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A Sleep Bundle Intervention to Promote Sleep Quality and Reduce Incidence Rate of Delirium among Critically Ill Patients

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Abstract: Background: Sleep disruption is strongly linked to delirium, a common and serious complication in ICU patients, associated with longer hospital length of stays, higher mortality, and long-term cognitive decline. Sleep bundle interventions are multifaceted strategies designed to enhance sleep quality and reduce the risk of delirium in intensive care units (ICUs). **Purpose:** This study aimed to evaluate the effectiveness of a sleep bundle intervention to promote sleep quality and reduce incidence rate of delirium among critically ill patients. Setting: Medical, Surgical, and Anesthesia ICUs in a tertiary care hospital. Sample: A convenience sample of 120 critically ill patients. **Design:** Quasi-experimental design. **Instruments:** Demographic and clinical data sheet; Sleep Quality Scale Index; Richards-Campbell Sleep Questionnaire; Intensive Care Delirium Screening Checklist (ICDSC); Confusion Assessment Method for the ICU (CAM-ICU); and APACHE II scale. **Results:** the intervention group showed significantly better sleep quality (31.78 ± 13.86) compared with the control group (54.38 ± 10.93) ($p < 0.001$). The incidence of delirium was significantly lower in the intervention group (0.33 ± 0.91) than the control group (0.83 ± 1.29) post-intervention ($p = 0.03$). The ICU length of stay was significantly shorter in the intervention group (4.15 ± 1.27 days) compared with the control group (4.75 ± 1.64 days; $p < 0.05$). There was a significant positive correlation between severity of illness and delirium incidence rate in the study group ($r = 0.619$, $p < 0.001$) and the control group ($r = 0.689$, $p < 0.001$). Co-morbidities also correlated positively with delirium in the study group ($r = 0.375$, $p < 0.001$) and control groups ($r = 0.617$, $p < 0.001$). **Conclusion:** Sleep bundle intervention effectively improved sleep quality, reduced delirium incidence rate, and shortened ICU length of stay among critically ill patients. **Recommendation:** Integrating sleep bundle intervention into routine ICU care is recommended to enhance clinical outcomes among critically ill patients.

Keywords: *Critically ill patients, Delirium, Sleep disturbance, Sleep bundle intervention, Sleep quality*

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1. Introduction

Critically ill patients admitted to Intensive Care Units (ICUs) frequently experience a range of physiological and psychological complications that negatively affect their recovery and long-term outcomes [1,2]. Sleep disturbances are particularly common complications among critically ill patients, affecting approximately 66% of patients, with nearly 28% continuing to experience poor sleep even 12 months after ICU discharge [3].

Sleep is a fundamental biological necessity essential for physical restoration, cognitive functioning, and emotional stability. It is a reversible and cyclical state characterized by reduced responsiveness to environmental stimuli, allowing crucial physiological recovery processes to occur. Good sleep quality is strongly linked to improved immunity and better clinical outcomes, whereas sleep deprivation contributes to cognitive impairment and multiple physiological disorders [4].

Sleep disturbance is one of the most frequently reported concerns among ICU patients. More than 60% of critically ill patients experience severely disrupted sleep patterns, characterized by poor subjective sleep quality, altered circadian rhythms, and reduced restorative sleep stages [5]. In Egypt the prevalence appears even higher exceeding 70%, largely due to persistent environmental stressors such as equipment alarms, continuous lighting, and frequent nursing interventions [6]. A recent prospective study involving 120 critically ill Egyptian patients reported that moderate-to-severe sleep disturbances

increased from 20% on admission to more than 55% by day seven, with prolonged ICU stay and mechanical ventilation being major contributing factors [7].

Sleep disruption in the ICU is attributed to both environmental factors (noise, light, and frequent procedures) and clinical factors such as severity of illness. Such factors disrupt normal sleep architecture by reducing total sleep duration, limiting slow-wave sleep, and diminishing REM sleep. Consequently, patients may develop cognitive impairment, mood disturbances, and an increased risk of delirium [8]. Additional risk factors such as advanced age, mechanical ventilation, sedative use, pain, anxiety, and co-morbidities further exacerbate poor sleep quality and increase delirium risk [7].

Delirium, an acute neuropsychiatric syndrome characterized by fluctuating cognitive dysfunction and inattention, affects up to 87% of ICU patients. Delirium shares multiple features with sleep deprivation, including perceptual disturbances and cognitive impairment [9]. Sleep disruption is considered one of the most significant precipitating factors for delirium, contributing to circadian rhythm disorder and prolonged ICU hospitalization [10].

Poor sleep quality presents significant challenges in ICU care affecting patient comfort, immune function, cognitive recovery, and overall prognosis. The strong association between sleep disturbance, anxiety, and delirium highlights the importance of early and effective interventions [11]. Non-pharmacological strategies, such as sleep-bundle interventions, have been recommended to reduce sensory overload. Evidence from clinical studies indicates that sleep bundles are simple, safe, and effective interventions for improving sleep quality among ICU patients [12]. Sleep bundles integrate multiple non-pharmacological practices including noise reduction, light control, relaxation techniques, and optimized care schedules. These bundles align with the Institute for Healthcare Improvement (IHI) model, which advocates combining several evidence-based practices to achieve superior outcomes [9]. Emerging evidence suggests that comprehensive sleep-promotion protocols may be more effective than single-component interventions [13].

Critical care nurses play essential role in mitigating the negative effects of sleep disturbances through evidence-based therapeutic strategies aimed at enhancing sleep and reducing complications such as delirium [14].

2. Significance of the Study

Poor sleep quality in critically ill patients is a central determinant of patient recovery and prognosis. The strong interaction between sleep disturbance, anxiety, and delirium highlights the urgent need for early, evidence-based interventions. Despite these risks, sleep preservation remains under prioritized in ICU protocols. ICU protocols often prioritize immediate medical needs over sleep preservation. Current interventions are fragmented, and there is limited evidence on systematic, early, and effective strategies to improve sleep quality in critically ill patients. Findings generated from the current study has the potential to transform critical care nurses' practices, improve patient outcomes, and set new standards for critical care nurses practices across acute setting and reducing healthcare costs by shortening ICU length of stays, lowering complication rates, and improving long-term outcomes.

3. Purpose of the Study

The study aimed to examine the effect of sleep bundle interventions on sleep quality and the incidence rate of delirium among critically ill patients.

4. Definitions of Variables

Dependent Variables:

Sleep Quality: Theoretically defined as overall satisfaction with the sleep experience, including sleep efficiency, latency, duration, and wakefulness after sleep onset [15]. In the current study, sleep quality is operationally defined as the maintained individual score of the Richards-Campbell Sleep Questionnaire (RCSQ), where scores <50 indicate poor or disturbed sleep [16].

Delirium Incidence Rate: Theoretically defined as an acute cognitive disorder characterized by confusion, inattention, and altered awareness [17]. In the current study, delirium incidence rate is operationally defined as the maintained individual score of the Intensive Care Delirium Screening Checklist (ICDSC), with scores >4 indicating delirium [18].

Independent Variables:

A Sleep Bundle Intervention: Theoretically defined as a structured set of evidence-based practices implemented collectively to improve patient outcomes [19]. In the current study, Sleep bundle Intervention is operationally defined as a three daily sessions delivered in (morning, afternoon, and night), each lasting 30 minutes, over seven consecutive days [9].

5. Hypotheses

1) Critically ill patients who receive the sleep bundle intervention will have a lower incidence rate of delirium compared with patients who receive routine hospital care.

2) Critically ill patients who receive the sleep bundle intervention will have better sleep quality than those who receive routine hospital care.

3) There is a relationship between the incidence rate of delirium and severity of illness among critically ill patients.

4) There is a relationship between the incidence rate of delirium and co-morbid conditions among critically ill patients.

5) There is a relationship between the demographic characteristics (such as age and gender) and the incidence rate of delirium among critically ill patients.

6. Methods

Research Design: A quasi-experimental design (control/study) was utilized.

Setting: The study was conducted in the Medical,

Surgical, and Anesthesia Intensive Care Units (ICUs) at a tertiary hospital, Egypt.

Sample: A convenience sample of 120 critically ill patients was collected over an eight-month period from May 2024 to December 2024. During this period, 200 critically ill patients were initially screened for eligibility. Eighty patients were excluded based on the exclusion criteria, leaving 120 eligible patients. These patients were monitored daily for potential enrollment into the sleep bundle intervention. Patients were randomly and alternately assigned into two equal groups; 60 patients to the intervention group, and 60 patients to the control group.

Eligible patients met the following criteria: a) aged 18–65 years; b) both sexes; c) able to communicate; and d) free from cognitive impairment to avoid interference with the intervention. Patients were excluded if they had: a) ear or eye disorders, delirium, or pre-existing sleep disorders upon admission (e.g., insomnia or obstructive sleep apnea); b) receiving sedative or narcotic medications during the study period; and c) medical conditions interfering with foot-bath application such as eczema, phlebitis, cellulitis, or vascular diseases.

Sample size calculation:

The sample size was calculated using G*Power software. A power level of 85% was considered adequate to detect a difference in the proportion of patients receiving the sleep bundle intervention, with a significance level of 0.05 and a small effect size (0.5). The effect size was based on a previous study [20], which reported a modest yet clinically relevant improvement in sleep quality after implementing a sleep bundle. Accordingly, the final required sample size was 120 patients.

Instruments of Data Collection

Instrument I: A Demographic and Clinical Data Sheet:

The researcher collected data on the patient's age, gender, and clinical data such as medical diagnosis and ICU length of stay. These data were extracted from the patient's medical record by the researcher at the initial point of data collection after ICU admission to the medical, surgical and anesthesia ICU.

Instrument II: Richard Campbell Sleeping Questionnaire (RCSQ):

It was developed by Richards et al. [21]; the RCSQ is a self-report, paper and pencil scale that takes approximately two minutes to complete. It consists of five items evaluating perceived sleep depth, sleep latency (time to fall asleep), number of awakenings, sleep efficiency (percentage of time awake), and over all sleep quality

The scale ranges from 0 to 100 mm, and scores are calculated by measuring responses on each line. The total score is calculated by summing the individual scores (out of 100) and dividing the total by five. Lower scores indicate poorer sleep quality (bad sleep: RCSQ score<50), while higher scores reflect a better sleep quality (good sleep: RCSQ score ≥50). Internal reliability of the Questionnaire (RCSQ) was high consistent with pervious findings [16]. In the present study, the scale reliability (test-retest and internal consistency) yielded Cronbach's alpha = 0.91 (P < 0.001)

Instrument III: Intensive Care Delirium Screening Checklist (ICDSC):

It was developed by Bergeron [18], the ICDSC assesses the presence of delirium using of eight items, which evaluate: altered level of consciousness, inattention, disorientation, hallucination or delusion, psychomotor agitation or retardation, inappropriate mood or speech, sleep/wake cycle disturbance, and symptom fluctuation. The Scoring system ranging from 0 to 8; a score of (0) indicates no delirium, 1-3 indicates as sub syndromal delirium and 4-8 indicates full delirium.

The validity of the ICDSC has demonstrated high specificity (98-100%) and strong internal consistency (r =0.952 p-value <0.001) [18]. The Inter rater reliability of the ICDSC was also high (kappa = 0.96; 95% confidence interval, 0.92-0.99) [22]. In the present study, the scale's reliability (test-retest and internal consistency) yielded Cronbach's alpha = 0.91 (P < 0.001)

Instrument IV: Acute Physiology and Chronic Health Evaluation II (APACHE II) Scale:

The APACHE II scale was developed by Knaus et al., [23]. APACHE II was designed to measure the illness severity for patients within 48 hours of ICU admission. The APACHE II score ranged from 0 to 71 and was computed based on several measurements such as patient's age and 12 routine physiological measurements: PaO_2 (depending on FiO_2), Body Temperature, MAP, pH, HR, RR, Serum Sodium and Potassium, Creatinine, Hematocrit, White Blood Cell Count, GCS. The scoring system of the scale interpreted as: 5 to 9 had 8% mortality risk, 10 to 14 had 15% mortality risk, 15 to 19 had 25% mortality risk, 20 to 24 had 40% mortality risk, 25 to 29 had 55% mortality risk, 30 to 34 had 75% mortality risk and >34 had 85% mortality risk.

The reliability of the APACHE II Scale was reported in a study of two hundred mechanically ventilated patients. Internal consistency was evaluated using Cronbach's alpha and was 0.95 (p<0.001) for the total scale [24]. The validity of the APACHE II scale was shown to be high when used in critically ill patients with Bravais-Pearson Correlation Co-efficient, 0.86 (p<0.01) [25]. In the present study, test-retest reliability on 10 patients produced Cronbach's alpha = 0.89 (p<0.001).

Instrument V: Charlson Co-morbidity Index (CCI):

The Charlson Co-morbidity Index was designed to categorize co-morbidities of patients based on the International Classification of Diseases (ICD). It consists of 19 categories of co-morbidity and predicts the ten –year survival in patient with multiple co-morbidities. Each condition is assigned with score from 0 to 6 depending on the risk of dying associated with this condition. A score of zero indicates that no co-morbidities were found and higher scores indicating greater co-morbidity. Patients with a score >5 have essentially a 100% risk of dying at one year [26]. The scoring system of the scale interpreted as: 0 points had 98% estimated 10-year survival, one point had 96%, two points had 90%, three points had 77 %, four points had 53%, five points had 21%, six points had 2%, and seven points or more had 0% estimated 10-year survival. The internal consistency in prior studies ranged from 0.86 to 0.95 [27]. In the present study, Cronbach's alpha was 0.92 (P < 0.001).

Instrument VI: Confusion Assessment Method in the ICU (CAM-ICU).

The CAM-ICU was developed by Ely et al. [28], as tool for assessing delirium in ICU patients. Delirium is

diagnosed based on the presence of Feature 1 and 2, and along with either feature 3 or 4. The CAM-ICU has shown high inter rater reliability (kappa = 0.96; 95% confidence interval, 0.92-0.99) and excellent validity with sensitivity of 100%, specificities of 98% [28]. In the present study, internal consistency (Cronbach's alpha) was 0.96 and concurrent validity with Pearson correlation (r=0.952; p <0.001).

Instrument VII: Sleep Quality Scale (SQS):

The Sleep Quality Scale Index was developed by Yi et al. [29], to evaluate the overall sleep quality across multiple domains including sleep latency, duration, disturbances, efficiency, and daytime dysfunction. The Scale consists of 28 items rated from 0 to 6, where 0 indicates no sleep problems and higher scores reflect increasing sleep disturbances severity. The scoring system of the scale is interpreted as follows: 0 points indicate optimal sleep quality, 1 to 3 points represent mild sleep disturbance, 4 to 6 points indicate moderate disturbance, and scores above 6 signify severe sleep impairment affecting daily functioning.

The SQS has demonstrated high internal consistency, with a Cornbrash's alpha coefficient of 0.92, and test-retest reliability (r = 0.81), [29]**.** In the present study, a test-retest reliability yielded a Cronbach's alpha of 0.91 (p < 0.001), confirming the scale's reliability in this patients.

Ethical Consideration

Ethical approval was obtained from the Faculty of Nursing, Menoufia University Research Ethics Committee (Approval No. 894). Official permissions were granted by hospital administration. Written informed consent was obtained from patients or their legal guardians prior to participation and the study procedures were explained to participants. Researcher explained that the only harm that could happened that the participants may experience little emotional distress from answering the questions. Confidentiality was guaranteed by coding patient data and storing data sheets in locked cabinets.

Pilot Study

A pilot study was conducted on 10% of the sample (12 patients) to assess the feasibility and applicability of the instruments and to estimate the time required for data collection. Participants in the pilot study were excluded from the final data analysis.

Data Collection Procedure:

Patients were approached over an eight- month period from the beginning of May 2024 to the end of December 2024. During that period, 200 patients were admitted to the ICU. Participants were screened based on the study inclusion and exclusion criteria. A total sample of 120 critically ill adults' patients was randomly assigned into two equal groups, 60 patients in the study group and 60 in the control groups. Data collection for the control group was completed first to prevent contamination. The control group received routine hospital care; the study group received the sleep bundle intervention.

Participants in both groups were recruited from the Medical, Surgical and Anesthesia Intensive Care Units to collect the data about baseline assessments which included the demographic and clinical data such as, age, sex and medical diagnosis, (2) The Richard Campbell Sleeping Questionnaire (RCSQ) were used to assess the sleep quality; (3) The Intensive Care Delirium Screening Checklist (ICDSC) were used to assess incidence rate of delirium at baseline and on the 7th day post intervention; (4) Acute Physiology and Chronic Health Evaluation II (APACHE II) Scale used to assess data about the illness severity and predict mortality; 5) Charlson Co-morbidity Index was used to categorize patients co-morbidities . 6) Confusion Assessment Method (CAM –ICU); was used to assess the incidence rate of delirium at baseline and on the 7th day post intervention. 7) Sleep quality scale was used to evaluate the overall sleep quality.

Daily RCSQ assessments were conducted each morning. Delirium screening with CAM-ICU and ICDSC was performed twice daily (morning and evening) to assure early detection of cognitive changes. Post-intervention measurements using the same instruments were collected on the 7th day for both groups. All assessments were documented immediately after each evaluation. At the end of the seven-day period, data were collected for both groups. The researcher supervised data collection and assured adherence to the protocol.

Control Group (Routine Care):

The control group received routine hospital care, which included analgesics administration, turning off the medical device alarms or dimming lights when appropriate, and repositioning the patients every two hours. Sleep quality and delirium incidence rates were measured at baseline and on day 7 post-intervention.

Study Group (Sleep Bundle Intervention):

Prior to implementation, a brief educational session was delivered to patients and nursing staff to introduce the intervention, reduce anxiety, and promote cooperation. Supplies including eye mask, ear plug, air freshener and baby oil for massage were prepared. The sleep bundle intervention was delivered three times daily (morning, afternoon, night) each session lasting 30 minutes for seven consecutive days to improve sleep quality and reduce incidence rate of delirium [30].

Component of the sleep bundle intervention:

1. Relaxation and comfort measures: Positioning patient in semi-flower position; maintaining a calm environment using air freshener to eliminate unpleasant odors; optimized pain control through non-pharmacological distraction (conversation and reassurance), foot bath and back massage. If pain was severe, analgesics were administered per physician ordered.

2. Foot bath: Patient placed in semi-fowler position; basin filled with warm water to the ankle; foot baths for 10 minutes followed by rest. Foot bathing was stopped immediately if the patient reported pain or discomfort.

3. Back massage: Patient positioned with pillows to support the chest and between legs; baby oil used to facilitate smooth strokes and enhance patients comfort during intervention. Effleurage and stroking (Effleurage was basically a form of massage involving a circular stroking movement made with the palm of the hand) techniques were applied from iliac crest toward the supra clavicular and axillary regions.

4. Environmental modifications: Light control (closing curtains, dimming lights) and noise reduction (asking staff to set monitors to night mode if possible, restrict non-clinical conversation near patients, and instruct staff or visitors to speak quietly).

5. Use the earplugs and eye mask: patients were

encouraged to wear earplugs and eye mask nightly for 7 consecutive days; typically, from 9 p.m. to 7 a.m. or during the patient's usual sleep period. Earplugs and eye mask were provided by the researcher.

6. Reorientation and circadian support: orientation to time, and place using a calendar and an analogue clock or the patient's phone; staff encouraged to state date/ time; open the curtains in the morning to reinforce day-night cues.

7. Early mobilization and activity**:** mobilize the patient as early as clinical feasible. Patients were encouraged to get out of bed when able; range of motion (ROM) exercise for upper and lower extremities were performed by patients or assisted by the researcher for 10 minutes, 2-3 times daily when out-of-bed mobilization was not possible.

Daily RCSQ assessments were performed each morning. CAM-ICU and ICDSC were used twice daily to screen for delirium. All assessments and intervention were recorded; adherence to the protocol was supervised by the researcher to maintain reliability and minimize bias.

Statistical Analysis:

Data were coded, entered, and analyzed using IBM SPSS the Statistics version 22. Descriptive statistics (means and standard deviations) summarized quantitative variables; frequencies and percentages summarized categorical variables. The Chi-square test (χ^2) assessed associations between categorical variables. Independent samples t-test compared mean scores between the control and intervention groups. Paired samples t-test evaluated within-group changes from baseline to post-intervention. Pearson correlation analysis explored relationships between continuous variables. All tests were two-tailed. A p-value of ≤ 0.05 was considered statistically significant; a p-value of ≤ 0.001 was considered highly significant.

7. Results

Characteristics of the Study Sample:

A total of 120 adult patients admitted to the Medical, Surgical, and Anesthesia ICUs were recruited over an eight-month period (May–December 2024). Participants were randomly assigned into two equal groups: a study group (n = 60) receiving the sleep bundle intervention and a control group (n = 60) receiving routine ICU care.

Table 1 shows that there were no statistically significant differences between the groups regarding demographic characteristics. The mean age of participants in the study and control groups was (58.78 ± 15.42) and (53.76 ± 14.09) years, respectively (p = 0.06). Regarding gender distribution, males represented 58.3% of the study and 48.3% of the control groups (p = 0.27).

Table 2 indicates that no statistically significant differences existed between the groups regarding clinical diagnoses or illness severity indicators. Cardiac disorders were the most frequent diagnosis (30% and 23.3%) in the study and control groups, respectively (p = 0.50). The mean APACHE II score was slightly higher in the study group (11.88 ± 5.07) compared to the control group (10.11 ± 6.04), but this difference did not reach statistical significant (p = 0.08). Similarly, the Charlson Co-morbidity Index did no significantly differ between groups, with mean scores of (3.0 ± 1.78) and (3.83 ± 0.97) for the study and control groups, respectively (p = 0.20).

Table 1. Demographic Characteristics of the Studied Sample (N=120)

Demographic Characteristics	Study Group (n=60)		Control Group (n=60)		Test	P -value
	No	%	No	%		
Age X ± SD	58.78 ±15.42		53.76 ± 14.09		t test =1.89	0.06
Gender						
Male	35	58.3%	29	48.3%	X^2=1.20	0.27
Female	25	41.7%	31	51.7%		

Not significant (p value>0.05) **t test**: Student t- test **X^2**: Pearson Chi-square test

Table 2. Clinical Data of the Studied Sample (N=120)

Clinical Data	Study Group (n=60)		Control Group (n=60)		Test	P -value
	No	%	No	%		
ICU Diagnosis						
Respiratory disorder	4	6.6%	5	8.3%	$X^{2=}$12.32	0.50
Cardiac disorder	18	30%	14	23.3%		
Renal disorder	11	18.3%	12	20%		
Neurological disorder	15	25%	22	36.6%		
Endocrine disorder	9	15%	7	11.6%		
Liver disorder	1	1.6%	0	0%		
Leukemia	2	3.3%	0	0%		
APACHE II Score (X ± SD)	11.88 ±5.07		10.11 ± 6.04		t test =1.73	0.08
Charleson comorbidity index Score (X ± SD)	3.0±1.78		3.83±0.97		t test =1.27	0.20

Note: not significant (p value>0.05) **t test**: Student t- test **X^2**: Pearson Chi-square test

Table 3. Effect of Sleep Bundle Intervention on Delirium Incidence Rate among the Studied Groups Post Intervention (N=120)

Incidence Rate of Delirium	Study Group (n=60)				Control Group (n=60)				Test	P -value
	Pre- intervention		Post-intervention		Pre- intervention		Post- intervention			
	N	%	N	%	N	%	N	%		
Presence of Delirium	0.0	0.0%	6	10%	0.0	0.0%	15	25%	$X^2 = 4.67$	
Absent of Delirium	60	100%	54	90%	60	100%	45	75%		0.03
CAM-ICU Score X ± SD	0.00 ± 0.00		0.33±0.91		0.00 ± 0.00		0.83±1.29		t test =2.44	0.01
ICDSC Score X ± SD	0.00 ± 0.00		0.33±0.91		0.00 ± 0.00		0.83±1.29		t test =2.44	0.01

Significant (p value<0.05) **t test**: Student t- test **X^2**: Pearson Chi-square test

Table 3 demonstrates that 10% of patients in the study group developed delirium post-intervention compared to 25% of the control group, representing a statistically significant reduction in delirium incidence rate after the sleep bundle intervention (p = 0.03). Additionally, both CAM-ICU and ICDSC mean scores were significantly lower in the study group compared to control group, after the intervention (p = 0.01), confirming the effectiveness of the sleep bundle in reducing delirium.

Table 4. Effect of Sleep Bundle Interventions on Sleep Quality among Studied Patients Post Intervention (N=120)

Sleep Quality	Study Group X ± SD (n=60)	Control Group X ± SD (n=60)	T test	P - value
Sleep Quality Scale				
Pre-intervention	56.31±17.29	54.83 ± 11.14	0.55	0.57
Post-intervention	31.78±13.86	54.38±10.93	9.91	<0.001
Paired t test P value	0.64 <0.001	0.94 <0.001		
Richard Campbell Sleep Questionnaire				
Pre-intervention	55.25±9.54	57.13±8.05	1.16	0.24
Post-intervention	79.778±8.10	57.10±7.99	15.48	<0.001
Paired t test P value	0.45 <0.001	0.76 <0.001		

Not significant (p value>0.05); highly significant (p value<0.001); **t test**: Student t- test, Paired t test

Table 4 shows a highly significant improvement in sleep quality in the study group after the intervention. The mean post-intervention Sleep Quality Scale score decreased to (31.78 ± 13.86) in the study group compared to (54.38 ± 10.93) in the control group (p < 0.001), indicating markedly better sleep quality following the intervention. Similarly, using the Richards-Campbell Sleep Questionnaire, the study group demonstrated substantial improvement (79.78 ± 8.10) compared to the control group (57.10 ± 7.99) (p < 0.001). Paired t-tests analysis confirmed significant within-group improvement only in the study group, supporting the effectiveness of the sleep intervention.

Table 5. Effect of Sleep Bundle Intervention on ICU Length of Stay of the Studied Sample Post Intervention (N=120)

Items	Study Group (n=60) X ± SD	Control Group (n=60) X ± SD	Independent t test	P – value
ICU length of Stay	4.15 ± 1.27	4.75 ± 1.64	2.23	<0.05

Note: significant (p value<0.05) **t test**: Student t- test

Table 5 shows that the study group had a significant shorter ICU length of stay (4.15 ± 1.27 days) compared to the control group (4.75 ± 1.64 days) (p < 0.05). This suggests that improved sleep quality and reduced delirium contributed to faster recovery and ICU discharge.

Table 6. Relationship between Delirium Incidence Rate, Severity of Illness and Co-morbidity Conditions among Study and Control Groups Post Intervention (N=120)

Items	Incidence Rate of Delirium			
	Study Group (n=60)		Control Group (n=60)	
	R	P – value	R	P –value
Severity of Illness (APATCH II Score)	0.619**	< 0.001	0.689**	< 0.001
Co-Morbidity Conditions (CCI score)	0.375**	< 0.001	0.617	< 0.001

**. Correlation is highly significant at the 0.01 level (2-tailed).

Table 6 reveals significant positive correlation between APACHE II score and delirium incidence rate in both groups (r =0.619, p<0.001) (r= 0.689, p<0.001) post interventions. Similarly, co-morbidities were positively correlated with delirium occurrence in the study (r =375, p<0.001) and control groups (r = 0.617, p<0.001), post interventions. These findings indicate that patients with higher illness severity or multiple co-morbidities were more likely to developed delirium.

Table 7. Relationship between Sleep Quality and Severity of Illness and Co-morbidity Conditions for the Study and Control Groups Post Intervention (N=120)

Items	Sleep Quality			
	Study Group (n=60)		Control Group (n=60)	
	R	P – value	R	P –value
Severity of Illness (APATCH II)	-0.317*	< 0.01	-0.215	< 0.05
Co-morbidity Conditions	-0.327**	< 0.01	-0.277	< 0.05

*. Correlation is significant at the 0.05 level (2-tailed).

Table 7 indicates a significant negative correlation between sleep quality and severity of illness in both the study and the control group post intervention with (r = -.0317; p<0.01) and (r = -0.215; p<0.05), respectively. Additionally, sleep quality correlated negatively with co-morbidities (r = –0.327; p < 0.01) in the study group and (r = –0.277; p < 0.05) in the control groups after the intervention. This result demonstrates that higher severity

of illness and increased co-morbidity was associated with poorer sleep quality.

Table 8. Relationship between Delirium Incidence Rate and Demographic Characteristic among the Study and Control Groups Post Intervention (N=120)

Items	Incidence of Delirium			
	Study group (n=60)		Control group (n=60)	
	R	P –value	R	P –value
Age	0.414	< 0.05	0.361	< 0.05
Gender	0.462	< 0.05	0.309	< 0.05

Table 8 shows statistically significant correlation between delirium incidence and age and gender in both groups ($p < 0.05$). This indicates that demographic characteristics influenced delirium development among the studied sample.

8. Discussion

Sleep disturbance is one of the most prevalent and challenging issues among critically ill patients in the ICU and has been identified as a major contributor to delirium development [31]. Consequently, implementing structured, non-pharmacological sleep bundle interventions such as eye masks, earplugs, relaxation strategies, massage, foot baths, and music therapy has become an essential nursing approach to improve sleep quality and reduce delirium risk [32].

Demographic Characteristics:

In the present study, more than half of the participants were middle-aged adults. This finding aligns with Yayla et al. [32], who reported that ICU admissions in Nigeria were predominantly among individuals aged 20–59 years. Similarly, Akinosoglou et al. [33] found that younger and middle-aged adults accounted for over half of ICU admissions in Spain. These consistent findings indicate that middle-aged individuals represent a substantial proportion of ICU populations across different settings, supporting the demographic pattern observed in the current study.

Effect of the Sleep Bundle Intervention on Delirium Incidence Rate:

Delirium remains a serious and frequent complication among critically ill patients, often triggered by sleep disruption, sensory overload, and environmental factors [34]. The study hypothesized that critically ill patients who receive the sleep bundle intervention will have a lower incidence rate of delirium compared with that receiving routine hospital care. The findings of the current study strongly supported this hypothesis and indicated a statistically significant decline in delirium among the intervention group compared with the control group post-implementation.

These findings are consistent with Karimi et al. [30]; Fahmy et al. [9]; Akpinar et al. [35], all of whom reported notable reductions in delirium following sleep bundle application. Similar outcomes were reported by kitsisin et al. [36]; Yayla et al. [32]; Lange et al. [37]; Sayed et al. [11], affirmed the effectiveness of multiple component of sleep strategies in lowering delirium rates. Further, Alegría et al., [38]; Kiliç & Kav [39], El-Maksoud & Khalil [40] highlighted that combining earplugs, eye masks, and clustered care significantly decreased nighttime disturbances and consequently reduced delirium.

However, the results of the present study are different from what was reported by Zhang et al. [41] who investigated the effect of sleep bundle strategies on delirium occurrence on ICU patients and did not observe any differences in delirium incidence rate between the studied groups. A possible rationale of Zhang's study results could be due to the use of a small, heterogeneous sample and inconsistencies in intervention delivery. These methodological issues may explain the variation in the outcomes.

Effect of the Sleep Bundle on Sleep Quality:

Sleep disruption is highly prevalent in ICU environments and is linked to poor outcomes, including impaired cognition and prolonged recovery Ruiz-Zaldibar et al. [42]. Sleep bundles demonstrate consistent improvements in both subjective and objective sleep measures that may enhance sleep quality through increase in total sleep time, sleep efficiency, slow-wave sleep percentage, and REM duration when bundles are well implemented Eschbach & Wang [19]. This conclusion is reinforced by studies conducted by Scott et al., [17]; Bellon et al. [43] all of whom reported better sleep quality following implementing sleep bundle. Study by Gorecki & Prasun [44], which observed positive effects of the sleep bundles intervention on sleep quality of both groups. These collective findings support the hypotheses of the present study suggested that critically ill patients who received the sleep bundle intervention having better sleep quality than those who received routine hospital care. The mean sleep scores improved significantly in the intervention group, demonstrating the effectiveness of the sleep bundle.

These results are in line with Xie et al. [45], who documented improvements in sleep quality following sleep-focused interventions. Similarly, Soh et al. [46] supported the positive effects of structured sleep bundles on minimizing sleep fragmentation and promoting continuous, deeper sleep. Also, Piller et al. [47] highlighted improvements in sleep outcomes through environmental modification and sensory protection.

In contrast, the study finding was different from what was found by Tonna et al. [48], who reported that sleep bundle intervention didn't improve sleep quality among ICU patients and found mixed outcomes. A possible reasoning of their study outcomes may be because of the persistent ICU stressors such as mechanical ventilation, frequent procedures, and inadequate environmental control may have limited the effectiveness of sleep interventions in their studies.

Effect of the Sleep Bundle on ICU Length of Stay:

Sleep disturbance in critically ill patients has been strongly linked to prolonged ICU length of stay, and adverse clinical outcomes Gorecki & Prasun [44]. Our study hypothesized that critically ill patient who receive the sleep bundle intervention will have reduced ICU length of stay than patients who receive routine care. The study findings showed a significant reduction in ICU length of stay among the intervention group, supporting the hypothesis that improving sleep quality and lowering

delirium incidence speed up the recovery. These results are consistent with studies by Zhang et al. [41]; Kang et al. [20]; Lange et al. [37] and Sayed et al., [11], which demonstrated that sleep-promoting interventions contribute to shorter ICU length of stays.

Conversely, the study outcomes were different from the results reported by Larsen, et al. [49], who found that sleep bundle intervention did not significantly reduced ICU length of stay. A possible explanation of Larsen's study results may be due to delayed implementation of the intervention, inconsistent practices, or the inclusion of patients with advanced organ failure, who may be less responsive to sleep-enhancing strategies.

Relationship between Delirium and Severity of Illness:

The study revealed a strong positive association between illness severity (APACHE II) and delirium incidence. Patients with higher APACHE II scores experienced significantly more delirium episodes. This finding supported the current study hypothesis that there was a relationship between severity of illness and delirium incidence rate. Similar results were reported by Andrews et al. [50]; Rosgen et al. [51], who noted that greater physiological instability increases vulnerability to acute cognitive dysfunction. In contrast, the study results were in difference with Ali et al. [17], who didn't observe this relationship between illness severity and delirium incidence rate. A potential explanation of Ali's study findings would be likely due to their sample's stable hemodynamic status and narrow severity range.

Relationship between Delirium and Co-morbidities:

Patients with multiple chronic conditions are more susceptible to developing delirium due to cumulative physiological decline, reduced cognitive reserves, polypharmacy, and the increased likelihood of metabolic disturbances. A significant positive correlation was observed between the number of co-morbidities and delirium incidence. Patients with cardiovascular, metabolic, or neurological co-morbidities were more prone to developing delirium. This aligns with findings from Feinkohl et al. [52]; Denk et al., [53] and Mossello et al., [54], who found a significant correlation between the presence of co-morbidities and the onset of delirium, particularly in patients with a history of chronic liver disease, diabetes. Nevertheless, the results of present study are different with what was illustrated by Choutko-Joaquim et al. [55], who reported no significant relationship between the co-morbidities and delirium incidence rate. A potential explanation of their study's findings may be due to lack of standardized methods for documenting co-morbidities or restricted variability in their sample.

Relationship between Delirium Incidence and Age and Gender:

Demographic factors have been increasingly recognized as influential determinants in the incidence and progression of delirium among critically ill patients. Variables such as age, gender, have shown significant associations with delirium development, particularly in intensive care [56]. The present study hypothesized that there is a relationship between demographic characteristics (such as age and gender) and the incidence rate of delirium among critically ill patients. The study found a significant association between age, gender, and delirium incidence. The results of the present study are comparable to those observed by Ahn et al. [57]; Huang et al., [58] and Bae et al., [56], who found independent predictive effect of age or gender on incidence of delirium. In contrast, the study results were in difference with Choutko-Joaquim et al. [55], who didn't found a significant association among age, gender and the incidence of delirium. A potential explanation of Choutko-Joaquim's study findings may be due to older age and the cognitively impaired study populations.

Relationship between Sleep Quality and Severity of Illness:

A significant negative correlation was identified between illness severity and sleep quality; patients with higher APACHE II scores reported poorer sleep. This outcome is in agreement with Henriquez-Beltran et al., [59]; Srikanth et al., [60] and Ierodiakonou et al., [61], they found that the presence of the illness severity led to poorer sleep. However, our study finding was not in line with the outcomes reported by Wiedermann et al., [62], who found no association between illness severities and sleep quality. A potential reasoning of Wiedermann's research findings can be related to reflecting shorter ICU stays and limited severity variation in their sample**.**

Relationship between Sleep Quality and Co-morbidity:

The study found a significant negative association between co-morbidities and sleep quality. Patients with multiple chronic illnesses experienced poorer sleep due to physiological stress, inflammation, nocturnal interventions, and symptom burden. These findings are consistent with Zhou et al., [63], whom revealed that the presence of co-morbidities such as dementia, CVA, and chronic heart failure was significantly associated with poor sleep. However, Vitkova et al. [64], reported no association, likely due to a homogenous sample with limited co-morbidity variation.

Limitations of the Study

- Use of a convenience sample, which restricts the ability to generalize findings to broader ICU populations and the lack of randomization, introduces the potential for selection bias, which may affect the internal and external validity of the results.
- Conducting the study in a single ICU setting may further limit the applicability of the findings to other institutions with different staffing, environmental conditions, and care practice.

9. Conclusion

The study demonstrates that a structured sleep bundle is an effective, safe, and non-pharmacological nursing intervention that significantly reduces delirium incidence, improves sleep quality, and shortens ICU length of stay. Its beneficial effects extend across varying levels of illness severity and co-morbidity, reinforcing its suitability for routine integration into critical care practice.

Recommendations

- Integrate sleep bundle intervention into standard

ICU nursing protocol as a non-pharmacological approach to enhance sleep quality and reduce the incidence of delirium among critically ill patients.

- Apply Individualized, non-pharmacological sleep strategies such as massage, relaxation techniques, foot baths, and environmental modifications for conscious, non-sedated ICU patients.
- Provide ongoing staff training and awareness regarding the importance of the proper application of sleep bundle components to guarantee consistency and effective implementation of sleep-enhancing practice.

Implication for Nursing Practice

- Continuous professional training for critical care nurses and healthcare providers are essential to support routine use of sleep promoting interventions.
- Integrating sleep-promoting practices into daily ICU nursing care empowers nurses to deliver holistic, patient-centered interventions without relying on pharmacologic methods, thereby minimizing sedation-related complications.
- Developing standardized documentation tools for sleep bundle intervention improves consistency, facilitates evaluation, and promotes best practices in improving patient outcomes.

Implications for Future Research

- Investigate emerging technologies such as AI-based environmental control, wearable sleep sensors, eye-tracking for early delirium detection, and VR tools for circadian rhythm regulation.
- Explore mechanisms of circadian desynchronization in critically ill patients and its relationship with delirium and sleep disturbances to guide targeted interventions.

Replicate the study using larger, randomly selected samples across multiple ICU, to enhance generalizability and ensure broader population representation

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