Sleep Deprivation in the Intensive Care Unit

Jillian Delves
John Hunter Hospital, Manning Base Rural Referral Hospital, Hunter New England Area Health Service

Abstract

Objectives:
• To review the literature on the detrimental effects of disordered sleep in Intensive Care Unit (ICU) patients;
• To identify the causative factors and immunological consequences of disturbed sleep and strategies to diminish their effects;
• To appraise the drugs frequently used within the ICU for the purposes of sedation in relation to their detrimental effect on sleep.

In light of the evidence reviewed in this work, recommendations to extend the scope and address the limitations of current nursing and medical practice and beliefs are made.

Method: A review of the literature was undertaken. A search of online journal databases for qualitative and quantitative studies on sleep deprivation published from 2000 to present was undertaken.

Findings: Sleep is an essential function for survival in humans. Sleep disturbances are common in critically ill patients and contribute to morbidity. Patients are known to have disturbed sleep patterns during their time in the ICU, irrespective of their diagnoses.

Conclusion: Factors implicated in contributing to sleep deprivation in the ICU include light, frequent disturbances and activity, and unfamiliar setting and anxiety. Although controversial mechanical ventilation is implicated as a factor in abnormal sleep patterns so are the use of sedatives and analgesics. Nurses are pivotal in implementing strategies to promote sleep, recognising conditions which predispose patients to sleep disturbances and advocating for patients regarding the appropriate use of pharmacological modalities that are known to hinder sleep.

Key Words: Intensive Care, Nursing activity, Sleep deprivation, Sleep.

INTRODUCTION

For over two decades sleep disturbance in critically ill patients has been a recognised phenomenon (Cooper, Thornley, Young, Slutsky, Stewart & Hanly, 2000). A sequela of sleep deprivation in the critically ill is a host of psychoneuroimmunological and physical consequences that can prove to be fatal.

Nursing activities in addition to routine administration of sedative and therapeutic drugs as well as drug use prior to hospitalisation have been implicated in contributing to this occurrence. (Parthasarathy & Tobin, 2006; Çelik, Öztekin, Akyolcu & İşsever, 2005; Bourne & Mills, 2004; Mistrarelli, Donatelli & Carli, 2005; Society of Critical Care Medicine & American Society of Health-System Pharmacists, 2002). Despite this knowledge sleep deprivation remains an issue in critically ill patients.

This review addresses the concept of sleep and the detrimental effects of disordered sleep in the ICU patient. Immunological consequences of disordered sleep are reviewed. The causative factors specific to disturbed sleep in the ICU in conjunction with strategies to diminish the effects are reviewed.

Drugs frequently used within the ICU for the purposes of sedation are appraised in relation to their detriment to sleep. From the evidence reviewed in this work, recommendations are made to address the limitations and extend the scope of current nursing and medical practices and beliefs.

SEARCH STRATEGY

This review examines modern approaches to foundational work on sleep deprivation in the ICU. The search range included the OVID and ProQuest online journal database and the search engine METAsearch. A total of seven search terms were used related to sleep deprivation in the ICU, and to melatonin and its role in sleep and psychoneuroimmunology. The publication years searched spanned 2000 to the present with exceptions occurring for particularly relevant work because it built the framework upon which current investigations rest. Authoritative institutional websites such as the Fellowship of the Royal College of Anaesthetists were also reviewed. An objective assessment of the impact of the research was considered prior to inclusion of the work. The search methodology was limited to the OVID and ProQuest journal databases. Only English or English translation articles were included. Additionally the review was limited by the search terms and years.

FINDINGS

The Need for Sleep

Sleep is a basic function for survival in humans and one third of each person’s life is spent asleep (Patel, Chipman, Carlin, & Shade, 2008; De Gennaro, 2008). Sleep disturbances are common in critically ill patients and contribute to morbidity (Bourne & Mills, 2004). It is known that patients in the ICU irrespective of their diagnosis have disturbed sleep patterns during their time spent in ICU and up to one week following (Orwelius, Nordlund, Nordlund, Edéll-Gustafsson & Sjöberg, 2008). An investigation of adult mechanically ventilated ICU patients conducted by Cooper, Thornley, Young, Slutsky, Stewart & Hanly (2000) concluded that none of the study participants demonstrated normal sleep patterns.
All body systems require an adequate amount of sleep to maintain proper function and any disruption in the sleep cycle can significantly impair any or all of the body systems (Patel, Chipman, Carlin & Shade, 2008). Experimental animal studies have demonstrated that rats deprived of sleep for three weeks die as a result (Kryger, Dement, & Roth, 2000).

Sleep disruption in critically ill patients has been recognized as a serious problem for over two decades (Cooper, Thornley, Young, Slutsky, Stewart & Hanly, 2000). Sleep disruption is considered as reduced nocturnal sleep capability and altered sleep patterns with an increase in wakefulness and Stage 1 non rapid eye movement (NREM) in conjunction with reduced slow wave sleep (SW5) and rapid eye movement (REM) sleep (Weinhouse & Schwab, 2006; Freedman, Gazendam, Levan, Pack & Schwab, 2001; Cooper, Thornley, Young, Slutsky, Stewart & Hanly, 2000). In addition, sleep distribution in the critically ill has been demonstrated to be abnormal as up to 50% of the total sleep time occurs during the day (Freedman, Gazendam, Levan, Pack & Schwab, 2001).

Normal patterns of sleep comprise two distinct phases, non rapid eye movement (NREM) and rapid eye movement (REM) (Patel, Chipman, Carlin & Shade, 2008). NREM is further divided into three stages; 1, 2 and N (Patel, Chipman, Carlin & Shade, 2008). Stage 1 sleep is a drowsy state characterized with high muscle tone and the presence of slow rolling eye movements (Patel, Chipman, Carlin & Shade, 2008). Stage 2 sleep is characterized by a decrease in muscle tone and usually occupies 50% of the sleep period (Patel, Chipman, Carlin & Shade, 2008). Stage N (also known as delta or stage 3/4 sleep or slow-wave sleep, SWS) is thought to be the most restorative part of sleep (Cabello, Parthasarathy & Mancebo, 2007) where during this stage an increase in growth hormone secretion and a decrease of body metabolism and cortisol secretion occurs (Patel, Chipman, Carlin & Shade, 2008).

Parthasarathy and Tobin (2006) found that approximately 50% of total sleep time in critically ill patients occurs during the day, with a marked diminution or complete absence of circadian rhythm. Critically ill patients exhibit more frequent arousals and awakenings than considered normal, and exhibit a decrease in REM and SWS (Parthasarathy & Tobin, 2006).

Implications of Sleep Deprivation

Minimal changes in sleep affect health (Yang-Deok et al., 2009). The physiological response to sleep deprivation is explained by the stress response (Lusk & Lash, 2005). The chief result of activation of the stress response is the release of cortisol from the adrenal cortex and aldosterone from the adrenal medulla giving rise to the phenomena of elevated blood pressure and immunosuppression (Lusk & Lash, 2005). Short-term partial sleep deprivation, defined as four hours per night for six nights, imposed on a group of healthy subjects resulted in an increase in cortisol levels and sympathetic nervous system activity in addition to decreased glucose tolerance (Ayas, White, Manson, Stamper, Speizer & Malhorta, 2003).

Immunological Consequences

Inadequate sleep induces a state of catabolism and impaired cellular and humoral immunity, which in turn may lead to delayed healing and increased susceptibility to infection (Bourne & Mills, 2004; Gabor, Cooper, & Hanly, 2001). Sleep deprivation has been reported to increase circulating levels of inflammatory markers such as IL-6, tumour necrosis factor, and C-reactive protein with significant elevations following only one night of disturbed sleep (Irwin, Wang, Campomayor, Collado-Hidalgo, & Cole, 2006; Meier-Ewert, et al. 2004; Vgontzas, et al. 2004).

Respiratory Dysfunction

Gabor, Cooper & Hanly (2001) and Olson, Borel, Laskowitz, Moore, and McConnell (2001) report that consequences of sleep disturbance in ICU patients can cause respiratory dysfunction, noted by decreased respiratory muscle endurance following 30 hours of sleep deprivation and as a consequence potentially prolonging the need for mechanical ventilatory support. In addition there are reports of decreased ventilatory responsiveness to hypercapnia and development of increased upper airway compliance (Bourne & Mills, 2004; Gabor, Cooper & Hanly, 2001).

Systems Breakdown

Sleep is a critical restorative process, with important circadian variations in protein synthesis and cellular division being present with peak activity occurring during sleep (Patel, Chipman, Carlin & Shade, 2008). Experimental animal studies inducing sleep deprivation have been associated with major physiological abnormalities including development of gastric ulcers, internal haemorrhage, pulmonary oedema, and systemic bacterial invasion (Patel, Chipman, Carlin & Shade, 2008).

Everson and Toth (2000) report bacterial translocation and its sequelae provide the mechanism by which sleep deprivation is detrimental to health. Previous experimental animal studies inducing sleep deprivation illustrated gradual deterioration in health culminating in fatal opportunistic facultative anaerobes generally ascribed as being of gut origin, such as Pseudomonas aeruginosa, Klebsiella pneumoniae, Staphylococcus aureus, Streptococcus agalactiae, and Corynebacterium jejiklu (Everson & Toth, 2000). In isolation these organisms are not associated with primary bacteraemia or life threatening consequence unless the host is immune-compromised (Everson & Toth, 2000). Everson and Toth (2000) conducted animal experiments where the principal finding was early infection of the mesenteric lymph nodes by bacteria translocated from the intestine. This finding highlights the importance of instituting early enteric nutrition in the ICU patient as opposed to total parenteral nutrition due to reported mucosal atrophy and increased intestinal permeability, reflective of intestinal barrier damage allowing for translocation of bacteria (Gatt, Reddy, & Macfie, 2007).

Causes of Sleep Deprivation and Nursing Strategies to Promote Sleep

There are a multitude of factors that contribute to disturbed sleep in ICU patients (Patel, Chipman, Carlin & Shade, 2008; Freedman, Gazendam, Levan, Pack & Schwab, 2001). A study conducted in a Brazilian ICU monitored noise levels for a period of six days (Carvalho, Pedroira & de Aguiar, 2005). The noise levels identified exceeded International Noise Council recommendations, with the most significant noise level produced by staff (Carvalho, Pedroira & de Aguiar, 2005). Olson, Borel, Laskowitz, Moore and McConnell (2001) further report that noise levels in the critical care environment often exceed recommendations of the United States Environmental Protection Agency (EPA) and have the potential to disrupt the normal sleep-wake sequence.
This finding is commensurate with Parthasarathy and Tobin’s (2006) work where it is reported an approximately 20% of arousals and awakenings are related to noise. Nursing efforts to reduce this phenomenon include the application of earplugs to patients. A study conducted by Wallace, Robbins, Alvord and Walker (1999) demonstrated utilisation of earplugs increased REM sleep, and decreased REM latency, however, the number of awakenings were not affected. Given Parthasarathy and Tobin’s (2006) report of noise contributing to 20% of arousals, earplugs are not a definitive method rather an adjunct to sleep promotion in the ICU patient.

Additional environmental factors such as light, frequent disturbances and activity, and unfamiliar setting and anxiety are implicated in contributing to sleep disturbance (Patel, Chipman, Carlin & Shade, 2008; Ugras & Öztekin 2007; Parthasarathy & Tobin, 2006; Olson, Borel, Laskowitz, Moore & McConnell, 2001).

Impact of Mechanical Ventilation

A controversial theme is the impact of mechanical ventilation on sleep. Orwelius, Nordlund, Nordlund, Edel-Gustafsson & Sjöberg (2008) feel that mechanical ventilation has no significant influence on sleep disturbances. However Bosma et al. (2007) and Ugras and Öztekin (2007) report mechanical ventilation has a significant impact on sleep because of ventilator dysynchrony. The study by Bosma, et al.,(2007) indicated statistically significant results (p < 0.05), demonstrating less arousals and fewer awakenings per hour and greater REM and SWS in addition to fewer episodes of asynchrony during proportional assist ventilation as opposed to pressure support ventilation in patients being weaned from mechanical ventilation.

Effect of Routine Nursing Care Activities

Routine nursing cares such as eye and mouth care, pressure area care, dressing changes, and washing the patient all require an environment that is well lit, further increasing the disturbance of sleep (Celik, Öztekin, Alyoklu & İşsever, 2005). Edwards and Schuring (1993) proposed a model of care to limit sleep disturbances by suggesting that nursing care activities be limited between 0100HRS and 0500HRS. The suggested nursing activities for limitation included checking of alarm parameters, position changes, bathing, and phlebotomy whilst simultaneously administering medications to induce sleep and decreasing light and sound levels (Edwards & Schuring, 1993). Some of the suggested limitations are impractical given the acuity and specific care needs of the ICU patient however the suggestions can be modified to work within the ICU. The sound level of monitor alarms can be reduced over night. In addition promotion of dimmed lighting in conjunction with noise reduction by means of closing the entrance door to the patient’s room can be achieved in times where care activities are not being undertaken. Currently at the tertiary referral hospital in Hunter New England Area Health Service it is customary for the night staff to perform the patient’s wash. A feasible suggestion to minimise nocturnal disturbances would be to change this customary timing of the wash.

Use of Sedative Medications

Sedatives are frequently administered to critically ill patients to promote patient comfort, decrease anxiety and agitation and promote amnesia and sleep (Parthasarathy & Tobin, 2006; Mistraletti, Donatelli & Carli, 2005; Society of Critical Care Medicine & American Society of Health-System Pharmacists, 2002). However, Bourne and Mills (2004) contend that sedative and analgesic combinations used to facilitate mechanical ventilation are among the most sleep disruptive drugs.

Regulation of the sleep-wake cycle and sleep stages occurs by a complex interplay of various neurotransmitters including norepinephrine, serotonin, acetylcholine, dopamine, histamine and gamma aminobutyric acid (Bourne & Mills, 2004). Melatonin is an important neurohormone that regulates the sleep-wake cycle in humans (Bourne & Mills, 2004). Biochemical markers signifying normal circadian rhythm are characterised by comparatively higher melatonin and lower cortical excretion at night (Frisk, Olsson, Nylen & Hahn, 2004).

In what can only be described as a self-perpetuating cycle, a range of treatments and conditions commonly found in the ICU can cause delirium. (McGuire, Basten, Ryan & Gallagher, 2000) (See Figure 1). Delirium in turn is known to alter the circadian rhythm of melatonin leading to sleep deprivation (Mistraletti, Donatelli & Carli, 2005; Shigeta et al., 2001).

In a prospective cohort analysis study atypical sleep patterns were demonstrated in critically ill patients receiving high doses of sedatives (Cooper, Thornley, Young, Slutsky, Stewart & Hanly, 2000). Benzodiazepines and clonidine have been implicated in abolishing the circadian rhythm of melatonin secretion (Frisk, Olsson, Nylen & Hahn, 2004) whereas morphine is reported as stimulating melatonin release (Mistraletti, Donatelli & Carli, 2005). Paradoxically narcotics, such as morphine, can suppress REM sleep - the most restorative phase of sleep.
Benzodiazepines improve behavioural aspects of sleep. That is, they decrease the time needed to fall asleep, decrease awakenings, increase sleep duration and the efficiency of sleep (the duration of sleep as a percentage of time in bed) (Kress, Pohlman & Hall, 2002). However, benzodiazepines increase cortical electroencephalogram (EEG) frequency at low doses, decrease EEG amplitude and frequency in addition to suppressing REM and SWS activity at high doses (Mistraletti, Donatelli & Carli, 2005; Bourne & Mills, 2004). In summary, a pharmacologically induced state of sleep may superficially resemble the natural state of sleep while not providing the same physiological benefits associated with true sleep.

Cardiovascular, gastric mucosal protection medications, along with anti-asthma, anti-infective, antidepressant and anticonvulsant drugs are commonly used in the ICU and are reported to cause a variety of sleep disorders (Bourne & Mills, 2004). In addition, a factor often over looked with regard to sleep deprivation is the consequence of recreational drugs used prior to ICU admission (Bourne & Mills, 2004). Among an array of adverse affects are withdrawal from cannabis, alcohol, and amphetamines that can produce insomnia (Bourne & Mills, 2004). This highlights the importance of being aware of this issue and, where appropriate, attempting to ascertain a drug use history.

An open, comparative, prospective, randomised study conducted in Sweden by Treggiari-Venzi, Borgeat, Fuchs-Buder, Gachoud & Suter (1996) compared the impact of overnight sedation using midazolam or propofol on factors including sleep quality. They found that there was no difference in sleep quality between two groups of nonintubated ICU patients receiving midazolam or propofol. However, there were several limitations to this study. The dose prescribed and administered to the patients was not stated. Propofol is a general anaesthetic and while can be used in lowered doses for monitored conscious sedation it is not described nor should it be prescribed as an agent to induce sleep (MIMS Australia, 2003).

Excretion of Melatonin

Interestingly, urinary excretion of the melatonin metabolite, 6 - sulphatoxymelatonin is reported to exhibit marked abnormalities in septic patients when compared to non-septic patients in whom the secretion remains normal (Mundigler et al. 2002). Equipped with this knowledge the nurse when caring for the septic patient should be aware they are more than likely to be suffering sleep deprivation.

RECOMMENDATIONS

Nursing and medical staff need to be informed through means of wider education on the importance and the physiological restorative benefits of sleep, especially in the critically ill. There is a need for greater awareness of how routine care activities are impinging upon sleep and the pharmacological effects of therapeutic and sedative drugs routinely administered in the ICU.

CONCLUSION

It is imperative nursing and medical staff understand the implications of sleep deprivation in critically ill patients. Furthermore nursing and medical staff need to be made aware of factors implicated in contributing to sleep deprivation in the ICU. It is crucial nurses receive education about this issue as they are pivotal in implementing strategies to promote sleep, recognise conditions which predispose patients to sleep disturbances and to advocate for patients in appropriate use of pharmacological modalities that are known to hinder sleep.

References


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