although patient self-assessment of sleep provides an ideal evaluation of sleep quality, there are reported difference between patient self-report on sleep quantity and total sleep time, as measured by PSG [12].

Strategies to minimize sleep disturbances

Given what is known about the negative impact of sleep disturbances experienced by patients in the ICU, several strategies to minimize alterations in sleep architecture are suggested.

Patient care activities

Patient care activities should be clustered to minimize sleep disruptions, promote sleep and improve circadian rhythms [10,11,24-26]. Routines should be modified to mitigate sleep fragmentation and interruptions [18]. Lines, catheters and devices should be kept in sight to avoid having them be placed under the patient. It is recommended that environmental stimuli should be decreased during certain hours of the night [8,9,16]. This may include keeping the door closed, if feasible, use of ear plugs, keeping pagers and phones in the silent mode, avoiding discussions at the bedside, and minimizing activity (e.g. emptying trash) and keeping the room at an appropriate temperature for sleep (too warm and too cool interferes with sleep). Clustering of activities and performing only those activities that are clinically indicated and evidence-based versus based on routine is also recommended [1,7-11,13,15,17-19,24,25]. Lights should be kept dim during sleep hours so as not to trigger arousal through melatonin suppression and disruption of circadian rhythms [11].

Mechanical ventilation

Data suggest that patients should be reconnected at night while liberation from mechanical ventilation is being attempted. It is further recommended to avoid excessive pressure support and smaller tidal volumes [9-11,13,21]. Nurses should monitor for discomfort associated with the endotracheal tube and monitor for patient/ventilator dyssynchrony.

Melatonin

Decreased circadian rhythms and decreased melatonin secretion have been reported in patients on mechanical ventilation [9]. Melatonin controls the sleep-wake cycle and augments circadian rhythm. Administration of melatonin may enhance sleep for patients in the ICU by regulating circadian rhythms; more data are needed [8,17].

Complementary Therapies

Numerous complementary therapies are suggested to help stimulate promote sleep. These include massage, foot rubs, relaxation techniques, reading, acupuncture, mobilization and optimizing comfort [9,11,18,25,27]. Massage may activate the parasympathetic nervous system, which results in a decrease in heart rate, blood pressure, respiratory rate and stress. Data suggest that as few as 3 min of massage may have a positive effect [9].

Conclusion

A number of factors can contribute to sleep disturbances in the ICU. Many of these factors are unavoidable. The primary focus of providers is management of the complex, multisystem problems that resulted in ICU admission. This makes it easy to neglect the value of sleep and ultimately fail to implement interventions that promote sleep [28]. Multidimensional approaches are necessary for enhancing patients' sleep while they are in the ICU, which is essential to recovery from critical illness.

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