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Hemodynamics Changes in the Phase Before, During, and After Sleep Based on Patients' Sleep Quality in High Care Unit

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Abstract

BACKGROUND: Sleep is a human physiological need that must be fulfilled. Sleep disturbance is generally experienced by hospitalized patients and measured by sleep quality. Sleep disturbance can adversely affect hemodynamic parameters, physiological, and psychological outcome that contribute to the healing of patients. However, few literatures discussing the hemodynamic changes based on the patients' sleep quality.

AIM: The study aimed to describe the hemodynamic changes before, during, and after sleeping phases

METHODS: This is an observational analytic quantitative study conducted between February and March 2019 and involved 45 patients. The samples were the conscious patients, aged between 18 and 60 years old (adult) and had been hospitalized for more than 2 days. The Richards-Campbell Sleep Questionnaire was utilized to measure the patients sleep quality, while hemodynamic values were observed by patients' bedside monitor before, during and after sleep. Data analysis used the Friedman test to determine hemodynamic changes.

RESULTS: The results showed that most respondents were female (75.6%), used oxygen (46.7%), sleep in supine position (55.6%), and average age of 35.47 (standard deviation [SD] = 9.581) years old. Patients' sleep quality score was 44.27 (SD = 22.809), with the average days of treatment were 2.47 days (SD = 694). The average score of Hemodynamic Mean Arterial Pressure (MAP), Heart Rate (HR), and Oxygen saturation (SpO_2) before sleeping was 97.64, 94.04, and 94.09, during sleeping was 89.87, 85.00, and 91.22 while after sleeping was 98.27, 97.56, and 97.89, respectively. There was a significant change in HR with p = 0.019, and there was no significant change in the MAP (p = 0.152) and SpO_2 (p = 0.149)

CONCLUSION: There were variations in hemodynamic score changes before, during, and after sleep, changes in MAP, HR, and SpO_2 score within normal ranges. The high hemodynamic changes in the early phase, decrease during sleep, and rise again after sleep. HR is a hemodynamic parameter that significantly changes in those three phases. Monitoring of hemodynamic values in patients could be carried out in the before, during, and after sleep phases to determine the patients' physiological and psychological condition so as to contribute the healing process.

Introduction

Sleep is a human physiological need that must be fulfilled. Lack of fulfillment of sleep rest is a common patient's health problem that appears during hospitalization. This condition is associated with changes in lifestyle behavior and the incidence of sleep disorders such as insomnia, obstructive sleep apnea (OSA) and neurological disorders. The short duration of sleep in patients and an increased incidence of cardiovascular disease occurs through activation of the autonomic nervous control changes, changes in inflammatory responses, or increases in oxidative stress [1], [2], [3]. Abnormal sleep can increase sympathetic activity, blood pressure, and heart rate (HR) [4], [5]. The increased risk of hypertension, diabetes mellitus, obesity, depression, a heart attack, and stroke is a consequence of losing sleep in chronic [4]. If sleep is disturbed, there will be no decrease in blood pressure during sleep which will increase the risk of hypertension and lead to cardiovascular disease [6]. People with sleep deprivation tend to have a higher systolic and diastolic blood pressure than those with normal sleep [7]. Changing hemodynamic parameters in patients with poor sleep quality are influenced by blood pressure and total sleep deprivation. The results of Slomko's research [8] show that the pre-hypertension and hypertension study group experienced a decrease in blood pressure. It is recommended that monitoring and interpretation of hemodynamics are essential components of critical care of ill patients [9]. The rapid parameter of assessing the patients' tissue perfusion is through the assessment of hemodynamic value of HR and Mean Arterial Pressure (MAP) [10].

Triyanta and Susi [11] study of the correlation between sleep quality and HR discovers the good sleep quality of 26.47%, moderate sleep quality of 29.41%, and poor sleep quality of 44.12% from the total sample size. There are 12 respondents with tachycardia, 18 respondents with normal condition and bradycardia with four respondents. Based on the description of electrocardiography (ECG) results in patients with myocardial infarct, it shows that there is a significant correlation between HR and sleep quality. The results of Desiani (2018) state that there is a correlation between sleep quality and hemodynamic status (MAP, HR, and respiration) in AMI patients. Jevon and Ewnes [9] state that there are several factors affecting the hemodynamic status in the intensive room, one of which is drugs/therapy such as analgesics and sedation. Several previous research mentions that the quality of sleep of patients in intensive and high care is influenced by noise, discomfort, pain, nursing procedures, medical equipment, anxiety, room brightness[12], [13], [14], [15], and also sleeping position [16].

Furthermore, the literature review result related to sleep quality and metabolic syndrome (MetS) mentions that the overall human sleep pattern and quality are significantly associated with MetS, including sleep complaints, sleep difficulties, difficulty maintaining, and inefficiency [17]. HR and blood pressure are significantly increased in people with poor sleep quality compared to people with normal sleep. The linear regression model for age, sex, and body mass index is the independent predictors of HR and sleep quality [18]. The previous researches have focused on analyzing the correlation between sleep quality and hemodynamics and their characteristics, both in health and illness. However, none have examined the description of changes in hemodynamic values in the sleep phase of patients. This research focuses on analyzing the descriptions and the changes in patients' hemodynamic index in the phases before, during, and after sleep associated with the patient's sleep quality. This research is important as the basis for evaluation and fulfillment of the patients' sleep needs during the treatment at High Care Unit of the Hospital.

Methods

This was an observational analytic descriptive quantitative research which involved 45 patients with consecutive sampling technique and conducted from February to March 2019. The samples were fully conscious patients, aged between 18 and 60 years old (adult) and had been hospitalized for more than 2 days. The quality of sleep was measured by Richards Campbell Sleep Questionnaire with the range score 0–100 and the higher score the better it is. Meanwhile, the hemodynamic values were observed through each patient's bedside monitor. The observation of hemodynamic values (MAP, HR, and SpO_2) was documented 3rd times that time before (07.00 pm), at (01.00 am), and after sleep (05.00 am) by two nurses in the High Care Unit of RS Prof. Dr Margono Soekardjo hospital. Descriptive analysis and Friedman test were implemented to analyze the data, to see the change of hemodynamic indices before, during, and after sleep and to describe the characteristic of respondent, and quality of sleep patients.

Results

The findings illustrated that most respondents were female (75.6%), used oxygen (46.7%), sleep in supine position (55.6%), and average age of 35.47 (standard deviation [SD] = 9.581) years old. Patients' sleep quality score was 44.27 (SD = 14.408), with the average days of treatment was 2.47 days (SD = 22.809) (Table 1). In the group of patients with very good and good sleep quality, changes in hemodynamic score (MAP, HR, and SpO2) increased in the before sleep condition, decreased during sleep, and returned to rise after sleep. However, the MAP score in the good sleep quality group was slightly different in that there was a decrease when the patient sleept and woke up. In poor sleep quality group, changes in the hemodynamic score were the same; an increase in the hemodynamic score at bedtime, a decrease during sleep, and an increase after sleep. Indeed, the group with very poor sleep quality showed a decrease in the HR score starting at sleep and waking up in the morning. The saturation score was also similar in that there was a decrease but unsignificant. Meanwhile, the MAP score decreased during sleep and increased after sleep in the morning (Table 2).

Table 1: Characteristics of respondents at HCU (n=45)

Characteristics	n (%)	Mean (SD)
Age		35.47 (9.581)
Hospitalization time		2.47 (22.809)
Sleep quality		44.27 (14.408)
Sex		
Female	34 (75.6)	
Male	11 (24.4)	
Use of oxygen		
Installed	21 (46.7)	
Not installed	24 (13.3)	
Sleeping position		
Supine	25 (55.6)	
Semi fowler	20 (44.4)	
Medical diagnosis		
Post SC	10 (22.2)	
Preeclampsia	11 (24.4)	
Congestive heart failure	5 (11.1)	
Hypertension	6 (13.3)	
Asthma	6 (13.3)	
Ketoacidosis diabetic	2 (4.4)	
Stroke	3 (6.6)	
Shock	2 (4.4)	
Quality of sleep		
Very good	10 (22.2)	
Good	16 (35.6)	
Poor	13 (28.9)	
Very poor	6 (13.3)	

Based on Table 3, it showed the p values of the bivariate analysis; the MAP variable (0.152), HR (0.019), and SpO2 (0.149). Unlike the MAP and SpO2 values, the HR value indicated a significant change.

Table 2: The hemodynamic changes in HCU patients

Sleep Quality	HR			SpO_2			MAP		
	Before sleep	During sleep	After sleep	Before sleep	During sleep	After sleep	Before sleep	During sleep	After sleep
Very good									
Mean	91.20	90.00	93.70	98.20	98.30	98.70	96.20	88.70	90.30
SD	19.22	17.53	13.72	1.87	2.26	1.25	19.08	16.63	15.73
Min-Max	63–121	68–119	74–112	95–100	93–100	96–100	68–132	67–122	75–114
Good									
Mean	89.75	83.50	85.44	98.44	97.75	97.94	97.19	97.06	86.12
SD	15.190	16.661	10.159	1.896	2.206	1.982	13.712	16.254	25.340
Min–Max	69–128	58–119	66–98	94–100	93–100	93–100	82–128	58–120	11–122
Poor									
Mean	88.00	85.38	94.23	98.00	96.92	97.62	98.92	96.23	96.69
SD	18.430	14.774	20.612	2.582	3.303	2.873	10.626	11.620	20.544
Min–Max	63–117	58–119	73–135	93–100	92–100	93–100	85–121	80–119	69–132
Very poor									
Mean	92.67	87.33	96.00	98.50	97.17	97.00	100.83	90.17	99.50
SD	20.630	26.090	17.390	1.517	1.472	2.828	16.216	8.44	20.66
Min–Max	63–123	65–121	67–115	96–100	95–99	92–100	83–121	79–101	80–126

Discussion

The results discovered that the average patient sleep quality was in the poor range, proven from the mean (SD) score. Based on its category, there were 13 patients with poor quality and six patients with very poor quality. These study findings were in line with the previous research which stated that the sleep quality of hospitalized patients tended to be poor. Subgroup and meta-regression analysis revealed that the patients in the hospital obtained poor sleep quality than patients in the community, especially for hypertensive patients or 52% [19]. Moreover, it was mentioned that women with sleep deprivation and then 5 h sleep or less had higher compared man. Longer or shorter period of sleep could be risk factor for high blood pressure, especially in women [20]. Patients who slept longer were likely not to do physical activities and associated with hypertension. Hypertensive patients significantly showed worse scores of sleep quality than those without hypertension [7]. Internal and external factors could cause the condition of poor sleep quality in the patients. This MetS is associated with the difficulty of falling asleep, sleep management, and sleep efficiency [17].

Table 3: Bivariate analysis of hemodynamic changes before, during, and after sleep

Variable	Time	n	Mean (SD)	Median(Mix–Max)	p value
MAP	Before	45	97.96 (14.198)	96 (68–132)	0.152
	During		94.04 (14.313)	97 (58–122)	
	After		94.09 (17.340)	92 (59–132)	
HR	Before	45	89.87 (17.242)	87 (63–128)	0.019
	During		85.00 (17.339)	83 (58–121)	
	After		91.22 (15.598)	99 (93–100)	
SpO_2	Before	45	98.27 (2.016)	99 (93–100)	0.149
	During		97.56 (2.491)	98 (92–100)	
	After		97.89 (2.259)	98 (92–100)	

The patients' sleep stage was affected by the temperature, drug, age, circadian rhythm diseases, and homeostasis. Moreover, the secretion of the hormone melatonin also influenced sleep quality [21]. Treatment toward patients could also affect the quality of sleep as most of patients obtained analgesics to reduce pain, including anti-inflammatory drugs which could cause negative effects, wakefulness at night, decreased sleep efficiency, and also cardiovascular and respiratory drugs [22], [23]. Age, sex, and body mass index were also cited as independent predictors of HR and sleep quality [18]. Decreased sleep quality in critical patients or inpatients was a common problem with various causes, including age, noise, pain, light, medication action, and installation of medical equipment [24]. Patients treated before and after surgery were reported not to get adequate rest due to the low levels of sleep quality [25]. Furthermore, the results of the research of Kita *et al*. [26] revealed that 5 h or less duration of sleep to 7 h or more showed a risk of developing diabetes, 5.37 (1.38–20.91) times without any diabetes mellitus history.

Patients treated in HCU room included general and maternal patients, they are categorized as patients who are not critical but require a high level of care, even though the patients had been treated for at 2 days, the average sleep quality was poor. This could also be due to adaptation to the condition of hospitalization, medication, and new environment. Regarding hemodynamic value, the changes were still within the normal ranges, because the patients had passed the critical phase and were in the process of recovery and treatment so that the patients' hemodynamic changes could be controlled by the therapy treatment. The increase in systolic and diastolic pressures in patients with ischemic and hemorrhagic strokes peaked at 04.00, systolic decreased at 20.00, and diastolic decreased earlier, at 08.00. However, the HR did not change significantly compared to normal patterns. In general, the circadian rhythm returned to normal after a stroke had passed the acute period [27]. It was known that most of the research respondents were hypertensive and there were stroke patients.

The research showed that from the interview results with most patients, they stated that their sleep was disturbed because of the new hospital environment and needed an adaptation and adjustment. They often woke up mainly due to discomfort and pain, especially for maternal patients. Related research stated that the sleep quality of patients treated in the intensive room was different from the 1st day and the next day. On the 1st day, sleep disturbances were caused by exposure to light, noise, and maintenance activities such as room temperature, being in a different place, tightness, procedures, and visitors. On the 3rd day, the major sleep disorders were pain, light, noise, and maintenance activities. The environment was a fairly important factor in the quality of sleep for patients, but pain dominated its effect on decreased sleep quality [28].

Based on the research results, it could be seen that the HR value was significantly (p = 0.019) change from the three phases, but MAP and SpO2 were not. The changes of HR values could be associated with the patients' sleep quality, but these changes were still in the normal range (HR: 70–110). The results of this study strengthen the statement of previous studies that there was a correlation between HR and sleep quality from the ECG images of patients [11]. Furthermore, it was also stated that poor sleep quality had a negative impact on the HR variable, HR, HR and blood pressure (Sajjadjeh, *et al*, 2020). HR would decrease during sleep, HR was affected by the body's circadian temperature, sleep phases, body movements, and wakefulness. During the non-rapid eye movement (NREM) stage during sleep, the parasympathetic innervation was more active and the cardiovascular system was stable, whereas during the rapid eye movement (REM) stage, the cardiovascular system was greatly affected by the sympathetic system [29], [30]. In the REM sleep phase, the value of HR increased generally depending on the autonomic activity of each patient, human's sleep was also related to the decrease of HR, BP, and sympathetic activity increased parasympathetic activity [31].

The changes of MAP value were not significant (p = 0.152) in the before, during and after sleep phases, this could be due to the different respondents, namely, general and maternal patients, gender, and type of disease including the type of treatment. Furthermore, the oxygen saturation value did not significantly change in these three phases (p = 0.149), this was because most of them use oxygen therapy so that the observation results showed good oxygen saturation. This condition could be seen from the average value of oxygen saturation in each phase that was not significantly different.

A total of 21 respondents in this research used oxygen therapy from the nasal cannula to NRM; it showed that the saturation oxygen score was in normal value because of the support of oxygen therapy. This might be caused by the fact that some of the patients were maternal patients with severe preeclampsia problems. Therefore, there were disorders related to pregnancy and also the postoperative process. Prospective observational study used polysmnography discovered that the sleep breathing disorder in the third trimester between 17 and 45% [32]. Oxygen therapy could significantly restore oxygen saturation from mild hypoxic to normal conditions [33]. Therefore, it was necessary to review the suitability of the inhalation aid instrument and the dosage for each patient. Poor sleep quality experienced by post-SC patients was caused by several factors, such as pain, an uncomfortable environment, and cardiovascular anxiety [34] due to several factors of anxiety and pain. Anxiety and sleep disturbance were experienced by almost all patients undergoing surgery, including patients with spinal and general anesthesia [35].

The semi fowler sleep position affected to the increased oxygen saturation. It improved lung expansion and the efficiency of the respiratory muscles as well as widening the airway. As a result, it could increase oxygen inspiration so that the oxygen needed by the body was fulfilled and the measurement of oxygen saturation was increased [4]. Furthermore, Sulistyowati [16] stated that 30–45° sleeping position resulted to good sleep quality and did not have any negative effect on changes in blood pressure. Research conducted by Kusumawati [37] stated that asthma patients with a semi fowler position could improve sleep quality and also impacted on the breathing stability pattern in hospitalized asthmatic patients [38]. For heart failure patients, a semi fowler position with 45° angle could reduce the risk of sleep disorders and apnea [39]. Uncontrolled asthma contributed to poor sleep quality due to the effect of circadian rhythms so that it was difficult in initiating sleep and occurred nocturnal symptoms [4].

The result of this research strengthened previous studies which stated that patients treated in hospital and showed poor sleep quality tended to experience changes in HR pressure [18]. In addition, it was stated that sleep quality (PSQI) was an independent predictor ($p < 0.05$) for central HR pressure ($\beta = 0.469$) and augmentation ($\beta = 0.364$). The main respiratory disorder associated with oxygen desaturation was hypoventilation. The awakening of the patient at night was associated with oxygenation during sleep, thus the worse the patient's arterial oxygenation during the night, the more disturbed his sleep was. The previous studies had presented an association between the incidence risk and severity of hypertension with the degree of OSA [6]. Age would increase OSA patients [40]. The occurrence to this condition was high in coronary artery diseases, diabetes mellitus [41], and also stroke patients [42]. NREM sleep architecture and REM sleep in the form of variations in brain waves, eye movement, and the muscle tones, sleep stages including pattern and changes were affected by the autonomic activity of the cardiovascular and the central nervous system. Physiological expressions of sleep fragmentation, intermittent hypoxia and sleep disturbances were also associated with stimuli of sympathetic activity. This condition described the physiological changes in sleep disturbance in patients with cardiovascular disease. Furthermore, the sleep disorder could change the control of glucose and lipid metabolism in patients [43].

The research data show that there were variations in the changes of hemodynamic value in before, during, and after waking up in each category of patients into good, very good, poor, and very poor. In general, the mean of MAP, HR, and SpO_2 was still in the normal range before going to sleep but it decreased during and after sleep. The rhythm of circadian determined the values change of hemodynamic, especially when the body temperature increased, the people would awake and they got back to sleep when the body temperature at the lowest [44]. The limitation of this research is the limited number and inhomogeneity of the samples recruitment included general and maternal patients. It is necessary to develop correlational research by involving more homogeneous samples and paying attention to confounding variables.

Conclusion

There are variations in hemodynamic score changes before, during, and after sleep. The changes of HR and SpO_2 are within normal ranges. HR is a hemodynamic parameter that significantly changes in those three phases. Monitoring of hemodynamic values in patients could be carried out in the before, during, and after sleep phases to determine the patients' physiological and psychological condition so as to contribute the healing process.

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Ethics Approval and Consent to Participate

The ethical clearance of research was obtained from Prof. Dr Margono Sokerjo hospital ethics commission (No: 420/004349/I/2019). Informed written consent was obtained from all of the participants.

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