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Improving physiological parameters in critically ill children through evidence-based sleeping pattern guidelines

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***Abstract*---Background:** Adequate rest is crucial for critically ill children's Healing process, Stress reduction, Immune function, and Emotional stability while Promoting sleep in ICUs can improve patient outcomes. **Study Aim and Methodology**: The study aimed to evaluate the impact of guideline implementation on sleeping patterns and physiological parameters among critically ill children. **Study Design and Setting**: A quasi-experimental design was used, conducted in the Critical Care Unit at Zagazig University Hospital. **Sample and Tools**: A convenient sample of 100 critically ill children was included. Data collection tools comprised: **1.** Structured interview questionnaire, 2. ST Mary's Hospital Sleep questionnaires, and 3. Physiological parameters assessment tool (pulse, respiration, and mean arterial blood pressure) **Results:** The majority of critically ill children have significant sleep disturbance, which is linked to physiological factors (heart rate, mean arterial blood pressure, and respiration). In critically ill children in CCUs, poor sleep quality causes significant alterations in heart rate, mean arterial blood pressure, and breathing. **Conclusion**: The implementation of guidelines positively influenced the enhancement of sleep patterns and physiological metrics in critically ill pediatric patients. **Recommendations**: These findings highlight the necessity for critical care health professionals to receive training on evaluating sleep, implementing measures to ensure sufficient sleep, and integrating these practices into the standard care of critically ill children in Critical Care Units.

***Keywords*---**Critically ill children, Physiological parameters, Sleeping pattern guidelines.

Introduction

Critically ill patients, particularly youngsters, frequently report fragmented sleep and shallow rest during the rapid eye movement (REM) phase of sleep (Pisani et al, 2015; Devlin et al, 2018; Khalil et al, 2019). Numerous factors, including non-circadian lighting, noise from medical staff, monitoring devices, and physical discomfort, have been connected to sleep disturbances in young patients by research employing invasive assessment methods (Aitken et al., 2017; Telias & Wilcox, 2019; Honarmand et al, 2020; Miranda-Ackerman et al, 2020). Cardiovascular, pulmonary, endocrine, renal, and neurological disorders have also been linked to a number of symptoms that interfere with the initiation and maintenance of restful sleep (Gay, 2010; Pisani et al., 2015; Drouot and Quentin, 2016; Rittayamai et al., 2016; Kimia et al, 2020).

A variety of physiological and psychological issues, including as problems with the immunological, respiratory, and cardiovascular systems, as well as anxiety, post-traumatic stress disorder, and a lower quality of life, can result from sleep abnormalities and may raise death rates. According to the different systems that respond to sleep disruptions, the effects go beyond the central nervous system and impact all aspects of the body (Finan et al., 2015; Medrzycka-Dabrowska et al., 2018; Chaudhary et al., 2020).

Because sleep disruptions cause the sympathetic nervous system to get activated and adrenaline and noradrenaline to be secreted, cardiovascular health is adversely affected. Blood pressure, heart rate, myocardial oxygen demand, and the risk of cardiac dysrhythmias are all increased when these hormones are released. These alterations have the potential to exacerbate myocardial ischemia and increase the likelihood of further heart attacks. According to Honarmand et al. (2020), prolonged sleep deprivation over a number of nights raises the production of inflammatory cytokines linked to diseases such acute coronary artery syndrome, hypertension, and atherosclerosis. Additionally, sleep disturbances have an impact on the respiratory system, resulting in decreased forced vital capacity and maximal inspiratory pressure, hypoventilation, and increased carbon dioxide and oxygen intake (Medic et al, 2017).

Polysomnography and observation are two methods used to assess sleep in the critical care unit (CCU). Traditional scoring techniques make interpretation of polysomnography more difficult, and the procedure is both invasive and technically complex (Drouot et al., 2012; Watson et al., 2013; Menear et al., 2017). As a result, nurses' subjective evaluations of sleep are thought to be a viable substitute for measuring sleep quality. Patients who are able to self-report can have their reported sleep duration or quality evaluated using rating scales, surveys, or structured interviews (Storti et al., 2015; Ritmala-Castren et al., 2016).

A dependable and methodical instrument for assessing a patient's sleep from the night before, the ST Mary's Hospital Sleep Questionnaire (SMHSQ) is meant to be used repeatedly (Ellis et al., 1981; Leigh et al., 1988). When supporting sleep for critically ill patients, critical care nurses need to take into account knowledge of sleep cycles, different factors that cause sleep disturbances, and both objective and subjective techniques of sleep evaluation (Aitken et al., 2017; Herscher et al., 2021).

Significance of the study:

Lack of sleep has been shown to negatively impact every physiological system, resulting in problems like poor emotional processing, compromised immunity, delayed wound healing, and a higher risk of heart attacks, strokes, hypoxia, hypercapnia, and hypertension (Wu & Sun, 2017; Astin et al., 2020). Critical care nurses frequently put cardiac monitoring and maintaining proper oxygenation ahead of both the quantity and quality of sleep in CCUs. Even though sleep is essential for general health and wellbeing, medical experts usually ignore its quality. Additionally, there is little data on how sleep disorders affect physiological indicators in children in critical care units. Therefore, the purpose of this study was to look at how sleep disturbances affected the physiological parameters of pediatric patients who were in critical condition.

Operational definition:

Sleep disturbance: Defined as inadequate duration or quality of sleep, measured in this study using the ST Mary's Hospital Sleep Questionnaire (SMHSQ).

Physiological parameters: These include metrics such as heart rate, blood pressure, and respiratory rate.

Aim of the study

This study aimed to evaluate the effect of guidelines implementation regarding sleeping patterns and its effect on physiological parameters among critically ill children.

Research hypothesis:

H1: Critically ill children given educational guidelines will demonstrate improved sleep patterns that will positively impact physiological metrics following the intervention.

Subjects and Methods:

Research design:

A quasi-experimental research design was employed to fulfill the objectives of the study.

Setting:

The investigation took place within the Critical Care Unit linked to Zagazig University Hospital. This facility is among the most prominent public teaching hospitals in Egypt, attracting numerous patients from diverse socioeconomic and educational backgrounds across various areas for medical treatment.

Subjects:

A convenient sample of 100 critically ill children was chosen, and they were monitored over a span of five days.

Sample size calculation:
Using the Epidemiology Information 2000 statistical software, the sample size was computed. The calculation was made using the expected frequencies of critical care units from prior studies, with a 95 percent confidence interval, 80 percent study power, 95 percent prevalence of critically ill patients, and a worst-case scenario of 5%. Based on the previously mentioned standards, a sample of 100 critically ill children was determined. These individuals were evenly divided into two groups, one for study and the other as a control group. The study group consisted of 50 critically ill children who followed specific guidelines, while the control group, also made up of 50 critically ill children, did not adhere to the guidelines.

Inclusion criteria included for children:
- All children with critical illnesses who are under 18 years old.
- Representing both sexes.
- Consent to take part in the research.

Data collection tools:
Three methods were employed to gather information:
Tool (I): A structured interview questionnaire: Created by the researchers following a review of relevant literature. This was arranged into two sections:
Section (1): It encompasses demographic details and has four elements concerning age, sex, educational background, and place of residence.
Section (2): It covers the medical history of children and includes three elements about prior admissions to the CCU, the presence of other health conditions, and past use of pain relievers.

Tool (II): The ST Mary's Hospital Sleep Questionnaire (SMHSQ):
The St. Mary's Hospital Sleep Questionnaire (SMHSQ) was adapted for this study. The original questionnaire consists of 14 items assessing sleep quantity and quality. For this study, the questionnaire was divided into two sections: sleep quantity (items 1, 2, 3, 4, 7, 8, and 14) and sleep quality (items 5, 6, 9, 10, 11, 12, and 13). Sleep quality scores range from 6 to 38, with higher scores indicating better sleep quality.

Tool (III): Physiological parameters assessment tool:
A tool was developed to assess physiological parameters, including pulse, mean arterial blood pressure, and respiration, based on a literature review **(Aitken et al, 2017; Medic et al, 2017**).

Validity and Reliability
Content validity was assessed by a panel of experts in critical care medicine and pediatrics, with Tool I1 scoring 89% validity. Cronbach's alpha coefficients (r = 0.834 and 0.831) confirmed the reliability of the evaluation tools.

Ethical Considerations
Official permission was obtained, and participants provided written consent with guaranteed confidentiality and anonymity.

Pilot Study
A pilot study was conducted with 10% of the sample to test the clarity and feasibility of the research study, with no changes made to the final version of the tools.

Fieldwork:
The study was conducted from June 2021 to July 2021, with data collection governed by researcher and participant availability.

Study Design

The study consisted of four stages:
Stage 1: Preliminary Assessment
Children's sleeping patterns and physiological parameters were assessed using standardized tools.
Stage 2: Guidelines Development
Guidelines on sleeping patterns and their impact on physiological parameters were developed, covering sleep physiology, factors facilitating and disrupting sleep, and their effects on critically ill children.
Stage 3: Guidelines Implementation
The guidelines were implemented through three educational sessions. Researchers observed 100 critically ill children, assessing their physiological parameters (pulse, respiration, and mean arterial blood pressure) for five days, data from bedside cardiac monitors were collected every two hours for each child, and sleep quality/quantity using the St. Mary's Hospital Sleep Questionnaire. Sleep quality and quantity were assessed daily in the CCU between 7-9 a.m. using the St. Mary's Hospital Sleep Questionnaire, evaluating the previous night's sleep over five consecutive days, with each questionnaire taking 15-20 minutes to complete.
Stage 4: Guidelines Evaluation
The guidelines' effectiveness was evaluated through a post-test assessing nurses' knowledge and children's sleeping patterns.

Statistical Analysis
SPSS Statistics (Version 22) was used for data analysis. Descriptive statistics and chi-square tests were employed to evaluate significance, with Pearson correlation assessing the impact of sleep disruptions on physiological parameters.

Results

Table (1): Demographic data of critically ill children in both studied groups (n=100)

Demographic data	**Study Group (n=50)**		**Control Group (n=50)**		**X^2(P)**
	No	**%**	**No**	**%**	
Age (**Yrs**.) 3 ≤ 6 6 ≤ 10	21 29	42.0 58.0	22 28	44.0 56.0	2.63 0.113
Gender Boy	29 21	58.0 42.0	37 13	64.0 36.0	3.94 0.139

Demographic data	Study Group (n=50)		Control Group (n=50)		X^2(P)
	No	%	No	%	
Girl					
Residence:	38	76.0	36	72.0	2.84
Urban	12	24.0	14	28.0	0.137
Rural					

Table 1 illustrates the demographic characteristics of children in both the study and control groups. It indicates that over half of the children studied, specifically 58% in the study group and 56% in the control group, were aged between 6 and 10 years. In terms of gender distribution, 58% of the children in the study group were boys, while the control group had a higher percentage of boys at 64%. Additionally, 76% of the children in the study group resided in urban areas, compared to 72% in the control group. Importantly, there were no statistically significant differences observed between the two groups regarding age, gender, and residence, with p-values exceeding 0.05.

Table (2): Medical data of critically ill children in both studied groups (n=100)

Medical data	Study Group (n=50)		Control Group (n=50)		X^2 (P)
	No	%	No	%	
Previous admission to CCU:	3	6.0	2	4.0	0.622
Yes	47	94.0	48	96.0	(0.744)
No					
History of other diseases:	5	10.0	4	8.0	0.534
Yes	45	90.0	46	92.0	(0.643)
No					
History of analgesic consumption:	18	36.0	20	40.0	0.725
Yes	32	64.0	30	60.0	(0.932)
No					

Table (2) indicates that 94% of critically ill children in the study group had not been previously admitted to the CCU, in contrast to 96% in the control group. Furthermore, 90% of the study group and 92% of the control group had no prior history of other diseases. Additionally, the table reveals that 64% of critically ill children in the study group had not consumed analgesics, compared to 60% in the control group.

Table (3): Average total score variations in sleep duration among critically ill pediatric patients in the experimental group compared to the control group (n=100)

Duration of night sleep	1st night	2nd night	3rd night	4th night	5th night
Study group	1.44±1.03	3.29±1.49	3.87±1.39	4.41±1.10	4.55 ±1.66
Control group	1.33±1.03	1.21±1.48	1.79±1.41	2.09±1.02	2.22±1.50
X^2(P- value)	**X^2= 16.78**		**P- value**=0.001**		

Table (3) illustrates an improvement in the mean length of sleep at night for critically ill children within the study group, rising from the first to the fifth night after admission (1.44±1.03 to 4.55±1.66). In comparison, the control group exhibited a change (1.33±1.03 to 2.22±1.50). A noteworthy statistical difference was found between the study group and the control group at the p=0.001 significance level.

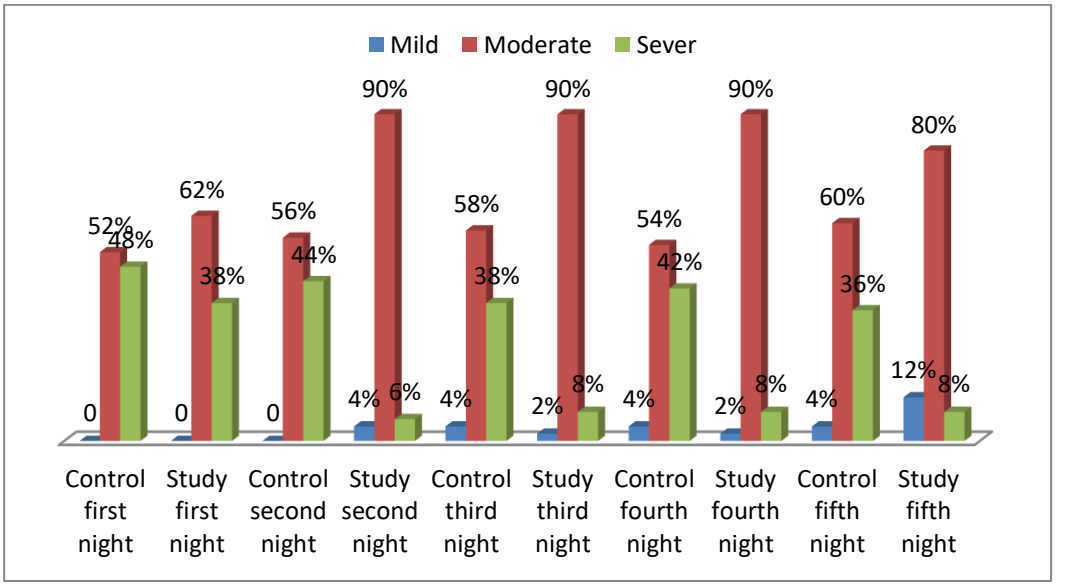

Figure 1: Total sleep quality levels of the analyzed critically ill pediatric children in both the study and control groups (n=100)

Figure (1) reveals that more than a third of the critically ill pediatric children (38%) in the research cohort faced significant sleep impairments during their initial night in the hospital, a percentage that dropped to 8% by the fifth night. In comparison, the control group reported 48% experiencing serious sleep issues on their first night, which declined to 36% by the fifth night.

Table (4): Mean scores differences in physiological parameters in the study group and control group (n=50)

Physiological Parameters	**Study Group** **Mean** ± SD	**Control Group** **Mean** ± SD	**t-test**
Temperature	37.2±0.04	37.4±0.13	0.51ns
Pulse	93.8±9.49	101.08±2.66	8.7**
Respiration	21.7±0.3	26.3±0.3	1.97*
Systolic blood pressure	97.5±2.3	97.2±4.5	0.96ns
Diastolic blood pressure	62.1±2.2	65.4±1.7	1.96*

Table 4 illustrates the average values and standard deviations of physiological parameters for both the study and control groups. The results indicated a reduction in the average pulse rate, respiration rate, and diastolic blood pressure within the study group. Statistically significant differences were observed in the

average pulse rate, respiration rate, and diastolic blood pressure between the study and control groups, except temperature and systolic blood pressure.

Table (5): The relation between the sleep quality scale and previous admissions to critical care units among critically ill pediatric patients in the study group (n=50)

Variable	Sleep Quality				X^2	P-value
	Severe sleep disorder(no=4)		Mild and moderate sleep disorder (no=46)			
	No	%	No	%		
Previous history of admission to the critical care unit						
No	4	100.0	52	88.0	0.475	0.000
Yes	0	0.0	6	12.0		

(**) statistically significant at p<0.001**

Table (5) illustrates that a significant majority (88%) of critically ill children examined, who experienced mild to moderate sleep disturbances, had no prior history of admission to the Cardiac Care Unit, with a highly statistically significant correlation at the p<0.0001 level.

Table 6: Correlation between sleep quality scores and physiological parameters in the critically ill children of the study group (n=50)

Physiological Parameters	Sleep quality score	
	r	P-value
Temperature	0.581	0.001*
Pulse	0.434	
Respiration	0.425	
Systolic blood pressure	0.531	
Diastolic blood pressure	0.417	

P-value <0.05 statistically significant

The study reveals a statistically significant correlation between overall sleep quality and physiological parameters in critically ill children (p < 0.05), as shown in Table 6.

Discussion

Sleep is characterized as a reversible state of unconsciousness, constituting approximately one-third of an individual's life. Research indicates that over 61 percent of hospitalized children experience inadequate sleep quality. Various factors contribute to this issue, with primary illnesses and their underlying pathophysiology playing a significant role in the poor sleep quality observed in hospitalized children, particularly in Critical Care Units (CCUs). The CCU environment is often associated with continuous monitoring, diagnostic assessments, and medical interventions such as mechanical ventilation and pharmacological treatments (Salandin et al., 2019).

The main factors causing sleep issues in severely ill youngsters are a loud surroundings, the extent of their condition, and the use of drugs. Interruptions in sleep may result in various negative impacts on both physical and mental well-being (Aitken et al., 2017). As a result, methods of distraction are commonly used

to shift a child's attention away from discomfort during medical treatments (**Astin et al., 2020).**

The study's findings support its hypothesis, showing: Improved sleep quality in critically ill children following guidelines. Better physiological parameters in the study group compared to the control group. The demographic similarity between groups (over half being boys) aligns with previous research, such as Abd El Khalik et al. (2020).

The study found no significant differences in demographic data between the study group and control group, suggesting that the groups were comparable and any differences in outcomes may be attributed to the intervention or treatment rather than demographic factors ($p > 0.05$), indicating that both groups were alike. Additionally, the results indicated that the average length of nighttime sleep improved over the first five nights after admission for critically ill children in the study group when compared to the control group, with a significant difference noted between the two groups. This improvement is linked to the successful application of the guidelines, which had a positive effect on the sleep duration for critically ill children in the study group.

That's a significant reduction in severe sleep issues among critically ill children in the study group: First night: over a third struggled with sleep, Fifth night: down to 8%. This improvement suggests effective care or interventions. This trend shows that sleep quality scores improved for critically ill children in the study group, highlighting the positive effects of the guidelines. Concerning physiological parameters, the findings showed decreases in average pulse, breathing rate, and diastolic blood pressure in the study group after the guidelines were followed. This result is different from what Miller et al. (2018) found, which showed no changes in physiological measurements between injured children and the control group when technology was used to manage pain. Therefore, while the improvement in sleep quality linked to the guidelines is related to lower pulse, respiration, and blood pressure to normal levels, it does not have a strong direct impact on the injured tissue.

The findings from the recent research show that many critically ill children studied have mild to moderate issues with sleep, and these problems are linked to physiological parameters like temperature, pulse, breathing rate, and blood pressure. The connection can be explained by the significant effect that frequent sleep problems have on these physiological parameters. Sauvet et al., (2016) , looked into how a lack of sleep affects blood vessel function in healthy people and found that sleep issues raise the sympathetic nervous system activity, which causes higher blood pressure and heart rate. Similarly, Menear and his team in 2017 studied how assessing sleep quality often and using methods to improve sleep in the ICU impacts health. They reported that bad sleep quality leads to important changes in heart rate, blood pressure, and breathing. Likewise, Yue and others in 2017 examined how sleep quality relates to blood pressure in Chinese individuals and discovered a similar positive connection.

The results of this study show that many critically ill children with mild to moderate sleep problems had not been previously admitted to the Coronary Care

Unit (CCU). This point to the idea that the stress, both physical and mental, that comes with being admitted to the CCU can have a harmful effect on how well they sleep. In research done by Daneshmandi and colleagues in 2012, which was called "Effect of Eye Mask on Sleep Quality in Children with Acute Coronary Syndrome," involving 60 kids, it was found that more than half were admitted to the unit for the first time. This suggests that the anxiety linked to being admitted to the CCU might lead to poorer sleep quality. Likewise, in a study by Magdy et al. (2019) reporting that over two-thirds of the children in their study were first-time admissions to a respiratory ICU.

The study found a strong positive correlation between sleep quality and physiological parameters in critically ill children, likely due to successful guideline implementation. This aligns with previous research: Chan et al. (2017) found notable differences in sleep quality among children receiving interventions based on guidelines. Kamdar et al. (2018) discovered that sleep deprivation worsened respiratory muscle fatigue and breathing rate. These findings highlight the importance and effectiveness of guidelines in improving sleep quality and physiological parameters in critically ill children.

Conclusion

The current study's findings and research hypothesis indicate that the implementation of guidelines, the study found significant improvements in sleep quality and physiological parameters among critically ill children in the study group compared to those in the control group..

Recommendations:

The recommendations outlined below are derived from the findings of the current study: -

- The results indicate that critical care healthcare professionals should receive training on assessing sleep and implementing measures to ensure sufficient sleep, which should then be integrated into the standard care practices for critically ill pediatric patients in Critical Care Units.
- Additional research involving a larger cohort of children is necessary to enhance the generalizability of these findings.

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