Factors Related to Sleep Duration and Night Waking in Hospitalized Infants with Cyanotic Congenital Heart Disease

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Abstract:

This study aims to describe factors related to sleep duration and night waking in infants aged 6-12 months old with cyanotic congenital heart disease (CCHD) who were admitted to a pediatric cardiology ward at a tertiary hospital between December 2019 and September 2021. Data were obtained using the Demographic Data Record Form, Sleep-related Factors Questionnaires (the severity of heart failure, temperament, and caregiving activity), and the Infants' Sleep-wake States Record Form. The record forms were assessed using video recording of the infants during 24 hours, and the data were then analyzed using descriptive statistics, the Pearson product-moment correlation coefficient, and Spearman's rho correlation. The results revealed that most hospitalized infants with CCHD had a mean total sleep duration during the 24 hours of 770.44 minutes. The average number of night waking was 14.26 times/night. According to the correlation analysis, the severity of heart failure did not show a statistically significant correlation with sleep duration or night waking. Temperament was moderately and significantly correlated with sleep duration but not with night waking. Caregiving activities were moderately and significantly correlated with sleep duration and night waking. These results demonstrate that nurses and healthcare professionals should be aware of sleep problems in infants with cyanotic congenital heart disease and plan interventions to manage sleep disturbance to ensure good sleep quality.

Keywords: Congenital heart disease in infants, Cyanotic congenital heart disease, Night waking, Sleep duration

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ปัจจัยที่สัมพันธ์กับระยะเวลาการนอนหลับและการตื่นตอนกลางคืนในทารกโรคหัวใจพิการแต่กำเนิดชนิดเขียวที่เข้ารับการรักษาในโรงพยาบาล

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บทคัดย่อ :

การวิจัยพรรณนานี้มีวัตถุประสงค์เพื่อศึกษาระยะเวลาการนอนหลับและการตื่นตอนกลางคืนรวมถึงปัจจัยที่เกี่ยวข้องของทารกโรคหัวใจพิการแต่กำเนิดชนิดเขียวอายุ 6-12 เดือนที่เข้ารับการรักษาในหอผู้ป่วยเด็กโรคหัวใจ โรงพยาบาลระดับตติยภูมิแห่งหนึ่ง ระหว่างเดือนธันวาคม 2562 ถึง กันยายน 2564 เครื่องมือที่ใช้ในการวิจัย ได้แก่ แบบบันทึกข้อมูลส่วนบุคคล แบบสอบถามปัจจัยที่สัมพันธ์กับการนอนหลับ (ความรุนแรงของภาวะหัวใจวายในเด็ก พื้นฐานทางอารมณ์ และกิจกรรมการดูแล) และแบบประเมินพฤติกรรมการหลับตื่นของทารก โดยบันทึกวิดีโอเป็นระยะเวลา 24 ชั่วโมง วิเคราะห์ข้อมูลด้วยสถิติเชิงพรรณนาและวิเคราะห์ความสัมพันธ์โดยใช้สถิติสหสัมพันธ์เพียร์สัน และสหสัมพันธ์แบบสเปียร์แมน ผลการศึกษาพบว่าทารกโรคหัวใจพิการแต่กำเนิดชนิดเขียวมีระยะเวลาการนอนหลับรวมทั้งวันเฉลี่ย 770.44 นาที และตื่นตอนกลางคืนเฉลี่ย 14.26 ครั้ง ผลวิเคราะห์หาความสัมพันธ์พบว่า ระดับความรุนแรงของภาวะหัวใจวายไม่มีความสัมพันธ์กับระยะเวลาการนอนหลับและการตื่นตอนกลางคืนอย่างมีนัยสำคัญทางสถิติ พื้นฐานทางอารมณ์มีความสัมพันธ์ระดับปานกลางกับระยะเวลาการนอนหลับอย่างมีนัยสำคัญทางสถิติ แต่ไม่พบความสัมพันธ์อย่างมีนัยสำคัญทางสถิติกับการตื่นตอนกลางคืน และกิจกรรมการดูแลมีความสัมพันธ์ระดับปานกลางกับระยะเวลาการนอนหลับและการตื่นตอนกลางคืน การศึกษาครั้งนี้แสดงให้เห็นว่าพยาบาลและบุคลากรทางการแพทย์ตระหนักถึงปัญหาการนอนหลับของทารกโรคหัวใจพิการแต่กำเนิดชนิดเขียว และนำข้อมูลไปวางแผนการพยาบาลเพื่อนำไปสู่คุณภาพการนอนหลับที่ดี

คำสำคัญ : ทารกโรคหัวใจพิการแต่กำเนิด โรคหัวใจพิการแต่กำเนิดชนิดเขียว การตื่นตอนกลางคืน ระยะเวลาการนอนหลับ

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Introduction

Sufficient sleep helps infants with congenital heart disease (CHD) in their recovery and health maintenance.[1] Lack of sleep may have a negative long-term effect on the immune, endocrine, and circulatory systems. Furthermore, there are delays in growth and development, and cognitive impairment.[2] Short-term effects include diminished alertness, enhanced pain perception, and poor emotion regulation (restlessness and crying)[3], resulting in increases oxygen use, which is dangerous for infants with CHD, especially infants with cyanotic congenital heart disease (CCHD) who have low blood oxygen due to physiopathology.

Sleep in hospitalized infant tends to be short sleep and frequent night waking. The National Sleep Foundation (NSF) recommends infants sleep 12-15 hours/day[4] and wake less than 2 times/night.[5] Several studies found hospitalized patients slept less than NSF recommendations.[6] Most hospitalization studies found significantly lower sleep duration than at home. In addition, it was reported that CCHD infants had more frequent awakenings and less sleep efficiency than acyanotic congenital heart disease and normal infants.[7] Various factors can cause sleep disturbance during hospitalization.

Sleep-related factors can be divided into child, parental, and environmental categories. First, child factors like demographics, development, temperament, symptoms (e.g., fever, pain, nausea, etc.), and disease severity or type. Inpatient sleep duration and night waking were all shown to be influenced by age, gender, race, and development in the majority of studies.[8] Sleep-wake behavior has been linked to temperamental style through hypothesized shared CNS arousal regulatory processes. Temperament is the way infants respond to the world. It can influence behavior in specific contexts with specific environmental stimuli and develops over time with maturation and interactions with the infant's environment.[9] On the basis of this theoretical explanation, we could predict that temperament influences sleep patterns and that infant sleep patterns influence the development of later temperament. Previous studies show that temperamental infants experience a shorter sleep duration[10] and more frequent night waking than infants with an easy temperament.[11,12] however, few studies have found no association between the infant's temperament and sleep outcomes.[13] In addition, illness symptoms (e.g., fever, pain, nausea, etc.) also disrupted sleep.[8] Previous studies found sparse information on illness severity and type that linked increasing severity or medical complexity to reduced sleep duration and more night wakings, but not specific diseases.[14] Thus, current knowledge cannot discuss how specific diseases affect sleep duration and night waking. Infants with CCHD have lower blood oxygen levels during sleep than normal infants, which stimulates the sympathetic nervous system and causes arousal.[15] In addition, heart failure is a common cause of morbidity and mortality in CCHD, resulting in a breathing disorder during sleep that awakes infants.[16] To date, there have been few studies on the relationship among infant CCHD and the severity of heart failure.

Second, parental factors, including parental characteristics (such as depression, anxiety, and stress), attachment, and sociocultural factors (e.g.,

socioeconomic, marital status, etc.). Several studies indicate that parental and sociocultural factors, such as infant-parent attachment, influence sleep outcomes.[8, 14, 17] In this study, the parent may visit the infant for two to four hours per day. Consequently, parental variables may have minor effect, and were not investigated in this study.

Third, the environmental factors such as light, noise, temperature, and caregiving activity. Light, noise, and temperature affect sleep in hospitalized infants.[8] Previous research indicated that sleep duration and night waking were frequently associated with caregiving activities by physicians, nurses, and other caregivers, such as nursing care activities, touching the patient, and monitoring vital signs.[8, 14, 18-21] However, little is known about the caregiving activities of hospitalized infants with CCHD, who may require different care activities than other hospitalized infants.

The literature review found few studies on CCHD infant sleep duration and night waking. One study examined sleep in hospitalized infants with CCHD.[7] Most studies examined hospitalized children with other diseases. Thus, this study intends to examine sleep duration and night waking in infants with CCHD, as well as sleep related factors. This study uses selected factors from previous studies that have been associated with infant sleep, such as the severity of heart failure, for which there have been few studies on infant sleep, temperament, for which previous research has produced conflicting results, and caregiving activities, for which there has been scant information in hospitalized infants with CCHD. The findings are crucial for preventing and treating early sleep problems.

Objectives

The objectives of this study were as follows: 1) to describe sleep duration and night waking in infants with CCHD during hospitalization; 2) to describe the sleep-related factors (the severity of heart failure, temperament, and caregiving activities) in infants with CCHD during hospitalization; and 3) to explore the relationship between sleep duration, night waking, and sleep-related factors (the severity of heart failure, temperament, and caregiving activities) in infants with CCHD during hospitalization.

Study Framework and Literature Review

This study's framework is derived from the neurophysiology of sleep and the literature reviews on infant sleep-related factors.

The neurophysiology of sleep

The reticular activating system (RAS) is a complex bundle of nerves in the brain that is responsible for regulating wakefulness and sleep-wake transitions. The ascending reticular activating system (ARAS) awakens the cerebral cortex by activating sensory pathways that ascend through the brainstem, especially somatosensory pathways (touch, pain, temperature, position, and vibration), which stimulate the nervous system and activate the ARAS.[15] Sleep requires balanced sympathetic and parasympathetic nervous systems.[1] Afferent signals from peripheral or central chemoreceptors, which respond to low blood oxygen and high blood carbon dioxide, reach CNS nuclei. As a result of increased sympathetic nervous system activation, sleep is disrupted.[22]

Factors relating to infants' sleep

Pediatric hospitalization sleep-related factors were divided into three categories: child, parental, and environmental factors. [8, 14] This study examines hospitalized infants' sleep by considering child and environmental factors and selected factors with limited data in previous studies. For the child factor, the severity of heart failure and temperament were chosen for examination in this study.

CCHD may affect sleep, resulting from the low level of oxygen and the high level of carbon dioxide in the arterial blood, which stimulate the peripheral chemoreceptors located in the carotid bodies and the central chemoreceptors in the brainstem, sending nerve signals to stimulate the functioning of the sympathetic nervous system and arousing the infant from sleep. Thus, infants with CCHD experienced more frequent awakening and less sleep efficiency than infants with acyanotic CHD and normal infants. In infants with CCHD, heart failure occurs when the heart cannot pump enough blood to all the organs. Heart failure can disrupt sleep and breathing, lowering blood oxygen levels. In order to restore oxygen levels, the body increases sympathetic nervous system activity, causing sleep disruptions.[23, 24] Temperament is the nature of behavior and emotions in response to stimuli or the environment, influenced by nine dimensions: activity level, rhythmicity, approach/withdrawal, adaptability, intensity, threshold of responsiveness, mood, distractibility, and attention span and persistence. Temperament can be classified into three types: difficult, easy, and slow-to-warm-up temperament. Difficult temperament was defined as including low rhythmicity, high withdrawal, slow adaptation, high frequency of negative mood, and intense reactions. The 'easy temperament' category, on the other hand, high rhythmicity, a positive approach to new situations, adaptability, a positive mood, and non-intense reactions, which is the opposite of difficult temperament. Whereas slow-to-warm-up temperament were described as exhibiting negative responses when exposed to new situations, but gradually accepting them with repeated exposure.[9] Some infants have mixed subscale temperaments; they are classified as intermediate high or intermediate low. Infants with difficult temperaments may tend to adapt to changing situations by exhibiting a slow, bad mood, with high response intensity, causing them to experience sleep problems.[25]

For environmental factors, the focus of this study was on caregiving activity. It refers to the frequency of activities given to infants by physicians, nurses, caregivers, and other health caregivers. There were three categories: mildly (e.g., bathing, stroking, touching, kissing, positioning, diaper changing, etc.), moderately (e.g., eyes, mouth, or nose cleaning, measurement of blood pressure, removal of tape or removal/replacement of oxygen saturation probe, etc.), or highly intrusive (e.g., suctioning, needle insertion, wet dressing, tube insertion, etc.).[18] Intrusive procedures affected infants' heart rate, respiratory rate, cyanosis, and sleep[18] because these activities send nerve signals to the cortex, activating the RAS and waking infants.[15]

Hypothesis

1. The severity of heart failure, temperament, and caregiving activities correlated with sleep duration in infants with CCHD during hospitalization.

2. The severity of heart failure, temperament, and caregiving activities correlated with night waking in infants with CCHD during hospitalization.

Methods

The purposive sample consisted of infants with CCHD aged 6–12 months admitted to a pediatric cardiac ward at a tertiary care hospital. The sample size was determined from December 2019 to September 2021. All infants with CCHD who met the study criteria in this period were recruited. The inclusion criteria were as follows: 1) good consciousness and not receiving sedative drugs; 2) without a diagnosis of neurological disorder or sleep apnea; 3) no fever and pain; 4) being admitted for at least 24 hours. The exclusion criteria consisted of subjects who were transferred to another ward or discharged on the data collection day.

The sample size was computed using G*Power program input, the lowest Pearson correlation coefficient (r) of all variables being 0.40,[12] with the two-tailed statistical significance level set at .05 and the power of the test set at .80, requiring at least 46 samples; 15% was added to prevent losing data, giving a sample size of 52 due to the time available for data collection and the limited target population. Although all 52 infants met the inclusion criteria, five were excluded by being transferred or discharged, with an additional 13 excluded because the video recording did not cover an entire 24-hour period. Therefore, the final sample size was 34 infants.

Research Instruments

Two types of instrumentation were used in this study: 1) Research instruments, including a video camera to record the infants' behavior and a clock for time recording, with the FLACC behavioral pain assessment scale for measuring the pain according to the inclusion criteria. 2) Data collection instruments were composed of three parts as follows:

Part 1: The demographic data recording form to ascertain age, sex, medical diagnosis, present illness, pain score, treatment, and current medications.

Part 2: Infants' sleep-wake states recording form and a manual on the evaluation of infants' sleep-wake behavior in Thai by Charastong[26], adapted from Parmelee and Stern.[27] The sleep-wake behavior states were classified by observation as follows: quiet sleep, active sleep, drowsy sleep, quiet alert, active alert, and crying. For 24 hours, a video camera recorded the subject infants' sleep-wake behavior. The researcher coded the infants' behavior from the beginning of the video, observing for at least five seconds.[28] The total sleep duration is the sum of sleep states measured in minutes from 7:00 a.m. to 7:00 a.m. of the following day. Daytime sleep is from 7:00 a.m. to 7:00 p.m., while nighttime sleep is the opposite. Night waking is the frequency of CCHD infants waking from 7 p.m. to 7 a.m. in a drowsy, quiet, active, or crying state. Night waking is timed. Interrater reliability was .92.

Part 3: Questionnaire on sleep-related factors

1) The Ross Heart Failure Classification for Children, an assessment for grading the severity of infant heart failure. The classification includes feeding difficulties, growth problems, and symptoms of exercise intolerance, manifesting as grades I through IV. A greater level indicates a greater severity.[29]

2) The Infant Temperament Interview Questionnaire was used to measure temperament, modified and translated into the Thai language from the Revised Infant Temperament Questionnaire[30] by Tattinapanich.[31] The Infant Temperament Interview Questionnaire consisted of 53 items, with a 6-Likert rating scale to assess the five subscales of temperament (rhythmicity, approach/withdrawal, adaptability, intensity reaction, and mood).[32] The questionnaire categorized infants into easy, intermediate low, slow-to- warm-up, intermediate high, and difficult, based on their scores for each dimension. A higher score means a characteristically difficult way of responding to the environment. The instrument reliability Cronbach's alpha coefficient was .82.

3) The Caregiving Activity Observation Tool was used to record caregiving activity following the criteria modified from the Zahr's Nursing Activity Observation Tool developed by Ratikarn Ngampiam.[18] Caregiving activities were divided into three subcategories: mildly, moderately, and highly intrusive. The frequency of caregiving activities was observed via the 24-hour video recording by the researcher or research assistant and noted in the tool by a nurse or practical nurse. The caregiving activities were recorded according to the number of times. The interrater reliability was equal to 1.

Ethical Considerations

This study was approved by the Institutional Review Board (IRB), Faculty of Medicine Ramathibodi Hospital, Mahidol University (No. MURA2019/841), and the Faculty of Medicine, Chulalongkorn University (No. 657/62). All participants were informed about the research work, including the objective, process of study, as well as their rights to participate in or withdraw from the study without any impact.

Statistical Analysis

The data were analyzed using descriptive statistics, including frequency, percentage, mean, and standard deviation (S.D.) for the demographic data, sleep variables, and factor-related sleep. The Pearson product-moment correlation coefficient was used to test the relationship between factors, sleep duration, and night waking. Variables were tested for statistical assumption to perform the correlation analyses. Spearman's rho correlation was employed for statistical analysis of the non-normal distribution. All tests used a p-value < 0.05 as a statistically significant value.

Data Collection

Following approval from the IRB and the research setting authorities, data collection was conducted in the general pediatric cardiology ward. The data collection procedures were as follows:

1. The research assistant identified the sample according to the inclusion criteria from the patient admission records in the general pediatric cardiology ward. The researcher explained the study objectives to the parent or caregiver, asked permission to collect data and record videos of the infant, and started to collect demographic data from medical records and interview patients and caregivers.

2. The severity of heart failure was again confirmed by a physician on the date of data collection. The researcher interviewed parents or caregivers for 10–15 minutes using the Infant Temperament Interview Questionnaire.

3. The researcher installed a video camera at the edge of the bed and adjusted the camera angle to clearly reveal the infant's face. The researcher checked for the camera function and position twice a day (at 7.00 a.m. and 7.00 p.m.). The 24-hour observation period started at 7.00 a.m. and ended at 7.00 a.m. on the following day. The data observed included sleep-wake behavior and caregiving activities. Moreover, caregiving activities were recorded by a practical nurse or nurse aide on that shift. The camera's recording could be stopped while nurses were providing care and then resumed afterward.

4. After recording the video, sleep duration and night waking were noted and interpreted minute by minute over a 24-hour period on the infants' sleep-wake states recording form (Excel). This was divided into daytime (7.00 a.m. to 7.00 p.m.) and nighttime (7.00 p.m. to 7.00 a.m.). One video takes at least 3–5 days to interpret.

Results

1. Demographic Characteristics

Most of the 34 infants in this study (67.50%) were male. Mean age 8.91 months (SD = 2.19). Most infants (76.47%) had tetralogy of Fallot. Most (82.35%) did not have other diseases, and all had cardiac surgery or catheterization. All infants took digitalis and diuretics. 52.94% of these infants received oxygen via corrugated tube. The mean hospital stay was 6.40 days (SD = 5.83), ranging from 2–23 days.

2. Sleep Duration and Night Waking

The mean daytime sleep duration (7.00 a.m. to 7.00 p.m.) was 176.82 minutes or 2.95 hours (S.D. = 58.38). The mean nighttime sleep duration (7.00 p.m. to 7.00 a.m.) was 593.62 minutes or 9.89 hours (S.D. = 66.96). The mean total sleep duration during the 24-hour period was 770.44 minutes or 12.84 hours (S.D. = 81.66), with the shortest duration being 593 minutes (9.88 hours) and the longest 935 minutes (15.58 hours). Night waking average was 14.26 times (S.D. = 3.89), ranging from 8–22 times. (Table 1)

Table 1 Sleep duration and night waking in hospitalized infants with CCHD (n = 34)

Sleep duration and night waking	Range	Mean	SD
Daytime sleep duration (min)	107–322	176.82	58.38
Nighttime sleep duration (min)	411–701	593.62	66.96
Total sleep duration (min)	593–935	770.44	81.66
Night waking (times)	8–22	14.26	3.89

3. Factors Relating to Sleep Duration and Night Waking

Severity of heart failure. Most hospitalized infants with CCHD had class II (64.71%) and class III (35.29%) heart failure. Class II heart failure which refers to an infant with mild tachypnea or diaphoresis with feeding symptoms while class III refers to an infant experiencing marked tachypnea or diaphoresis symptoms during feeding or prolonged exertion. None of the infants in this study had class I and IV heart failure.

Temperament. The mean score for temperament was 156.09 (SD = 23.37), ranging from 121–207. Most of the infants hospitalized with CCHD were classified as having an easy temperament (41.18%), followed by difficult temperament (32.36%), and slow-to-warm-up temperament (2.94%), respectively.

Caregiving activities. The infants were subjected to caregiving activities for a total of 75.82 times on average (SD = 15.85), ranging from 50–114 times in a 24-hour period. Infants were cared for 51.47 times (SD = 12.07) during the day and 24.35 times (SD = 6.20) on average during the night. Over a 24-hours period, infants were subjected to mildly, moderately, and highly intrusive caregiving 58, 14.32, and 2.03 times, (SD = 13.27, 4.15, and 1.68), respectively. During a 12-hour night, mild, moderate, and highly intrusive caregiving activities were performed 18, 4.47, and 0.91 times (SD = 4.27, 2.08, and 0.75), respectively.

4. Hypothesis Testing

Relationship between sleep-related factors, sleep duration, and night waking

The severity of heart failure showed no statically significant correlation with sleep duration (r = .06, p> .05) (Table 2) and night waking (r = .14, p> .05) (Table 3). Temperament was statistically significant, showing a moderate negative correlation with sleep duration (r = -.48, p< .01) but no correlation was found with night waking (r = .29, p> .05). Caregiving activities were statistically significant, showing a moderate negative correlation with sleep duration (r = -.52, p< .01) and a moderate positive correlation with night waking (r = .56, p< .01). Moreover, mildly intrusive caregiving activities were statistically significant, showing a moderate negative correlation with sleep duration (r = -.61, p< .01) and a moderate positive correlation with night waking (r = .53, p < .01). (Table 3)

Table 2 Correlation coefficients for the severity of heart failure, temperament, caregiving activities, and sleep duration (N = 34)

Variables	1	2	3	3.1	3.2	3.3	4
1 Severity of heart failure	1						
2 Temperament	0.01(a)	1					
3 Caregiving activities	0.00(a)	0.58**	1				
3.1 Mildly intrusive	-0.15(a)	0.61**	0.95**	1			
3.2 Moderately intrusive	0.45**(a)	0.17(a)	0.33(a)	0.11(a)	1		
3.3 Highly intrusive	0.49**(a)	0.07(a)	0.33(a)	0.15(a)	0.57**(a)	1	
4 Sleep duration	0.06(a)	-0.48**	-0.52**	-0.61**	-0.06(a)	0.03(a)	1

*p < .05, **p < .01, a = Spearman's Rho correlation

Table 3 Correlation coefficients for the severity of heart failure, temperament, caregiving activities, and night waking (n = 34)

	1	2	3	3.1	3.2	3.3	4
1 Severity of heart failure	1						
2 Temperament	0.01[(a)]	1					
3 Caregiving activities	0.00[(a)]	0.58[**]	1				
3.1 Mildly intrusive	-0.15[(a)]	0.61[**]	0.95[**]	1			
3.2 Moderately intrusive	0.45[**(a)]	0.17[(a)]	0.33[(a)]	0.11[(a)]	1		
3.3 Highly intrusive	0.49[**(a)]	0.07[(a)]	0.33[(a)]	0.15[(a)]	0.57[**(a)]	1	
4 Night waking	0.14[(a)]	0.29	0.56[**]	0.53[**]	0.34[(a)]	0.31[(a)]	1

*p < .05, **p < .01, a = Spearman's Rho correlation

Discussion

1. Sleep Duration and Night Waking

According to the study, the hospitalized infants with CCHD slept for about 770 minutes or 12.80 hours in a 24-hour period, which is within the National Sleep Foundation's (NSF) recommended range of 12-15 hours (or 720-900 minutes) for infants aged 6-11 months.[4] In contrast, Erondu et al.[33] reported that infants slept 412 minutes on average in a hospital. Another previous study found that ill one- to two-year-olds in the general pediatric unit slept 10 hours a day,[18] also less than the NSF recommendations. The total sleep duration of hospitalized infants was longer in this current study than in previous studies because nurses and staff were holding, stroking, or touching infants to promote sleep. As Dixley and Ball[34] claim, swaddling was associated with increased quiet sleep duration in infants and reduced the number of sleep state changes among infants.

This study reveals that the infants awakened an average of 14.26 times in a 12-hour nighttime period (7.00 p.m. to 7.00 a.m.), ranging from 8-22 times, which was more frequent than normal infants of the same age. As Galland, Taylor, Elder, and Herbison[35] found that infants aged from 7-11 months who slept at home awoke only 1.10 times during the night. These findings are similar to those of Bruni et al.[5] who revealed that normal infants aged from 6-12 months awoke 1.40-1.80 times on average during the night. Furthermore, Ratikan Ngampiam[18] found that pediatric patients aged from 1-2 years old, admitted to the general hospital, had an average night awakening rate of 7.95 times. This study is consistent with Ykeda, Filho, Lopes, and Alves[7] compared in-hospital infants with CHD with a normal control group and found that CCHD infants experienced increased wakefulness with a consequent decrease in sleep efficiency. The level of night waking found in the present study was greater than in the previous study because CCHD can cause systemic hypoxia and cyanosis, resulting from a

mixture of oxygenated and desaturated blood shunting through the systemic circulation. Hypoxia or hypercapnia may induce abnormally high levels of sympathetic nervous system activity. These neuropathological changes are mediated by chemoreceptors in the carotid body and brainstem. High levels of sympathetic activity and nervous system activity drive wakefulness.[22]

2. Testing the Hypothesis Results

Severity of heart failure, sleep duration, and night waking

More than half of infants with CCHD experience class II rather than class III heart failure, according to the findings of this study. In addition, none of the infants had heart failure of classes I and IV. Since, infants with class I had no symptoms and did not require hospitalization, whereas infants with class IV had severe symptoms and life-threatening conditions that could not be admitted to the general pediatric cardiology ward.

The findings revealed that the severity of heart failure showed no statistically significant correlation with sleep duration and night waking. In contrast, a previous study compared in-hospital infants with CCHD and normal infants, found that infants with CCHD experienced increased wakefulness, resulting in decrease sleep efficiency.[7] An explanation for this finding might be that most infants had class II heart failure, which refers to mild signs and symptoms. In addition, all infants received a diuretic drug to help reduce the signs and symptoms of heart failure.

Temperament, sleep duration, and night waking

Most of the hospitalized infants with CCHD were classified as having an easy and difficult temperament. These results are in accordance with Chong et al.[36] reported that American infants had an easy temperament than a difficult temperament. Similarly, this study is consistent with the study by Tratornpisudhikul[37], who found that most Thai infants aged from 4-8 months attending the well-baby clinic had an easy temperament. In contrast, the study by Abuhammad et al.[38], who examined the temperament of first-year infants admitted to Maternal and Child Healthcare centers in Jordan, more infants were found to have a difficult temperament than an easy temperament. These findings are different from those reported in the present study because the infants had acute illnesses, leading to crying and fussiness. Consequently, more parents may have reported difficult temperaments.

This study found a correlation between temperament and sleep duration, aligning with the findings of Spruyt et al.[39], who reported that in infants aged 6-11.5 months, decreased sleep duration was correlated with an increase in the subscale of temperament score. Moreover, the results revealed no statistically significant correlation between temperament and night waking. In contrast, a previous study reported that difficult temperament showed a statistically significant correlation with night waking in infants.[11, 12] This may be because as soon as infants cried, nurses or staff in the ward provided nursing care such as touching, stroking, and swaddling. Hence, there is no difference between easy and difficult temperaments. However, another possible explanation is a small sample size in this study that may affect correlation between night waking and temperament.

Caregiving activities, sleep duration, and night waking

Most caregiving activities found to be mildly intrusive followed by moderately, and highly intrusive during both daytime and nighttime similarly. Mildly intrusive consisted mostly of touching, stroking, and swaddling, followed by administering and applying medication, diaper changing, dressing/wrapping, feeding, an axillary temperature or pulse rate measurement, body cleaning, positioning, physician examination by auscultation, and bedsheets changing, respectively. Similarly, Ngampiam[18] found that pediatric patients aged from 1–2 years old admitted to the general hospital experienced more mildly intrusive caregiving activities than highly intrusive.

Caregiving activity correlated with sleep duration and night waking. According to the study, mildly intrusive caregiving also negatively correlated with sleep duration, on the other hand, mildly intrusive caregiving also positively correlated with night waking. Ngampiam[18] found a correlation between caregiving and sleep duration and night waking in 1–2 year-olds hospitalized children. Most caregiving activities in this study are mildly intrusive, such as bathing, tepid sponge, clothing, changing bedsheet, touching, etc. This might be explained by caregiving activities awakening infants by activating somatosensory pathways near the pons-midbrain junction in the upper brain stem.[15] For this reason, the infant had shorter sleep and frequent night waking. However, moderately and highly intrusive caregiving activity shows no statistically significant correlation with sleep duration and night waking because those activities did not occur frequently. This was probably because most of the infants admitted to this ward remained in hospital for at least one night, with the average stay being 6.4 days. Therefore, they had been subject to highly intrusive caregiving activities prior to data collection, and most infants had class II heart failure with no serious health problems.

Recommendations for Nursing Practice

Healthcare professionals should have a consistent schedule of activities so that infants with difficult or slow-to-warm-up temperaments can easily adapt to changes in their daily lives, including sleep patterns. Furthermore, healthcare professionals should cluster some procedures together to decrease the amount of disturbance to the infants, such as vital sign measurement, diaper changing, and swaddling, and should be careful that the mildly intrusive activity can disturb the infant's sleep, especially at night.

Recommendations for Future Study

1. A researcher should be spending no more than 4 hours per day to interpret the video recording in order to prevent the researcher's physical and phycological fatigue.

2. Further study should evaluate the physical performance data (e.g., vital signs, desaturation times) to indicate the health status of infants with CCHD that can affect sleep-wake behavior.

3. The study protocol should identify the start date for data collection in the sample on the same day (start at day 0, day 1, or day 2 after admission) because it may affect the caregiving activities provided

to infants. The first day of admission might have more caregiving activity than the next day.

Limitations of the Study

There are certain limitations to this study. Firstly, the infant's sleep-wake behavior was collected by recording a 24-hour video. Hence, if the camera angle changed or the video camera stopped working, it would result in missing data. Secondly, if the researcher became fatigued when interpreting sleep-wake behavior from a 24-hour video, this might cause inaccuracies in interpreting the data. Thirdly, the study did not consider parental factors, and this could affect the results. Finally, the sample size was small due to missing data in numbers of cases, and limitation of target population and time.

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