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An adequate amount of high quality sleep is required for optimum physical and psychological functioning. In fact, lack of sleep has been listed as a potential source of harm to a person's health and wellbeing (Pilkington, 2013). The stress and physical effects of acute illness combined with the hospital environment make it difficult for hospitalized patients to receive sufficient amounts of quality sleep. The noise, lights, medications, and frequent patient care activities interfere with patients' ability to fall asleep and stay asleep. For these reasons, sleep deprivation is common in hospitalized patients. It is reported that approximately 75 percent of ICU patients experience "poor" or "very poor" sleep (Kamdar et al., 2016). Sleep deprivation has many negative effects on both the physical and psychological health of the patient. Adverse effects include, but are not limited to, decreased immune function, reduced inspiratory muscle strength, prolonged length of stay, delirium, and increased levels of fatigue, anxiety, and stress.

Since nursing staff has a significant amount of direct interaction with patients, they are in the perfect position to assess for and prevent sleep deprivation. Interventions are often tailored to counteract the conditions that cause sleep disruptions. Nurses are aware of and interested in sleep-promoting interventions. However, frequent required assessment and nursing actions are often barriers to implementation (Eliassen & Hopstock, 2011). The presence of these barriers prevents most institutions from having sleep promotion protocols (Kamdar et al., 2016). This newly gained knowledge will positively shape my personal nursing practice and promote my patients' sleep. The purpose of this paper is to describe normal sleep, tools to measure qualities of sleep, causes of sleep disturbances in the hospital, the physical and psychological effects of sleep deprivation, and nursing interventions that combat the problem. A discussion on the implications of this information on my personal nursing practice will also be included.

Normal Sleep

Sleep, just as eating and drinking, is essential for human survival. It promotes optimum physiologic and psychological function (Delaney, 2016). The human body cannot function without it. Kamdar, Needham, and Collop (2011) define sleep as a “periodic, reversible state of cognitive and sensory disengagement from the external environment” (p. 97). This resting period allows the body to achieve physical and psychological restoration. Normal sleep has certain distinctive characteristics. When a person is sleeping, specific circadian rhythms, sleep architecture patterns, and normal physiologic occur.

Circadian Rhythms

The normal sleep-wake cycle circulates around a 24-hour clock. This “biological clock” is regulated by the suprachiasmatic nucleus of the hypothalamus and the ventolateral preoptic nucleus of the anterior hypothalamus (Delaney, 2016; Pisani et al., 2015). These regulatory processes determine when and how a person sleeps. Kamdar, Needham, and Collop (2011) describe these regulatory centers as Process C and Process S respectively. Process C, or the circadian pacemaker, controls the timing of sleep and wakefulness. It is considered the principle regulatory sleep mechanism (Delaney, 2011; Kamdar, Needham, & Collop, 2011). Process S, the sleep homeostat, regulates sleepiness, sleep onset, and sleep promotion. Adenosine and the diurnal secretion of melatonin by the pineal gland drive Process S (Kamdar, Needham, & Collop, 2011). Zeitbergers, or environmental cues, help maintain the circadian rhythm. Light exposure, social triggers such as meal times, and non-photic cues such as melatonin secretion provide guidance for the induction of and maintenance of sleep (Delaney, 2011).

Sleep Architecture

Normal sleep architecture includes four to six cycles of alternations between two types of sleep. The two types of sleep include non-rapid eye movement (NREM) sleep and rapid eye movement sleep (REM). Each cycle of NREM and REM sleep lasts between 90 and 110 minutes (Delaney, 2016; Kamdar, Needham, & Collop, 2011). NREM sleep is split into three stages: N1, N2, and N3. Stages N1 and N2 are considered light sleep. N1 is the transition stage from wakefulness to sleep (Delaney, 2016). People spend approximately two to five percent of total sleep time in this stage (Kamdar, Needham, & Collop, 2011). Memory consolidation occurs during stage N2, which makes up between 45 and 55 percent of total sleep time. Stage N3 of NREM and REM sleep are the restorative stages of sleep (Delaney, 2016; Kamdar, Needham, & Collop). Stage N3 is the most restful period of sleep. It includes anabolic restoration and the release of growth hormone. Protein synthesis, tissue healing, and physical restoration occur in stage N3 (Delaney, 2016). Between 15 and 20 percent of total sleep time is spent in this stage (Kamdar, Needham, & Collop, 2011). Mental restoration, emotional healing, dreaming, and perceptual learning occur during REM sleep. REM sleep makes up between 20 and 25 percent of total sleep time (Delaney, 2016; Kamdar, Needham, & Collop, 2011).

Sleep Physiology

There are normal physiologic changes that occur in the body while a person is sleeping. These changes occur in all body systems and often vary based on sleep stage. Temperature regulation is diminished or absent based on sleep stage. Temperature sensitivity is decreased during NREM sleep. While body temperature is dependent on the surrounding environment during REM sleep. The body loses compensatory temperature regulation responses such as shivering and sweating while in this stage (Kamdar, Needham, & Collop, 2011). Respiratory

pattern and depth become involuntary during sleep. Each stage of sleep has a distinct respiratory pattern associated with it. Hypoxic and hypercapnic ventilatory drives are also reduced during all stages (Kamdar, Needham, & Collop, 2011). Changes in the cardiovascular system vary between the two stages of sleep. Blood pressure, heart rate, and systemic vascular resistance are all decreased during NREM sleep. Tonic REM sleep is characterized by bradyarrhythmias and sinus pauses, while phasic REM is characterized by an increase in heart rate and blood pressure of up to 35 percent (Kamdar, Needham, & Collop, 2011). In regards to the gastrointestinal system, esophageal motility is reduced, however, contraction of the esophageal sphincter prevents aspiration while voluntary control of swallowing is lost (Kamdar, Needham, & Collop, 2011). Rectal tone is preserved, maintaining bowel control throughout the sleep period. Certain hormones are released during sleep. Their release is significantly affected as a result of sleep deprivation. Thyroid stimulating hormone is inhibited by N3 sleep and increased with sleep deprivation. Changes in the secretion of these hormones cause adverse physical effects. Growth hormone and prolactin, which are necessary for cell differentiation and proliferation, are suppressed during sleep deprivation (Kamdar, Needham, & Collop, 2011). Adequate physical restoration cannot occur without proper secretion of growth hormone and prolactin.

Sleep Measurement Tools

The measurement of sleep can be done either objectively or subjectively. Objective measurement tools include polysomonography, actigraphy, and the bispectral index (Kamdar, Needham, & Collop, 2011). Subjective sleep measurement is done through the completion of surveys. The Richards-Campbell Sleep Questionnaire, the St Mary's Hospital Sleep Questionnaire, and the Verran Snyder-Halpern Sleep Scale are three . Nurses and/or patients are able to complete these surveys (Hoey, Fulbrook, & Douglas, 2014).

Objective Assessment Tools

Polysomonography. The current gold standard for the measurement of sleep is polysomonography (Hoey, Fulbrook, & Douglas, 2014; Kamdar, Needham, & Collop, 2011). Polysomonography is simultaneous recording of an electroencephalogram (EEG), an electromyogram (EMG), and electrooculogram (EOG) (Kamdar, Needham, & Collop, 2011). These monitoring systems track brain waves, muscle activity, and cardio-respiratory activity. This information is used to determine sleep onset, measure sleep duration, describe sleep architecture, and record the number and timing of awakenings (Hoey, Fulbrook, & Douglas, 2014). Although polysomonography is extremely accurate and reliable, it is expensive, takes up a significant amount of space, and requires specially trained personnel to operate it. Therefore, polysomonography use is often restricted to research purposes.

Actigraphy. Actigraphy uses motion data to estimate sleep-wake periods and sleep efficiency. It is a wristwatch that monitors patient motion. It is a low cost and minimally invasive sleep measurement tool. However, it has been found to overestimate total sleep time due to its inability to distinguish between true sleep and motionless wake periods (Kamdar, Needham, & Collop, 2011).

Bispectral Index. The bispectral index is a score on a scale of 0-100. It is determined based on the patient's measured level of consciousness. A single foam sensor containing several EEG electrodes is used to measure the patient's level of consciousness. Sleep-wake periods, sleep efficiency, and sleep depth can be measured using the bispectral index. Limitations of this assessment tool include electrode detachment and artifact due to movement. As a result, sleep architecture can be inaccurately characterized (Kamdar, Needham, & Collop, 2011).

Subjective Surveys

Subjective surveys require the input of the patient and/or the provider regarding various characteristics of sleep. There are many subjective assessment options available as they are often designed for specific patient populations. Hoey, Fulbrook, & Douglas (2014) found the Richards-Campbell Sleep Questionnaire, the St Mary's Hospital Sleep Questionnaire, and the Verran Snyder-Halpern Sleep scale to be the most appropriate subjective surveys for use in a hospital setting.

Richards-Campbell Sleep Questionnaire. The Richards-Campbell Sleep Questionnaire is a 5-item questionnaire set on a zero to ten visual analogue scale. The scale reports the patient's perception of their sleep the previous night. This questionnaire takes approximately 2 minutes to complete and can be done by either the patient or the care provider. Through research, the questionnaire has demonstrated strong correlation with measurements of deep sleep, stage N2 sleep, and REM sleep. The Richards-Campbell Sleep Questionnaire has reliability coefficient of 0.90-0.92 (Hoey, Fulbrook, & Douglas, 2014). Although it has thus far had limited application beyond the critical care setting, Hoey, Fulbrook, and Douglas (2014) believe it is the best subjective assessment tool for the acute care setting. It is brief, easy to use, and has demonstrated reliability and validity. Nurse-patient interreliability of this questionnaire was found to be only "slight" to "moderate" by Kamdar et al. (2012). This indicates that nurses overestimate the sleep quality and quantity of their patients. The use of the tool exclusively by the care provider to assess sleep is strongly cautioned.

St Mary's Hospital Sleep Questionnaire. The St Mary's Hospital Sleep Questionnaire is a 14-iten questionnaire including both scaled and open response items. It captures sleep onset, length, and awakenings. Scoring is not standardized. Therefore, reliability ranges from .70 to

.96 (Hoey, Fulbrook, & Douglas, 2014). The St Mary's Hospital Sleep Questionnaire results should be used exclusively to assess sleep characteristics.

Verran Snyder-Halpern Sleep Scale. The Verran Snyder-Halpern Sleep Scale is a 14-item questionnaire. Each response receives a score ranging from zero to 100. It was originally eight items, however six items were added. It takes between ten and 15 minutes to complete. The scale was originally validated in healthy adults, but has shown little correlation between the Verran Snyder-Halpern Sleep Scale and polysomonography (Hoey, Fulbrook, & Douglas, 2014). Just as with the St Mary's Hospital Sleep Questionnaire, the Verran Snyder-Halpern Sleep Scale should not be exclusively used to assess sleep characteristics.

Causes of Sleep Deprivation

The hospital environment is a challenging place to sleep. Patients sleep lighter and for a decreased amount of time while in the hospital. Less than 50 percent of sleep occurs during the normal nighttime hours (Bernhofer, Daly, Burant, & Hornick, 2013). The noise, lights, patient care activities, medications, pain, and other factors make it difficult for patients to fall asleep and stay asleep. Therefore, sleep deprivation is a common problem in hospitalized patients.

Noise

Environmental noise is a common problem in the hospital setting. Distracting noises come from a variety of sources around the unit. Patients commonly report noise as a main source of their sleep disturbances (Kamdar, Needham, & Collop, 2011). The combination of staff conversations, various alarms, ventilators, overhead pages, televisions, and telephones creates a relatively loud environment (Kamdar, Needham, & Collop, 2011; Pilkington, 2013; Pisani et al., 2015). Nocturnal noise levels range from 50 to 60 dB in the ICU and between 40 and 55dB in a general unit (Delaney, 2016). Noise levels this high cause sleep disruptions for

patients staying on the unit. This reported noise level exceeds both the Environmental Protection Agency (EPA) and World Health Organization's (WHO) guidelines (Delaney, 2016; Kamdar, Needham, & Collop, 2011; Pilkington, 2013). The EPA recommends a maximum noise level of 45 dB during the day and 35 dB at night (Kamdar, Needham, & Collop, 2011). The WHO suggests and even quieter environment with a recommended maximum noise level of 30 dB (Delaney, 2016). This quiet environment allows patients to fall and stay asleep. Kamdar, Needham, and Collop (2011) found that between 11 and 18 percent of arousals and between 17 and 24 percent of awakenings could be attributed to noise alone.

Light

Light is another common source of sleep disruption for the hospitalized patient. Both excessive amounts of light and the absence of natural light can cause sleep disruption. Bright light is often required for adequate patient assessment and the performance of patient care activities and procedures. The excessive amount of bright light prevents patients from falling and staying asleep. Kamdar, Needham, & Collop (2011) found that nocturnal light levels ranged from 128 lux to 1445 lux. This level is below the 1500 lux required to awake a person from sleep, but over the level required to suppress melatonin secretion. Melatonin secretion is important for sleep induction. By restricting the amount of light a patient is exposed to, circadian rhythms are disrupted. A distinct difference between nighttime and daytime light levels is required for the maintenance of circadian rhythms. Bernhofer et al. (2013) found light exposure in hospitals to be inversely associated with fatigue and mood. It was also found to be insufficient for circadian rhythm maintenance. Low light exposure is a predictor of fatigue, a compounding factor of sleep deprivation (Berhofer et al., 2013).

Patient Care Activities

Nurses provide patient care around the clock. Patient assessment, vital signs, equipment adjustment, medication administration, radiography, and wound care need to be completed at certain times (Kamdar, Needham, & Collop, 2011). In an ICU setting, focused nursing assessments are required hourly, while head-to-toe assessments are required as often as every other hour. Patients confined to a bed need to be repositioned at least every two hours in order to prevent the formation of pressure sores. These frequent nurse-patient interactions prevent patients from obtaining a full night of uninterrupted sleep. In order to reach the restorative stages of sleep, stage N3 and REM, patients must complete the 90 to 110 minute sleep cycle. Hospitalized patients do not reach the restorative stages of sleep due to patient care activities. Kamdar, Needham, and Collop (2011) found that patients experience between 40 and 60 interruptions each night. This accounted for seven percent of sleep arousals and 18 percent of awakenings.

Medications

Some medications, such as benzodiazepines and opioids, cause disruptions in the sleep cycle, contributing to patients’ sleep deprivation (Kamdar et al., 2016). Even at low doses, benzodiazepines increase stage N2 sleep and reduce the amount of time spent in N3 sleep. Stage N2 is a lighter stage sleep, while stage N3 is a deeper, restorative sleep stage. Opioids promote sleep onset, however, they inhibit the restorative stages of sleep, N3 and REM, provoke nocturnal awakenings, and precipitate central apnea (Kamdar, Needham, & Collop, 2011). It is important for patients to experience maximum amounts of stage N3 and REM sleep to promote proper healing. In addition to disrupting the sleep cycle, benzodiazepines and opioids are associated with ICU delirium (Kamdar, Needham, & Collop, 2011).

Pain

Pain is another significant contributor to patient awakenings (Kamdar, Needham, & Collop). Pain causes disruptions in sleep architecture by decreasing the amount of time spent in the restorative stages (Pilkington, 2013). Pilkington (2013) described sleep and pain as a self-perpetuating cycle in which they have adverse effects on each other. As patients become more sleep deprived, they experienced more pain. As they experienced more pain, they sleep even less. Poor sleep was also linked to higher pain levels through out the next day (Pilkington, 2013). Untreated and uncontrolled pain contribute to patients' sleep deprivation.

Mechanical Ventilation

Patients who are mechanically ventilated experience more fragmented sleep, reduced sleep efficiency, increased daytime sleep, and sleep deprivation (Kamdar, Needham, & Collop, 2011). This occurs as a result of increased discomfort, more frequent alarms, suctioning, positioning, and assessment. Mechanically ventilated patients with sleep deprivation experience increased ventilatory effort, abnormal gas exchange, and patient-ventilator dysynchrony (Kamdar, Needham, & Collop, 2011). Patients requiring mechanical ventilation have a significant amount of healing to do, however the physical restoration that occurs during sleep does not occur when patients are sleep deprived.

Other

While hospitalized, many patients experience a lack of social cues for the induction of sleep (Delaney, 2016). The lack of social cues, such as meal times, leads to alterations in circadian rhythms and sleep deprivation. Anxiety and stress caused by an unfamiliar environment, inability to speak, or illness cause disruptions in sleep architecture (Kamdar, Needham, & Collop, 2011; Pilkington, 2013). As with other disruptions of sleep architecture,

patients with anxiety and stress spend less time in stage N3 sleep and REM, the restorative stages of sleep.

Effects of Sleep Deprivation

Sleep is a restorative body process. Protein synthesis, tissue healing, physical and mental restoration, emotional healing, and perceptual learning all occur while a person is asleep. When the body is deprived of sleep and this restorative process is interrupted, the body suffers. There are negative effects on both physiologic and psychological functioning.

Physical Effects

All systems of the body are affected by sleep deprivation. The body initiates a stress response as a result of increased secretion of inflammatory markers (Delaney, 2016; Hoey, Fulbrook, & Douglas, 2014; Pilkington, 2013). This stress response negatively affects immune function and activates the HPA access, leading to the release of catecholamines and cortisol (Delaney, 2016). The immune system experiences a decrease in t-helper and natural killer cell function coupled with an increase in the number of leukocytes and monocytes. This disruption of the normal cell distribution causes an increase in susceptibility to opportunistic infections and an impaired ability to fight acquired infections (Delaney, 2016; Kamdar, Needham, & Collop, 2011; Pilkington, 2013). Patients who experience sleep deprivation have an increased length of stay, longer antibiotic therapy, and have an increased risk of death from septicemia (Kamdar, Needham, & Collop, 2011).

Elevated levels of catecholamines adversely affect both cardiovascular and endocrine functioning. Elevated catecholamins result in heart rate and blood pressure lability and an increased risk of myocardial infarction (Delaney, 2016; Kamdar, Needham, & Collop, 2011). The increased catecholamine secretion adversely affects the activity of anti-inflammatory

cytokines (Delaney, 2016). The body enters a catabolic state with increased carbohydrate metabolism (Delaney, 2016; Hoey, Fulbrook, & Douglas, 2014; Kamdar, Needham, & Collop, 2011). This results in insulin resistance, decreased glucose clearance and regulation, and increased oxygen consumption (Delaney, 2016; Kamdar, Needham, & Collop, 2011). Insulin secretion is also decreased (Kamdar, Needham, & Collop, 2011).

The respiratory system is also significantly affected by sleep deprivation, especially in patients with preexisting pulmonary condition (Hoey, Fulbrook, & Douglas, 2014; Kamdar, Needham, & Collop, 2011). Patients experience reduced inspiratory muscle strength, decreased responsiveness to hypoxic and hypercapnic states, and decreased FEV1 and FVC measures (Delaney, 2016). The detrimental effects on sleep deprivation on all the body systems can be long lasting. Patients who experience sleep deprivation through out their hospital stay have increased 1-year mortality rates (Hoey, Fulbrook, & Douglas, 2014).

Psychological Effects

Sleep deprivation negatively affects psychological functioning. Patient who experience sleep deprivation show increased levels of fatigue, anxiety, stress, and depressive symptoms (Kamdar, Needham, & Collop, 2011). In addition, pain and fatigue are positively associated (Bernhofer et al., 2013). As patients experience more fatigue and sleep deprivation, they report higher levels of pain. There is a also correlation between sleep deprivation and delirium. This is associated with an increased length of stay, long-term decline in cognitive functioning, and increased patient mortality (Delaney, 2016). Some patients that experience sleep deprivation may develop post-ICU psychiatric disorders as a result (Kamdar, Needham, & Collop, 2011). Executive functioning and health-related quality of life measures are also affected. Patients experience decreased attention levels, short-term memory loss, and decreased reaction time.

Health-related quality of life measures that are negatively affected include overall wellbeing, physical, mental, emotional and social measures (Kamdar, Needham, & Collop, 2011).

Interventions

Sleep promotion interventions are designed to minimize sleep disruptions and maintain the normal sleep-wake cycle. Interventions are tailored to counteract the common causes of sleep disruptions. Controlling environmental noise and light are two simple ways for nurses to decrease sleep disruptions. Requesting the staff lower their voices, customizing alarm settings for each patient, offering earplugs, and installing noise-absorbing tiles and curtains can decrease the noise level throughout the hospital. (Delaney, 2016; Kamdar, Needham, & Collop, 2011). Light interventions have two components; eliminating unnecessary light and allowing enough light exposure to maintain the sleep-wake cycle. Throughout the night and during resting periods, lights should be dimmed and unnecessary light should be eliminated. Nurses can offer eye masks to patients if environmental light reduction is not realistic. However, it is also important for patients to have enough light exposure to maintain circadian rhythms. Pilkington (2013) recommends a diurnal light schedule in which lights are brighter during the day and significantly dimmed at night. The maintenance of social cues such as meal times and ensuring that patients are able to see a clock also help maintain circadian rhythms (Delaney, 2016).

Since patient care activities must occur during all hours, it is important for nurses to plan care in clusters. Doing care in clusters allows for patients to have uninterrupted periods of sleep (Delaney, 2016; Eliassen & Hopstock, 2011; Kamdar, Needham, & Collop, 2011). Recall that each sleep cycle takes between 90 and 110 minutes, with the restorative stages occurring later in the cycle. In order for patients to reach the restorative stages of sleep, they must be allowed prolonged periods of uninterrupted sleep. Patient sleep is also enhanced when their comfort is

ensured. Nurses need to ensure that the patient is comfortable in bed, has their pain under control, and has their emotional needs addressed (Eliassen & Hopstock, 2011). Medications such as opioids and benzodiazepines should be used with caution and according to guidelines given their effect on sleep architecture (Kamdar, Needham, & Collop, 2011).

Su et al. (2012) found that playing 45 minutes of non-commercial music at nocturnal sleep time improved sleep quality as well as some physiologic characteristics. Patients in the experimental group experienced longer stage N3 sleep and had a lowered mean arterial pressure, respiratory rate, and heat rate. This is a simple intervention that can be applied if patients are experiencing sleep deprivation regardless of environmental factors.

Effects on My Future Personal Practice

After completing this research, I am more aware of the prevalence of sleep deprivation in hospitalized patients, sleep assessment techniques, the common causes of sleep disruptions, the detrimental effects of sleep deprivation, and interventions I can personally implement to promote patient sleep. The noise, lights, medications, and frequent patient care activities make it challenging for patients to fall asleep and stay asleep. Therefore, sleep deprivation is extremely common in hospitalized patients. Both objective and subjective assessment techniques are currently available to determine patients sleep characteristics. The detrimental physical and psychological effects of sleep deprivation can and should be prevented. This can be done by assessing for the presence of sleep deprivation, evaluating the causes, and implementing interventions to fix the problem.

Following graduation, I will be working as a registered nurse in the pediatric intensive care unit at Helen DeVos Children's hospital. I intend to assess my patients for sleep deprivation using the Richards-Campbell Sleep questionnaire. Although this questionnaire has been shown

to overestimate sleep quality when completed solely by the nurse, it is the best quick assessment tool available. Regardless of whether patients are experiencing sleep deprivation at the time of assessment, I plan to implement sleep promotion interventions to prevent the development of sleep deprivation. I will control environmental noise and light while still providing a diurnal environment, cluster patient care activities, and ensure each patient is comfortable and pain free. By implementing these simple interventions, my patients will not be one of the 75 percent of ICU patients that experience sleep deprivation while hospitalized. They will hopefully be able to avoid the adverse short and long term effects sleep deprivation causes.

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