Review Article

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# Sleep deprivation in Intensive Care Unit – systematic review

https://doi.org/10.1515/med-2018-0057
received February 23, 2018; accepted June 6, 2018

**Abstract**: Background: Sleep disturbances in intensive care unit (ICU) patients have been studied worldwide for over 30 years. Factors contributing to sleep disturbances are still being identified, and therapeutic procedures aimed at the mitigation of such ailments are consequently being developed.

Objectives: The aim of this study was to review the literature on sleep disturbances in intensive care unit patients.

Material and Methods: MEDLINE PubMed, OVID, Web of Science, and EBSCO databases have been searched using adequate keywords.

Results: Sleep disorders in ICUs were common among all of the analysed articles. Noise plays a significant role in sleep interruption (11.5 - 17% of awakenings). It was noted that the introduction of "white noise" into the ICU environment proved unsuccessful in reducing the magnitude of changing noise levels. Nursing care activities significantly disturb nocturnal rest, and 42.7 such procedures per every 12-hour night shift were registered. Aggregating nursing care interventions was suggested in order to reduce the number of stimuli experienced by the patient.

Conclusion: Changes in sleep structure developing during an ICU stay may significantly contribute to sleep disorders once the hospitalisation is over.

**Keywords:** Sleep; Intensive care; Sleep disorders; Sleep assessment

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## 1 Introduction

Sleep is indispensable for the regeneration of both body and mind. Nocturnal rest leads to the tuning down of the nervous system and the regeneration of muscles, and results in physiological rest [1]. Such regeneration is not observed in patients suffering from sleep disorders, which results in patients experiencing cognitive deficits and physical fatigue. Sleep disturbances in intensive care unit (ICU) patients have been studied worldwide for over 30 years. Factors contributing to sleep disturbances are still being identified, and therapeutic procedures aimed at the mitigation of such ailments are consequently being developed [2]. The nocturnal rest of ICU patients is influenced by noise, pain experienced, discomfort, medication administered in the intensive care setting and the mode of mechanical ventilation. Sleep assessment is subjective in its nature, therefore it is hard to perform in the ICU setting. As communication with a patient is hampered, they are not able to provide clear information on their perceived rest and the most disturbing factors. Therefore, nocturnal rest is an issue commonly forgotten and frequently ignored by medical personnel [1,2].

## 2 Physiological sleep and circadian rhythm

The average duration of nocturnal rest in a healthy adult is 7-8 hours. The biological requirement for sleep is, however, hard to estimate. It varies individually and depends on genetic factors, age and gender. Entire nocturnal sleep can be divided into cycles. Each cycle lasts for 90-110 min [3]. Sleep structure is defined by criteria developed by the American Academy of Sleep Medicine. Each night cycle consists of two phases, namely REM (rapid eye movement) and NREM (non-rapid eye movement). The REM phase is characterised by rapid eyeball movement, muscle atonia and dreams. The NREM phase is divided into three addi-

tional stages: N1 – the lightest sleep, the transition from wakefulness to sleep; N2 - the moment of falling asleep, characterised by light sleep; N3 - deep sleep, the hardest to interrupt [4]. An additional factor, which normalises nocturnal rest, is the circadian rhythm. This is mainly influenced by light, which indicates the time for rest. Light stimuli that fall on the retina influence the functioning of anterior subthalamus, i.e. suprachiasmatic nuclei. This structure is responsible for synchronising all circadian systems of the body [5].

## 3 Literature on sleep assessment in intensive care units

The assessment of sleep structure in unconscious patients hospitalised in ICUs is possible due to advanced systems monitoring brain electrical activity and sleep parameters. Once the patient regains consciousness and he is able to communicate with the outside world, the ready-to-use assessment scores are available. There are two types of scores, i.e. objective and subjective [Table 1].

## 4 Polysomnography

Polysomnography is the gold standard test for sleep assessment. Such an examination includes electroencephalography (EEG), electrooculography (EOG), subcutaneous electromyography (EMG), electrocardiography (ECG), monitoring of thorax movements and pulse oximetry. It is therefore possible to characterise particular sleep stages, as well as determining their duration. In the ICU setting, the course of polysomnographic examination is additionally hampered by the presence of a number of sensors monitoring basic vital functions, which are attached to the patient's body. Such a procedure is expensive, and requires precision and the secure placement of the sensors. Its course is supervised by a technician, who registers each measurement. The results may be tracked and interpreted using dedicated software [6]. In order to assess the impact of particular stimuli in the intensive care setting, it is necessary to document the time and duration of medical interventions. This enables research staff to precisely evaluate the sleep disorders at a given moment.

## 5 BIS

The Bispectral Index (BIS) is used to minimise the amount of equipment required to perform EEG. BIS is calculated by the multiple analysis of the native EEG waveform, including power spectroscopy analysis, bispectral analysis and timing analysis of the suppression to stimulus index. A BIS value ranges from 0 (no EEG signal) to 100, which indicates a clinically fully awake patient. BIS may potentially assess the depth of sleep, yet it is not a standard method for assessing sleep in the ICU setting [7].

## 6 Actigraphy

Actigraphy is one of the methods for sleep assessment commonly referred to in the literature. It is a continuous method for registering a patient's activity during the day and night using a special device called an actigraph (usually lasting several days). Technically, the device comes in the form of a watch. It is placed on the patient's wrist, which enables researchers to evaluate the patient's wakefulness on the basis of their movements. Once the subject is asleep the device detects no movement at all [8]. Actigraphy allows the calculation of total and average sleep duration, sleep onset latency (the length of time that it takes to fall asleep), the number of awakenings during sleep, the number of naps during the day, and the amount of active and non-active time during the day. However, ICU patients commonly show neuromuscular fatigue and require continuous sedation, which makes it impossible to obtain precise results [6].

## 7 Sleep assessment by the patient

Subjective methods make it possible to assess sleep in more ICU patients. One such method is the RCSQ (Richards-Campbell Sleep Questionnaire). This five-item scale evaluates the patient's perception of their depth of sleep, sleep onset latency, sleep duration, sleep onset latency after awakening, and overall sleep quality. Patients who are able to maintain logical communication mark their score on a scale of 0-10. Studies correlating the BIS technique with the RCSQ questionnaire, which were performed in 2007, revealed that patients overestimated the quality of nocturnal sleep [6]. Critically ill patients may have memory problems due to the administration of sedatives, as well as experiencing hallucinations [9]. Additional circadian rhythm disturbances and lack of

conscious awareness, about which time of day it actually is, may negatively impact the outcome. Thus, the use of subjective tools is limited by cognitive dysfunctions and limited perception experienced by ICU patients.

## 8 Sleep assessment by nurses

Nurses may assess a patient's sleep by direct observation, as well as by using scales and questionnaires. Studies performed in the 1980s, where nurses observed patients every 15 minutes, revealed discrepancies in the total sleep time (TST) measured by means of polysomnography and by nurses [10]. Recent studies proved that direct observation by nurses may be insufficiently accurate for an evaluation of the amount of sleep and for identifying sleep disorders [6]. Results of a study published in 2012, which compared a patient's self-assessed sleep and an assessment performed by the nurse taking care of the patient during a particular shift using the RCSQ questionnaire, showed that nurses tend to overestimate the score. The depth of sleep and number of awakenings during nocturnal rest assessed by the nurses and patients were 67(21) vs. 48(35), (p=0.001), and 68(21) vs. 60(33) (p=0.03) [11], respectively. Due to the continuous nature of care that nurses provide to patients, they should take sleep and rest into consideration in the process of taking care of the patient [12-17].

## 9 Sleep disorders in ICU patients

The sleep of ICU patients is light and intermittent in nature. An increased number of awakenings may have similar consequences as sleep deprivation. They include: weakening of the immunological system leading to an increased risk of infections, reduced respiratory parameters, increased perception of pain, reduced glucose tolerance, increased sympathetic activity and increased protein catabolism. The above-mentioned factors were identified during studies performed in healthy people. Fatigue observed in intensive care unit patients leads therefore to more pronounced consequences of sleep deprivation, which in turn can hamper the recovery process. Low quality sleep may also contribute to the occurrence of psychotic states, i.e. delirium in ICU patients [17-19].

Over 60% of patients who were discharged from an ICU reported sleep disorders or sleep deprivation [15,19]. Other studies revealed that patients could remember frequent interruptions, pain, anxiety and fear, which all reduced their ability to sleep [19,20]. One study, which included 464 patients, demonstrated that 51% of them experienced dreams and nightmares, whereas 14% of these subjects reported nightmares negatively influencing their quality of life even 6 months after their ICU stay [21]. The first polysomnography examinations in ICU patients revealed the presence of sleep disorders, reduced TST and changes in sleep structure, i.e. prolonged N1 and N2 stages, whereas the duration of N3 and REM stages was shortened. The examinations were performed during 8-hour nocturnal sleep only, and mechanically ventilated and sedated patients were excluded from the study [22,23]. 24-hour polysomnography was performed to determine the circadian rhythm in ICU patients. The obtained results varied significantly in terms of TST (3.2-19.4 hours), and such extreme results as 1 hour of total sleep time were also observed. Over 14% of sleep took place during day-hours. Disturbed sleep structures with no physiological sleep stages were observed as well. Most disturbances take place in N1 and N2 stages, while the duration of N3 and REM stages is shortened [24]. A major breakthrough, however, were studies which included sedated subjects receiving intensive hemodynamic support. A 24-hour polysomnography examination was performed in each of these 20 patients. Three patient groups were distinguished based on predominant EEG patterns: disturbed sleep (each sleep stage was present, but their proportion was disturbed), atypical sleep (with no N2 stage) and coma (SWS-Slow Wave Sleep and N3 accounted for 50% of sleep).

## 10 Sleep disturbing factors

Many factors disturb the sleep of patients in ICUs with specific environment and invasive therapeutic interventions contributing to the development of such sleep disorders. The inability to obtain physiological sleep depends on the patient's illness, previous sleep experience, and varying severity of the illness. The following factors have been identified as disrupting sleep: pain and discomfort, nursing care and medical interventions, mechanical ventilation, the ICU environment (including noise), pharmacological agents, and disease severity (Table 2) [25].

## 11 Aim

The aim of this study was to systematically review the available literature on sleep disorders in intensive care unit patients.

**Table 1:** Methods of sleep assessment [6,7,12,14-18]

| Sleep assessment method | Nature and reliability | Advantages | Disadvantages | Clinical application |
|---|---|---|---|---|
| Polysomnography | Gold standard<br>Inter-rater reliability in critical care, kappa = 0.79–0.83 [6,12]. | Monitors the amount and quality of sleep. Distinguishes particular sleep stages. | Continuous attendance of a technician is needed during monitoring to obtain adequate results. Partially subjective assessment during the first stage of sleep.<br>The amount of equipment hampers sleep in non-sedated patients.<br>Cost-expensive in the ICU setting.<br>A patient's critical condition may result in EEG disturbances. | Not performed in routine clinical sleep assessment. |
| BIS | All patients with BIS values below 80 were asleep [7]. | BIS sensor easily applied.<br>The entire equipment to measure BIS is easy to use.<br>Inexpensive examination.<br>Outcome readily available. | BIS sensor may disturb the patient.<br>Muscle movements may disturb BIS measurement.<br>Once the measurement is complete it is necessary to upload the data to a personal computer for analysis. | Not performed in routine clinical sleep assessment.<br>Validation of the examination, and algorithm development are required. |
| Actigraphy | Correlation with polysomnography for TST 0.72-0.98 [7,14]. Not validated versus polysomnography in the ICU setting. | Non-invasive.<br>May be performed by non-technicians and non-specialists.<br>Inexpensive once the device and accessories are purchased. | Neuromuscular fatigue increases the risk of overestimating sleep quality.<br>Nursing staff may displace the sensor, in the form of a watch, during nursing care interventions<br>Periods of physical inactivity - chronic state in ICU patients, may be scored by the sensor as sleep. | Used to determine circadian rhythm. |
| Patient assessment | Sleep in the Intensive Care Unit Questionnaire - not validated versus polysomnography [15]<br>Richards-Campbell Sleep Questionnaire reliability (Cronbach's alpha =0.90) correlation versus polysomnographic sleep efficiency index in ICU patients = 0.58 [12]. | If capable, a patient can compare the baseline sleep value with the one experienced.<br>Relatively quick. | Cannot be used in patients with cognitive dysfunction. Memory problems may reduce its accuracy.<br>Cannot be performed in sedated patients.<br>Circadian rhythm disturbances may adversely affect the nocturnal sleep perception. | RCSQ scale does not apply to sedated patients, patients with cognitive dysfunction and with delirium. |
| Nurse assessment | Direct observation at 15-minute intervals, assessment of sleep state compared to polysomnography correct for 81.9% of the time [16].<br>RCSQ - reliability versus patient's assessment (Cronbach's alpha = 0.83–0.95) [17,18]. | Easy to perform during routine nursing care. | Overestimated TST.<br>Frequent patient assessment required.<br>Risk of data loss caused by other direct and indirect nursing care activities.<br>It is not possible to present an accurate report of the patient's total sleep quality. | Easy and targeted tool for sleep assessment on ICU patients who meet the requirements for such an evaluation. |

**Table 2:** Sleep disturbing factors in ICU patients [25].

| Environmental factors | Pharmacological agents | Medical interventions |
|---|---|---|
| Noise | Steroids | Presence of tracheal tube |
| Light | Beta-blockers | Postoperative period |
| Nursing interventions | Chronic intake of hypnotic drugs | Dialysis |
| Diagnostic tests | Diuretics | Non-invasive ventilation |
| Vital parameters measurement | Benzodiazepines | |
| Blood collection | Regular administration of opioids | |
| Administration of medication | Magnesium | |

# 12 Methods

This systematic review was performed using the most recent standards for systematic reviews published by the Medical Institute.

## 12.1 Search strategy

The following literature and abstract databases were searched: PubMed/MEDLINE, Web of Science, EBSCO. The following key words were used: sleep disorders in intensive care, intensive care, sleep disturbing factors. The search was limited to studies published in English. No adequate literature in Polish was found. Articles published between 2000 and 2017 were included in the study. Single key words as well as their combination using AND and/or OR operators were used. The citation number in each search was scanned and reduced according to the inclusion criteria. Only studies performed in intensive care settings that evaluated the quality of sleep and sleep disturbing factors were selected. The initial analysis allowed the inclusion of 8 articles, for which full texts were obtained.

## 12.2 Inclusion criteria

Articles included in the analysis:
- evaluation of sleep in ICU settings using known and validated tools;
- description of sleep disturbing factors characteristic for ICUs;
- inclusion of an objective or a patient's subjective sleep assessment.

The following articles were excluded:
- opinions, case studies on animals, as well as articles published neither in English nor in Polish;
- studies where sleep was evaluated by nurses;
- articles where sleep was evaluated in non-ICU patients;
- studies evaluating the impact pharmacological agents have on particular sleep stages in non-ICU patients.

Each article that was found was independently assessed by two reviewers using the above-mentioned selection criteria in terms of their suitability for the study. In the event of divergent opinions, the opinion of a third reviewer was requested.

## 12.3 Data acquisition

Both reviewers independently assessed the articles selected using normalised data acquisition charts to register the required data. These data included: name of the first author, publication year, type and aim of the study, method of sleep assessment, results and study limitations.

The quality of each study was assessed based on the following criteria:
- reliability of the sleep assessment method;
- factors that were considered to disturb sleep in the ICU setting;
- description of inclusion and exclusion criteria.

A literature analysis scheme for a systematic review is shown in Fig.1.

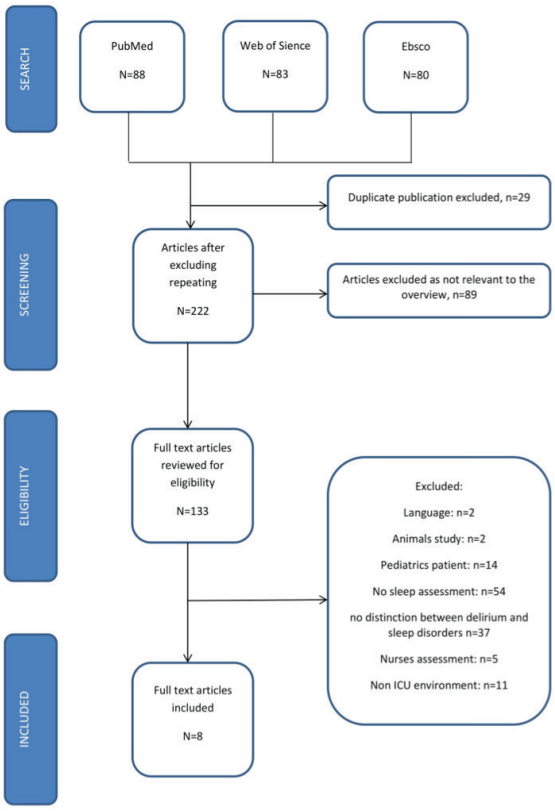


**Figure 1:** Scheme for articles qualified for a systematic review.

## 13 Results

The assessment of patients' sleep in the ICU setting is a complex task. Studies prove that polysomnography is the gold standard. Many studies have identified sleep disturbing factors for ICU patients. They have been divided into three groups: environmental, pharmacological, and factors related to mechanical ventilation [1,2,25,26,27]. In the second part of the article, a systematic review of studies identifying sleep disorders in ICUs and their impact on sleep structure is presented. A total of eight articles were included in the review. Sleep disorders in ICUs were common among all of the analysed articles. Noise plays a significant role in sleep interruption (11.5 - 17% of awakenings). It was noted that the introduction of "white noise" into the ICU environment proved unsuccessful in reducing the magnitude of changing noise levels. Nursing care activities significantly disturb nocturnal rest, and 42.7 such procedures per every 12-hour night shift were registered. Aggregating nursing care interventions was suggested in order to reduce the number of stimuli experienced by the patient [15,26,33,34]. A systematic review of research on factors that disrupt patient sleep is detailed in Table 3.

## 14 Discussion

Intensive care unit patients assess the quality of their sleep as low. This is commonly associated with fear, anxiety and nightmares, which reduce their quality of life. Quantitative and qualitative sleep disorders negatively influence physiological body mechanisms, the immunological system and mental well-being [24].

Due to the specific ICU environment and the fact that patients remain unconscious, it is the duty of a therapeutic team to assess a patient's sleep. Such a task requires adequate study tools. Polysomnography remains the gold standard procedure for qualitative and quantitative sleep assessment in the ICU setting. The specific ICU environment has forced researchers to use alternative methods of sleep assessment. Every technique has its own limitations, which should be considered while planning each research. One alternative objective method is BIS, which demonstrates significantly more advantages in comparison to actigraphy in the ICU setting. Further development of the BIS algorithm, as a measure for sleep quantity may facilitate the conduction of large scientific studies in the ICU setting (lasting for many days). On the other hand, the simplicity of subjective methods, i.e. self-assessment, seems very attractive. One should be especially careful and precede each examination with a determination of the patient's state of consciousness [6]. It is the nurses who will contribute most to sleep assessment in ICU patients in the future.

In 2003, Nordstrom used the Richards-Campbell Sleep Questionnaire scale to acquire data on how patients perceive their sleep, as well as the ability of nurses to assess it. No significant difference in the perception of sleep was observed between 31 patients and 31 nurses. Although the above-mentioned questionnaire was designed for ICU patients, the reduction of cognitive abilities makes it repeatedly impossible for the patient to fulfil the questionnaire unaided. Therefore, the role of nurses is very important, as they are at the patient's bedside 24 hours a day [28].

In 2008, Beecroft et al. conducted an observational study which compared the accuracy of sleep assessment performed by nurses and 24-hour polysomnography. This study demonstrated that nurses lack the tools, knowledge and abilities to precisely assess the sleep of ICU patients.

**Table 3:** Systematic review of studies on factors disturbing a patient's sleep [1,2,15,25,26,27,32,33].

| Author | Type and aim of study | Number of subjects | Sleep assessment method | Outcome | Limitations |
|---|---|---|---|---|---|
| Freedman et al. 2001 | Effect of environmental noise on sleep disruption in the intensive care unit. | 20 mechanically ventilated and 2 non-mechanically ventilated patients. | Continuous polysomnography and noise intensity measurement for 24-48 h. | Sleep cycle disturbances: TST = 8.8 ± 5.0 hours. Increased sleep fragmentation. Environmental noise responsible for 11.5 - 17% of awakenings. Noise arousal index: 1.9 ± 2.1 arousals/hour of sleep. | Small study group. |
| Parthasarathy and Tobin 2002 | Effect of the mode of mechanical ventilation on sleep quality in critically ill patients. The backup rate in assisted ventilation reduced the risk of sleep apnoea. | 11 patients. | The medical ventilator was set in the assist-control mode with a backup rate of 4 breaths per minute and a tidal volume of 8 ml/kg. The backup rate in assist-control ventilation was set at 4 breaths below the patient's own respiratory rate and then kept at that setting for the rest of the examination. Pressure was adjusted to achieve a TV equivalent to that during assist-control ventilation (8 ml/kg). Assessed using polysomnography, capnometry, EEG and pulse oximetry. All examinations were performed between 10:00 p.m. and 06:00 a.m. The elastance and resistance of the respiratory system were measured. | More awakenings and arousals were observed during PSV than ACV: 79±7 versus 54±7 events/hour. More episodes of central apnoea and heart failure in 6 PSV patients compared to patients subjected to ACV (83% versus 20%). | One ventilation mode.<br>11 subjects.<br>One study centre. |
| Tamburri et al. 2004 | Randomized, retrospective study. Nursing care interventions considered as a sleep disturbing factor. Discussion on nocturnal care and its impact on sleep in ICUs. | 50 patients. | Medical record documenting nursing care interventions in 50 patients during night shifts (7 p.m. to 7 a.m.) was analysed. The frequency and type of nocturnal interventions were determined. | The study was performed over 147 nights. The mean number of care interventions per night was 42.7. Least interventions took place at midnight and 3 a.m. A period of 2-3 hours without any nursing care intervention was registered on 9 nights only. | As no direct contact with the patients was available it is hard to determine the actual quality of sleep. |
| Stanchina et al. 2005 | Whether the addition of "white nose" to the intensive care unit environment reduces patients' awakenings by reducing the magnitude of changing noise levels. | 4 patients. | Polysomnography.<br>Maximal noise levels registered for each awakening. | A total of 1178 awakenings, increased during noise, yet were not reduced by "white noise". Peak noise was not a main determinant of sleep disturbances caused by ICU noise. | |

**Table 3 continued:** Systematic review of studies on factors disturbing a patient's sleep [1,2,15,25,26,27,32,33].

| Author | Type and aim of study | Number of subjects | Sleep assessment method | Outcome | Limitations |
|---|---|---|---|---|---|
| Bihari et al. 2012 | Evaluation of sleep quality in ICU patients and the identification of sleep disturbing factors. | 100 patients. | Evaluation according to a modified Freedman questionnaire (point scale evaluating particular factors, 1 - worst, 10 - best).<br>Patients 2 days post extubation who were orientated to time and place. Patients independently completed the questionnaire. | Self-reported quality of sleep was 7.0 ± 2.2 at home and 4.0 ± 1.7 in the ICU setting ($p<0.001$).<br>Factors which most significantly affected sleep quality: bedside phone [0.92 (0.87-0.97), $p<0.01$], prior quality of sleep at home [1.30 (1.05-1.62), $p=0.02$], and use of steroids [0.82 (0.69-0.98), $p=0.03$]. | |
| Tembo et al. 2013 | ICU patients, intubated, mechanically ventilated, subjected to daily sedation interruption. A schematic interview assessing sleep during the ICU stay was conducted two weeks and 6-11 months after discharge from the ICU. | 8 patients. | Qualitative study. Schematic interview. Data were analysed thematically: "longing for sleep" and "being tormented by nightmares". Subjects' experiences and concerns were registered. | The findings suggest a need for models of care that aim at supporting restful sleep and preventing or alleviating sleep deprivation and nightmares.<br>These models of care should promote both the quality and quantity of sleep during an ICU stay and once the hospitalisation is over. They should also identify patients suffering from sleep disorders. | Results analysis requires significant effort. |
| Ritmala-Castren et al. 2015 | Evaluation of the quality of sleep of non-intubated ICU patients. Evaluation of the effect of nursing care activities on the quality of sleep. | 21 patients. | Continuous 24-hour polysomnography, with all nursing care activities additionally documented. Nursing care activities were later documented on the polysomnographic recording. | The median amount of sleep was 387 (170 - 486) minutes The portion of deep (non-REM) sleep ranged from 0% to 42% and REM sleep from 0% to 65%. The frequency of arousals and awakenings varied from 2 to 73 per hour. The median amount of nursing care activities was 0.6/hour. Every tenth activity awakened the patient. Patients who experienced more care activities had more N1 sleep, less N2 sleep, and less deep sleep. Only 31% of the intervals between nursing care activities lasted longer than 90 min. | Very precisely documented nursing care activities. |
| Boyko Y. et al. 2016 | Whether improving the ICU environment would enhance sleep quality. Study performed in mechanically ventilated patients. | 17 patients. | Continuous polysomnography. | The noise level analysis showed only a slight effect of the intervention on noise reduction ($P=0.3$). The analysis of polysomnography revealed that only 53% of the patients had identifiable features of normal sleep, whereas pathologic patterns were observed in 47% of them. No correlation was found between environmental intervention and the presence of normal sleep polysomnographic patterns. | Problems with the identification of an appropriate study group. |

It should be noted, however, that polysomnography itself has its own limitations as well. Electrodes and a registering device may introduce potential disturbances into the examination environment [28,29].

In 2009, another study was performed in the United Kingdom, which included 120 nursing students during their vocational training. This study revealed that nurses lack the comprehensive knowledge and understanding of sleep physiology [29]. It is therefore important to raise nurses' awareness of sleep issues. ICU patients are commonly mistakenly considered as sleeping. However, the structure of sleep in ICUs differs completely from physiological sleep.

Noise is a dominating sleep disturbing factor for ICU patients. Freedman et al. studied its impact on sleep structure in 2001 and observed changes of total sleep time (8.8±5.0 hours) and increased sleep fragmentation. Environmental noise appeared to be responsible for 11.5-17% of awakenings [30]. The noise arousal index was 1.9±2.1/hours of sleep. In 1999, the World Health Organisation recommended noise levels remain under 35 dB in patient rooms. Johansson et al. placed a sound registering device in a 13-bed ICU room and showed that the noise exceeded 55 dB 70-90% of the time [31].

Stachina et al. studied the impact of adding "white noise" as an additional noise element in an ICU. They observed 1178 awakening episodes, yet the reduction of the magnitude of changing noise levels did not reduce the number of awakenings during "white noise". Among factors other than environmental ones, self-assessed sleep quality before an ICU stay presents a strong correlation with sleep quality during hospitalisation. Multiple nursing care interventions contribute to increased sleep fragmentation [32]. Tamburri et al. considered such interventions as moments of sleep interruption [33]. The studies of Bilhari et al. demonstrated that patients assessed the inconvenience of nursing care interventions at 3.5 in a 10-point scale [25]. It should also be noted that the presence of nurses nearby increases a patient's sense of security [1,34].

Another issue, widely discussed in the literature, is the impact of pharmacological agents on particular sleep stages. Previous results and observations, conducted mainly in postoperative departments, prove their significance. From the clinical point of view, it is highly problematic to limit or discontinue therapy due to the potential risk of quantitative and qualitative sleep disorders [25].

It has been proven that increasing awareness of the issue and interaction within the therapeutic team may minimise sleep disorders. The main measures should aim at increasing the comfort of patients, reducing light and noise intensity at night, and the good organisation and aggregation of nursing care interventions to prevent sleep interruptions. Noise reduction may be obtained by adjusting monitor and medical ventilator alarms, minimising staff talking and paying attention to keeping the doors to patients' rooms closed [36]. Light intensity may be reduced by keeping dimmed light in the rooms and providing patients with blindfolds. An adequate mode of mechanical ventilation is also important for the comfort of patients [26]. Regular assessments of pain intensity and appropriate methods of pain control play a key role as well [1,2,34].

## 15 Conclusions

Modern studies suggest that the quality of sleep experienced by ICU patients is low. Sleep in critically-ill patients is characterised by frequent disturbances to its structure, changes in circadian rhythm, disturbances in sleep depth and no regeneration stage. It is the patient's critical condition and not the consequences of sleep disorders that are given priority. Nurses do not attach much importance to a patient's quality of sleep as they have many other duties and need to provide the patient with holistic care. It seems, however, that they play a crucial role in assessing the patient's sleep. Nurses' awareness of sleep disturbing factors in the ICU setting and techniques of their prevention may significantly improve the quality of sleep that patients experience. Changes in sleep structure developing during an ICU stay may significantly contribute to sleep disorders once the hospitalisation is over.

**Funding sources:** None declared

**Conflict of interest:** None declared

**Acknowledgments:** This research was partially performed within the scope of project No. ST-549 of the Medical University of Gdansk, Poland.

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