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RESEARCH ARTICLE

SLEEP QUALITY AND CIRCADIAN RHYTHM DISRUPTION IN CRITICALLY ILL PATIENTS IN INTENSIVE CARE UNIT

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Abstract

Aim: The aim of this study was to evaluate the quality of sleep in critically ill patients in the Intensive Care Unit (ICU).

Method and Material: This study investigated the night-time sleep of 135 patients admitted to the general ICU of the General Hospital of Athens "G. Gennimatas" between January 2021 and December 2023. Data were collected using the Richards Campbell Sleep Questionnaire (RCSQ). Sensory stimuli, including noise, light, nursing activities, and invasive procedures, were reduced during the night to improve patients' sleep. Measures to reduce light included implementing special lighting during nursing tasks and using bedside lamps during care. Noise reduction strategies involved closing doors, minimizing monitor alarms, and discouraging staff from speaking near patient beds. Grouping patient care activities was also promoted to limit sleep disturbances.

Results: Patients in the intervention group showed improved sleep quality compared to the control group, with a significant overall RCSQ score ($p<0.05$). Gender and age did not significantly affect sleep quality. However, hospital stay duration differed between groups, with the control group experiencing shorter stays. A negative correlation was observed between the duration of hospitalization and sleep quality, with longer stays linked to lower RCSQ scores. Additionally, extended mechanical ventilation was associated with poorer sleep quality.

Conclusion: ICU patients often exhibit abnormal levels of alertness, poor quality of daytime sleep, disrupted nighttime sleep, and sleep patterns that lack both slow-wave and rapid eye movement (REM) sleep. Gaining a deeper understanding of the role circadian rhythms play in managing critical illness could pave the way for future chronotherapeutic strategies, enhancing clinical outcomes and promoting recovery for patients.

Key words: Intensive care unit, sleep quality, circadian rhythm.

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INTRODUCTION

Sleep disturbances are a prevalent issue among patients in Intensive Care Units (ICUs), with sleep deprivation and circadian rhythm disruptions recognized as serious complications in critically ill individuals. Poor sleep quality in the ICU is often associated with longer hospital stays, increased mortality rates, and the onset of delirium. The ICU environment itself, mechanical ventilation, medications, and the severity of a patient's illness are major contributors to disrupted sleep patterns.[1,2,3]

Sleep is crucial for restoring the body's normal functions, with the circadian rhythm playing a key role in regulating the sleep-wake cycle. In ICU patients, disturbances in sleep quality and circadian rhythm are widespread, and these disruptions can have significant effects on a patient's recovery and overall health.[4]

Critically ill patients frequently experience poor sleep quality due to a range of environmental and physiological factors. Continuous monitoring by staff, bright lighting, and constant noise in the ICU disturb the natural sleep cycle, contributing to sleep deprivation and further complicating patient recovery. Sleep disturbances are often linked to an increased risk of infections, decreased respiratory function, elevated pain levels, and delirium, a common complication among critically ill patients.[5,6,7]

The circadian rhythm, which controls the sleep-wake cycle and regulates hormone secretion and other vital functions, is often disrupted in ICU patients. The absence of natural light, along with artificial lighting used during the night, can disturb the body's biological clock. This disruption leads to irregular sleep patterns, increased fatigue, and a prolonged recovery time. The effects of circadian rhythm disruption in ICU patients are severe, contributing to weakened immune function, increased susceptibility to infection and a worsened overall prognosis.[8,9,10]

Certain medications administered in the ICU, such as sedatives, antipsychotics, and opioids, also play a role in affecting sleep quality. Medications like propofol and benzodiazepines are known to suppress critical stages of sleep, particularly REM and NREM stages, which are essential for restoring bodily functions. Prolonged use of these medications can lead to fragmented sleep, and abrupt discontinuation may result in rebound insomnia. Additionally, pain management is crucial for maintaining sleep quality in ICU patients, as inadequate pain relief can cause frequent awakenings. Anxiety, stress, and the inability to communicate due to illness further exacerbate sleep disturbances.[2,11]

Mechanical ventilation is another major factor that disrupts sleep in ICU patients. Patients on mechanical ventilators often experience frequent interruptions due to equipment, tubes, and the effort required for breathing, which reduces total sleep time and sleep quality.[12]

Recent research has increasingly emphasized the relationship between mechanical ventilation and sleep disturbances, highlighting the necessity for more effective strategies to mitigate these effects.[13,16]

Improving sleep quality in the ICU is essential for facilitating faster patient recovery. Strategies such as reducing noise levels, adjusting lighting to mimic natural circadian rhythms, and utilizing non-pharmacological interventions like light therapy and earplugs have been explored as potential solutions. Additionally, optimizing the timing of medication administration and minimizing the use of sedatives can help restore circadian rhythm and improve sleep quality.[17,18]

Polysomnography studies in ICU patients reveal that, compared to healthy adults, these patients experience fragmented sleep, prolonged sleep latency, and reduced sleep efficiency. Approximately 50% of their sleep occurs during the daytime and is characterized by transitions to lighter sleep stages. The sleep disturbances observed in the ICU are multifactorial, influenced by environmental factors such as noise and light, many of which can be modified to enhance sleep quality. [10,19]

Sleep disturbances are widespread among ICU patients, with prevalence rates ranging from 22% to 61% across various studies. Epidemiological data from Europe and the United States highlight the significant impact of factors like noise, frequent staff interventions, and patient anxiety on sleep quality. In Europe, around 50% of ICU patients report sleep problems, while in the United States, about 70% of adults experience poor sleep quality at least once a month.[20,21,22]

In Greece, data on sleep disturbances in ICU patients are limited, primarily coming from small-scale studies or individual hospital reports. Sleep disorders, including insomnia and sleep apnea, are prevalent in the general population, affecting individuals across various age groups and genders. These sleep difficulties are closely associated with physical and emotional problems, mental health disorders, and chronic health conditions such as cardiovascular disease, obesity, and diabetes.[19,23]

Efforts to improve sleep quality in ICU patients, including non-pharmacological interventions like bright light therapy and ear-plugs, have yielded mixed results. The lack of natural light and excessive artificial light during the night remain key challenges in promoting better sleep and maintaining circadian rhythms in the ICU setting.[24]

METHODOLOGY

Participants

The aim of this study was to evaluate the quality of sleep among critically ill patients in the Intensive Care Unit (ICU). The study sample consisted of 135 patients admitted to the ICU of the General Hospital of Athens "G. Gennimatas" from January 2021 to December 2023. A convenience sampling approach was used. The ICU facility consisted of 17 beds and as a mean maintained a nurse-to-patient ratio of 1:2.

Eligible participants were patients aged 16 years and above, both with and without the need for mechanical ventilation, and exhibiting hemodynamic stability. Exclusion criteria included patients under 16 years of age, those with hemodynamic instability, sedation, a history of sleep-disordered breathing (such as sleep apnea syndrome), chronic neuromuscular disease, psychiatric illness, previous sleep pathologies, alcohol addiction, illicit drug abuse, and cognitive dysfunction (including dementia). Data collection adhered to strict anonymity and confidentiality protocols. The process commenced only after obtaining informed and voluntary consent from each patient. To maintain integrity and confidentiality, the data in the questionnaires were coded and anonymized. Each patient was assigned a unique code number with no direct reference to their identity.

Description of Richards-Campbell Sleep Questionnaire (RCSQ)

Data collection was conducted using the Richards-Campbell Sleep Questionnaire (RCSQ), which was completed by the researcher during the study. The RCSQ is a brief, self-reported questionnaire consisting of 5 items used to assess nighttime sleep quality. Specifically, it evaluates:

1. Sleep Depth
2. Sleep Latency
3. Number of Awakenings
4. Sleep Efficiency (percentage of time awake)
5. Overall Sleep Quality

Each item is rated on a visual analogue scale ranging from 0 mm to 100 mm, with higher scores indicating better sleep quality. The average score of the five items is known as the "total score" and represents the overall perception of sleep. Additionally, a sixth item was included to assess Night-time Noise Level (range: 0 mm for "very quiet" to 100 mm for "very noisy"). Demographic and clinical characteristics of the participants (gender, age, length of stay, days on mechanical ventilation, days on spontaneous breathing, whether they underwent tracheostomy and the type of tracheostomy) were also collected.

Intervention

The intervention in this study was conducted in the ICU. It involved techniques to reduce sensory stimuli (noise, light, nursing activities, invasive procedures) during the night and recorded the quality of sleep of the patients. Measures to reduce light included implementing a lighting program for nursing procedures or conducting night-time care activities with bedside lighting when possible. Noise control measures included closing doors when not in use, reducing alarms from monitors, and adjusting phone volumes. Staff were discouraged from talking around patient beds, and efforts were made to consolidate patient care and treatment activities to minimize the number of individual disturbances for each patient.

Ethical issues

Regarding the ethics of this study, it has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki). The study was approved by the hospital's review boards (Ref No 3369/8-2-2021). Data collection and analysis were conducted after obtaining informed, written consent from all patients' relatives during ICU care. The patients' personal data and the hospital's name remained anonymous at all stages of the study.[16]

Statistical Analysis

Data analysis was performed using SPSS version 24. Descriptive statistics for quantitative variables were presented as means and standard deviations (M ± SD), while categorical variables were presented as absolute (n) and relative frequencies (%). Normality tests were conducted using the Kolmogorov-Smirnov test. Factor analysis was performed to determine the construct validity of the RCSQ. Data adequacy for factor analysis was assessed using the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test of sphericity. Reliability of the RCSQ was assessed using Cronbach's alpha coefficient (α). Values of the index greater than 0.7 or 0.8 are generally considered satisfactory. Differences between RCSQ scores and demographic-clinical characteristics were explored using parametric t-tests and non-parametric Mann-Whitney tests. Correlations between two quantitative variables were examined using Pearson's correlation coefficient (r) for parametric and Spearman's rank correlation coefficient (ρ) for non-parametric data. Statistical significance was set at p<0.05.

RESULTS

Demographic Characteristics

The sample of this study consisted of 135 individuals, of whom 71.1% (n=96) were men and 28.9% (n=39) were women, with an average age of 56.70 (SD=16.35).

The mean duration of hospitalization was 39.07 (SD=62.83) days, the mean duration of mechanical ventilation was 34.79 (SD= 62.23) days, and the mean duration of spontaneous respiration was 4.40 days (SD=3.65).

Among the participants, 56.3% (n=76) had undergone a tracheostomy, while 43.7% (n=59) had not (**Table 1**).

Characteristics of RCSQ

The average score for depth of sleep was 56.00 (SD=15.17), time to fall asleep was 48.37 (SD=18.66), number of awakenings was 46.22 (SD=16.16), return to sleep was 50.96(SD=17.95), sleep quality was 47.19(SD=20.68), and noise level was 51.04(SD=19.29) (**Table 2**). The mean total RCSQ score without the noise level question was 49.759SD=15.09), a moderate score, while the mean total RCSQ score including the noise level question was 49.96(SD=15.60). Of the patients, 48.9% (n=66) reported good sleep, 40.7% (n=55) reported poor sleep, 8.1% (n=11) reported very poor sleep, and 2.2% (n=3) reported very good sleep.

Factor Analysis of RCSQ

The adequacy of the data for factor analysis was tested using the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's sphericity test. The factor analysis showed that the KMO measure was 0.846 and Bartlett's sphericity test had a chi-square value of 483.670 with p<0.05, indicating that the data is suitable for factor analysis (**Table 3**).

Cronbach's Alpha Reliability Coefficient for RCSQ

The reliability of the RCSQ was tested using Cronbach's alpha coefficient. The coefficient was calculated as 0.900, indicating excellent reliability of the RCSQ. No removal of questions significantly increased the value of the coefficient.

Comparisons and Correlations between Demographic Characteristics and Patient Group

The gender of the participants did not seem to relate to the patient group (p=0.466). Both the intervention and control groups had more men than women.

The age of the patients did not differ between the control and intervention groups (p=0.881). However, the days of hospitalization appeared to differ between the two groups (p=0.006). Individuals in the control group had fewer days of hospitalization compared to those in the intervention group. Additionally, the days on mechanical ventilation differed by patient group (p=0.07). Patients in the control group had fewer days on mechanical ventilation compared to patients in the intervention group. The days on spontaneous breathing did not differ between the control and intervention groups (p=0.115). No statistically significant relationships were found between the patient group and whether they had undergone a tracheostomy (p=0.703), their transfer (p=0.212), or the receipt of mild sedation for sleep promotion (p=0.391) (**Table 4**).

Comparisons and correlations of demographic characteristics and RCSQ

The participants' gender did not show differences in the RCSQ scales nor in the overall RCSQ score (p>0.05) (**Table 5**).

The age of the patients did not appear to be related to any of the RCSQ scales nor to the total RCSQ score (p>0.05) (**Table 6**).

In contrast, the length of patients' hospitalization appeared to be negatively correlated with the RCSQ scales and the total RCSQ score (p<0.05). Slight and very slight statistically significant negative correlations were found, suggesting that as the duration of patients' hospitalization increases, their scores on the RCSQ scales and the total RCSQ score decrease (**Table 7**).

The duration of patients' hospitalization under mechanical ventilation appeared to be negatively correlated with the RCSQ scales and the total RCSQ score ($p<0.05$). Slight and very slight statistically significant negative correlations were found, suggesting that as the duration of patients' hospitalization under mechanical ventilation increases, their scores on the RCSQ scales and the total RCSQ score decreases (**Table 8**).

None of the RCSQ scales or the total RCSQ score were statistically significantly correlated with the duration of patients' hospitalization under spontaneous breathing ($p>0.05$) (Table 9).

The scores on the RCSQ scales for Sleep Depth and Sleep Quality did not differ based on tracheotomy ($p>0.05$). In contrast, the scores on the RCSQ scales for Sleep Latency, Number of Awakenings, Returning to Sleep, Noise Level, and the total RCSQ score were found to differ based on tracheotomy ($p=0.007$, $p=0.008$, $p=0.015$, $p=0.022$, and $p=0.008$, respectively). Patients who underwent tracheotomy had lower scores on the Time to Fall Asleep, Number of Awakenings, Returning to Sleep, Noise Level scales, and the total RCSQ score compared to patients who did not undergo tracheotomy (**Table 10**).

Finally, there was a statistically significant relationship between the RCSQ categories and the group to which the patients belonged ($p<0.001$). In the control group, most individuals (n=41) reported poor sleep, and none reported very good sleep. In contrast, in the intervention group, most individuals (n=54) reported good sleep, and 3 individuals reported very good sleep (Table 11 &12).

DISCUSSION

The findings of this study regarding sleep quality in critically ill patients align with several previous studies, reinforcing the significant impact of environmental factors on sleep disturbances in the ICU.

For instance, Ahn et al.,[25] highlighted that sleep disturbances in ICUs are frequently linked to excessive noise and patient care interactions, which corroborates our observations of the detrimental effects of such factors on sleep quality. The Korean version of the Richards-Campbell Sleep Questionnaire (K-RCSQ) was used for subjective sleep quality assessment. The study identified modifiable factors that could improve sleep quality in ICU settings, emphasizing the need for further research in this area.

Similarly, Lewandowska et al.,[26] using the Richards-Campbell Sleep Questionnaire, found that vital signs check and bright lighting were significant disruptors of sleep, echoing our findings about the ICU environment's role in impeding restful sleep. Also, higher pain levels on the first ICU day were associated with greater sleep disruption. The study emphasizes the need for medical staff to be aware of and reduce sleep-disrupting factors. Additionally, our study's results regarding the implementation of targeted interventions to reduce sensory stimuli resonate with the conclusions drawn by Naik et al.[27] They emphasized the need for non-pharmacological strategies to improve sleep quality in mechanically ventilated patients. In our research, the reduction of noise and light during nighttime care resulted in significantly improved RCSQ scores in the intervention group, suggesting that practical measures can lead to tangible benefits in patient sleep quality.[27]

Moreover, our results showing a negative correlation between the duration of hospitalization and sleep quality align with the findings of Sayılan AA et al.[28] who reported that longer ICU stays correlate with increased sleep disturbances. This connection implies that improving sleep quality may not only enhance patient recovery but also potentially reduce the length of ICU stays, which is crucial for optimizing resource utilization in healthcare settings.

In contrast, while many studies, such as those conducted by Demir et al.,[29] focused primarily on identifying sleep disruptors, our research contributes to the literature by providing evidence that specific interventions can significantly improve sleep outcomes. The observed improvements in the intervention group emphasize the need for a proactive approach in managing sleep quality for critically ill patients.

Overall, the convergence of findings across these studies highlights the urgent need for healthcare professionals to prioritize sleep quality in ICU settings, integrating both awareness of sleep disruptors and effective intervention strategies into patient care protocols.

The findings of our study regarding sleep quality in critically ill ICU patients are consistent with the research conducted by Frisk and Nordström,[30] which highlighted that, patient receiving hypnotics or sedatives reported significantly worse sleep quality. This suggests that while these medications may be necessary for managing agitation and discomfort, they can have detrimental effects on the overall sleep architecture of ICU patients, reinforcing the need for careful consideration of pharmacological interventions.

Additionally, our observations align with those of Simons et al.,[31] who found that environmental noise adversely affects sleep quality in ICU settings. In our study, we similarly identified high noise levels as a significant factor contributing to sleep disturbances, underscoring the urgent need for implementing effective noise reduction strategies in ICUs to create a more conducive environment for rest and recovery.

Furthermore, the study by Menear et al.,[32] evaluated the impact of sleep-promoting interventions and reported no significant improvement in sleep quality despite their implementation. This resonates with our findings, where the effectiveness of certain interventions varied among patients, indicating the complexity of sleep management in the ICU. It highlights the necessity for individualized approaches to address the unique needs of each patient while optimizing sleep conditions.

Moreover, the prospective descriptive study involving 125 ICU patients revealed that pain, anxiety, staff voices, alarm sounds, and intravenous lines significantly impacted sleep quality. Our findings support this, as we observed that optimizing pain management and minimizing disturbances were crucial in enhancing sleep quality among our participants. Addressing both physiological and environmental factors appears essential for improving sleep outcomes in critically ill patients.[33]

Lastly, the research conducted by Pamuk et al.,[34] demonstrated that a circadian lighting system positively affected sleep quality and physiological parameters in ICU patients. Our study further supports the idea that structured interventions targeting light exposure can lead to improvements in sleep quality. By aligning the ICU environment more closely with natural circadian rhythms, we may enhance patient recovery and overall health outcomes.

Recognition of Research Limitations

The limitations of research on sleep quality in Intensive Care Units (ICUs) are present in this study and should be considered. Issues arising from conducting an experiment include the fact that subjects, as in field research, should not be aware they are being studied, as this can lead to biased behavior and responses. A challenge that arises is that, in reality, it is difficult to fully isolate experimental conditions and eliminate bias from the subjects, such as in the answers they provide.

Another limitation is the variability in patients' histories regarding medication or sleep disorders, which may affect the results, even with efforts to exclude such patients. Small sample sizes and single-center studies also limit the generalizability of findings to other ICUs and populations.

In clinical research, subjective assessments of sleep quality, such as questionnaires, can be influenced by recall bias, and objective tools like polysomnography (PSG) and actigraphy are often difficult to use in ICUs due to costs and technical demands. Additionally, many studies do not account for noise levels or light exposure, both key factors in ICU sleep quality.

The varying prevalence of sleep disorders among critically ill patients further complicates generalization across ICU populations. These limitations emphasize the need for more comprehensive, standardized methods to improve the understanding of sleep quality in ICUs.

CONCLUSION

This study underscores the significant impact of sleep disturbances and circadian rhythm disruption on critically ill patients in the ICU. Despite efforts to minimize environmental stimuli such as light and noise, patients continue to experience fragmented sleep, particularly those requiring mechanical ventilation. The findings suggest a clear link between longer ICU stays and poorer sleep quality, highlighting the importance of adopting more effective strategies to enhance sleep in this population. Future research should focus on refining non-pharmacological interventions and optimizing the ICU environment to promote better sleep, ultimately improving patient recovery and outcomes.

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ANNEX

TABLE 1. Demographic and clinical characteristics of the sample.

Gender	
Male/Female	71,1% (96)/ 28.9% (39)
Age(years), mean ± SD	56.70±16.35
Days of Hospitalization, mean ± SD	39.07±62.83
Days on Mechanical Ventilation, mean ± SD	34.79±62.23
Days on Spontaneous Breathing, mean ± SD	4.40±3.65
Tracheostomy N (%)	
No/ Yes	43.7% (59)/ 56.3% (76)
Type of Tracheostomy	
Surgical/ Percutaneous	19.7% (15)/ 80.3% (61)

TABLE 2. Patient scores on the RCSQ Questionnaire.

Parameter	**Mean**	**SD**	**Range**
Depth of Sleep	56.00	±15.17	0-100
Sleep Latency	48.37	±18.66	0-80
Number of Awakenings	46.22	±16.16	0-80
Return to Sleep	50.96	±17.95	0-80
Sleep Quality	47.19	±20.68	0-100
Noise Level	51.04	±19.29	0-80
Total RCSQ (5 parameters)	49.75	±15.09	6-78
Total RCSQ (including noise level)	49.96	±15.60	5-78

TABLE 3. KMO and Bartlett's Test.

Measure	Value
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.846
Bartlett's Test of Sphericity, Approx. Chi-Square	483.670
Degrees of Freedom (df)	10
Significance (p)	<0.001

TABLE 4. Distribution of demographic characteristics between control group and intervention group.

	Control Group (n=62)	Intervention Group (n=73)	P value
Gender			
Male/Female	74.2% (46)/ 25.8% (16)	68.5% (50)/ 31.5% (23)	0.466
Age	57.61 ± 15.21	55.65 ± 17.28	0.881
Days of hospitalization	37.31 ± 51.38	41.04 ± 71.85	0.006
Days on mechanical ventilation	32.34 ± 49.67	37.29 ± 71.88	0.007
Days on spontaneous breathing	4.97 ± 3.99	3.90 ± 3.29	0.115
Tracheostomy			
No/ Yes	41.9% (26)/ 58.1% (36)	45.2% (33)/ 54.8% (40)	0.703

TABLE 5. Comparisons between RCSQ and gender.

	Gender		p-value
	Male (n=96)	Female (n=39)	
1. Sleep Depth	56.04 ± 13.26	55.90 ± 19.29	0.677
2. Sleep Latency	48.85 ± 17.10	47.18 ± 22.24	0.816
3. Number of Awakenings	46.98 ± 15.30	44.36 ± 18.18	0.455
4. Returning to Sleep	51.15 ± 17.64	50.51 ± 18.91	0.752
5. Sleep Quality	46.98 ± 19.64	47.69 ± 23.34	0.768
6. Noise Level	50.94 ± 17.72	51.28 ± 22.96	0.555
Total RCSQ (5 parameters)	50.00 ± 14.15	49.13 ± 17.36	0.988

Table 6. Correlations between RCSQ and age.

	Age	**p-value**
1. Sleep Depth	0.067	0.439
2. Sleep Latency	-0.058	0.501
3. Number of Awakenings	-0.013	0.878
4. Returning to Sleep	-0.045	0.603
5. Sleep Quality	-0.073	0.403
6. Noise Level	-0.091	0.293
Total RCSQ (5 parameters)	-0.031	0.722

TABLE 7. Correlations between RCSQ and hospitalization duration in days.

	Hospitalization Days	**p-value**
1. Sleep Depth	-0.293	0.001
2. Sleep Latency	-0.434	<0.001
3. Number of Awakenings	-0.379	<0.001
4. Returning to Sleep	-0.296	<0.001
5. Sleep Quality	-0.249	0.004
6. Noise Level	-0.370	<0.001
Total RCSQ (5 parameters)	-0.379	<0.001

TABLE 8. Correlations between RCSQ and duration of mechanical ventilation in days.

	Days on Mechanical Ventilation	**p-value**
1. Sleep Depth	-0.298	<0.001
2. Sleep Latency	-0.437	<0.001
3. Number of Awakenings	-0.373	<0.001
4. Returning to Sleep	-0.297	<0.001
5. Sleep Quality	-0.257	0.003
6. Noise Level	-0.376	<0.001
Total RCSQ (5 parameters)	-0.382	<0.001

TABLE 9. Correlations between RCSQ and duration of mechanical ventilation in days.

	Days on Spontaneous Breathing	**p-value**
1. Sleep Depth	0.002	0.983
2. Sleep Latency	-0.103	0.238
3. Number of Awakenings	-0.147	0.091
4. Returning to Sleep	-0.064	0.463
5. Sleep Quality	0.022	0.801
6. Noise Level	-0.010	0.911
Total RCSQ (5 parameters)	-0.069	0.427

TABLE 10. Comparisons between RCSQ and tracheotomy.

	Tracheotomy		**p-value**
	No (n=59)	Yes (n=76)	
1. Sleep Depth	57.97 ± 16.48	54.47 ± 13.99	0.080
2. Sleep Latency	53.22 ± 17.36	44.61 ± 18.86	0.007
3. Number of Awakenings	50.34 ± 15.53	43.03 ± 16.00	0.008
4. Returning to Sleep	55.25 ± 16.12	47.63 ± 18.68	0.015
5. Sleep Quality	51.02 ± 17.78	44.21 ± 22.35	0.086
6. Noise Level	55.76 ± 16.00	47.37 ± 20.87	0.022
Total RCSQ (5 parameters)	53.56 ± 14.33	46.79 ± 15.09	0.008

TABLE 11. Comparisons between RCSQ and patient group.

	Group		**p-value**
	Control Group (n=62)	Intervention Group (n=73)	
1. Sleep Depth	50.65 ± 15.35	60.55 ± 13.53	<0.001
2. Sleep Latency	39.19 ± 18.40	56.16 ± 15.06	<0.001
3. Number of Awakenings	39.19 ± 15.92	52.19 ± 13.87	<0.001
4. Returning to Sleep	42.42 ± 17.43	58.22 ± 15.03	<0.001
5. Sleep Quality	35.65 ± 19.64	56.99 ± 16.05	<0.001
6. Noise Level	40.81 ± 18.13	59.73 ± 15.72	<0.001
Total RCSQ (5 parameters)	41.42 ± 13.61	56.82 ± 12.51	<0.001

TABLE 12. Correlations between RCSQ categories and patient group.

Group			**p-value**
	Control Group (n=62)	Intervention Group (n=73)	
Very poor sleep	14.5% (9)	2,7% (2)	<0,001
Poor sleep	66.1% (41)	19,2% (14)	
Good sleep	19.4% (12)	74,0% (54)	
Very good sleep	0.0% (0)	4,1% (3)	