Understanding sleep quality among postoperative patients in Intensive Care Unit: A conceptual analysis approach

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Abstract

Background: Sleep quality is an important yet understudied element influencing postoperative recovery in intensive care units. Considering that there is a lack of consistent knowledge of the quality of sleep, it is difficult to establish appropriate tests and therapies.
Purpose: To do a conceptual analysis of sleep quality in postoperative intensive care units patients utilizing the Walker and Avant framework, delineating its qualities, antecedents, consequences, and empirical referents.
Methods: This study used the Walker and Avant eight-step process for idea analysis, which included a systematic literature evaluation of papers published between 2020 and 2024 in databases such as PubMed, Scopus, ScienceDirect, and ProQuest. Data was evaluated to determine important defining qualities, causes, outcomes, and measurable indicators of sleep quality.
Results: The analysis identified four defining attributes of sleep quality: sleep architecture, sleep disturbances, subjective experience, and physiological indicators. Antecedents included environmental noise, lighting, pain, anxiety, and frequent medical interventions. Poor sleep quality was associated with adverse outcomes such as increased delirium risk, delayed wound healing, and prolonged intensive care units stays. Empirical referents included patient-reported tools like the Pittsburgh Sleep Quality Index, polysomnography, and actigraphy.
Conclusion: Sleep quality is a multidimensional concept central to postoperative care in intensive care unit. Addressing environmental and psychological factors through targeted interventions can improve sleep quality and enhance recovery outcomes.

Keywords: concept analysis; intensive care unit; postoperative recovery; sleep quality

Introduction

Sleep quality is a complex and multidimensional concept without a universally accepted definition, often assessed subjectively based on factors such as sleep duration, depth, and continuity (Nelson et al., 2022). Poor sleep quality is linked to adverse health outcomes, including delayed recovery and reduced health-related quality of life, particularly in Intensive Care Unit (ICU) settings (Jespersen et al., 2023). Postoperative sleep disturbances are prevalent, affecting 59–72% of ICU patients, with 57% still experiencing poor sleep six months after discharge (Sert et al., 2024; Yildiz et al., 2021). These disturbances are characterized by fragmented sleep, reduced time in deep restorative stages, and sleep efficiency (44-78%) (Lee & Wilcox, 2022).

Despite known environmental, psychological, and demographic contributors to postoperative sleep disturbances, comprehensive studies integrating these factors remain limited (Tegegne & Alemnew, 2022; Yu et al., 2023). Interventions such as noise reduction, pain management, and behavioural therapies show potential but lack standarized evaluation frameworks, restricting their application across clinical settings (Berezin et al., 2023; Darnall et al., 2023). Additionally, the absence of a universally accepted definition of sleep quality hinders the development of effective assessment tools and interventions, particularly in nursing care, where sleep promotion is crucial (Nelson et al., 2022). More research is needed to clarify the factors affecting sleep quality in ICU patients' post-surgery and its implications for clinical practice.

This study adopts a conceptual analysis approach to elucidate the definition, attributes, and clinical implications of sleep quality, contributing to a more robust framework for postoperative care. This conceptual analysis specifically addresses sleep quality among adult postoperative patients admitted to the ICU, with emphasis on sleep experiences occurring during ICU hospitalization. Post-discharge sleep disturbances and long-term recovery trajectories are considered consequences rather than defining elements of the concept, ensuring a clear distinction between conceptual attributes and contextual factors.

Materials and Methods

Study Design

This study employed a concept analysis using Walker and Avant's eight-step framework, complemented by a systematic literature evaluation conducted in accordance with the PRISMA 2020 guidelines to ensure transparency, reproducibility, and methodological rigor.

Concept Analysis Framework

The Walker and Avant approach guided the conceptual phases, including: (1) concept selection, (2) determination of the analysis purpose, (3) identification of all uses of the concept, (4) determination of defining attributes, (5) construction of model and related cases, (6) identification of antecedents and consequences, and (7) definition of empirical referents.

Information Sources and Search Strategy

A systematic literature search was conducted across four electronic databases: PubMed, Scopus, ScienceDirect, and ProQuest. These databases were selected to capture multidisciplinary evidence spanning nursing, critical care, and perioperative medicine.

Search strategies were developed iteratively with Boolean operators and Medical Subject Headings (MeSH) where applicable. An example of the PubMed search string is provided below: ("sleep quality" OR "sleep disturbance" OR "deep sleep") AND

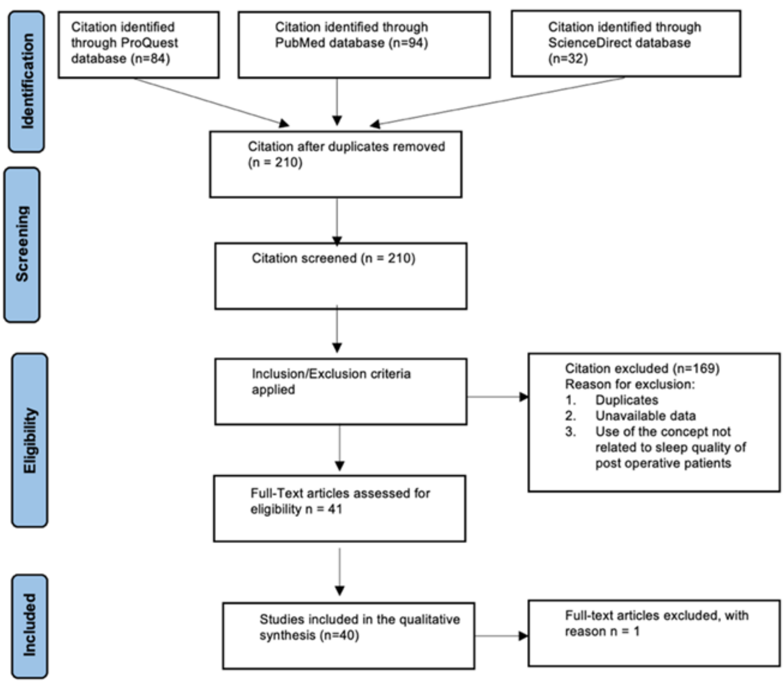

Figure 1. Searching flow chart

("postoperative" OR "post-surgery" OR surgical) AND ("intensive care unit" OR ICU OR "critically ill"). Equivalent adaptations were applied to other databases. The full search strings for all databases are provided in Supplementary Table 1.

Eligibility Criteria

Eligible studies were primary empirical investigations published between 2020 and 2024 and available as full-text articles in the English language. Studies were required to include a sample size of at least 25 participants and to focus on adult postoperative patients admitted to intensive care units. In addition, included studies had to assess sleep quality using at least one recognized objective method, such as polysomnography or actigraphy, or a validated subjective instrument, such as the Pittsburgh Sleep Quality Index.

Studies were excluded if they were review articles, editorials, study protocols, or case reports. Investigations involving pediatric populations were not considered. Studies that did not evaluate sleep quality as an outcome or that were conducted in non–intensive care unit settings or among non-postoperative populations were also excluded.

Study Selection Process

All identified records were imported into reference management software and duplicates removed. Two reviewers independently screened titles and abstracts, followed by full-text assessment. Discrepancies were resolved through discussion or consultation with a third reviewer. Inter-rater agreement during full-text screening demonstrated substantial reliability (Cohen's $\kappa = 0.82$). A total of 185 articles were excluded at the full-text stage, primarily due to non-ICU populations, lack of sleep quality measurement, or inappropriate study design. The study selection process is illustrated in Figure 1 (PRISMA Flow Diagram).

Data Extraction

A standardized data extraction form was used to collect information on study design, sample characteristics, ICU setting, sleep assessment methods, and key findings related to sleep quality attributes, antecedents, and outcomes.

Risk of Bias and Quality Appraisal

Methodological quality and risk of bias were assessed independently by two reviewers using appropriate tools based on study design (e.g., observational or experimental). Domains evaluated included selection bias, measurement bias, and confounding. Studies were not excluded based on quality alone; instead, appraisal results informed the interpretation of conceptual attributes and empirical referents.

Synthesis Approach

Findings from the 40 conceptually relevant studies were synthesized narratively and mapped to Walker and Avant's analytical components, ensuring that defining attributes, antecedents, consequences, and empirical referents were grounded in systematically evaluated evidence.

Results

Select a concept

Sleep quality is crucial for ICU patients' recovery post-surgery, encompassing rest, depth, and satisfaction. It encompasses duration, latency, continuity, and disturbances, often disrupted by environmental and physiological factors and indicators.

Purpose of the analysis

This study explores sleep quality in critical care unit patient post-surgery, identifying factors affecting it, quantifying it, and using it to inform clinical evaluations and treatment plans while also identifying gaps in the literature.

Uses of the concept

This review of Walker and Avant's process aims to identify the key aspects of the concept and explore its various applications, establishing an evidence base that supports the analysis's findings (Khalili et al., 2024).

Common definition — Sleep quality is an individual's satisfaction with their sleep, encompassing factors like time spent, consistency, depth, and calmness upon awakening. It reflects the sleep process's effectiveness in maintaining physical and mental health and is crucial for overall well-being (WHO, 2024).

Objective definition — Sleep quality refers to the measurable aspects of sleep, including duration, time spent asleep, percentage of time spent in bed, and nightly awakenings. PSG and actigraphy are instruments used to evaluate these characteristics by measuring data on sleep patterns and disturbances (Oren et al., 2020). Polysomnography (PSG) is the gold-standard method for objectively assessing sleep. It involves continuous, overnight monitoring of multiple physiological parameters such as brain activity (electroencephalography), eye movements, muscle tone, heart rhythm, and respiratory patterns. PSG provides detailed information on sleep architecture, sleep stages, and sleep disturbances, making it highly accurate but resource-intensive and less feasible for routine use in intensive care units. Actigraphy is a non-invasive, wearable method that estimates sleep–wake patterns based on body movement, typically using a wrist-worn device. It allows for continuous, long-term monitoring in natural clinical settings and is more practical in intensive care units. Although less precise than PSG in identifying sleep stages, actigraphy is useful for evaluating sleep duration, fragmentation, and circadian rhythm trends (Oren et al., 2020).

Subjective definition — Subjective sleep quality is an individual's assessment of their sleep experience, contrasting with objective sleep quality.

Table 1. Attribute of sleep quality among postoperative patients in ICU

Attribute Domain	Operational definition (what defines the concept)	Common indicators & thresholds (when available)	ICU feasibility notes
Sleep architecture & continuity	Objective characteristics describing the structure and consolidation of sleep during the ICU stay	• Sleep latency (prolonged if >30–45 min) • Total sleep time (often <5 h/night in ICU) • Sleep efficiency (poor if <85%) • Wake after sleep onset (WASO: frequent/prolonged awakenings)	PSG provides detailed architecture but is rarely feasible; actigraphy and ECG-derived metrics are more practical for continuity and fragmentation
Sleep disruption pattern	Frequency and pattern of within-sleep interruptions reflecting fragmented or non-restorative sleep	• Number/duration of nocturnal awakenings • Day–night sleep inversion • Increased arousal frequency	Routinely inferred from actigraphy, nursing observations, and sleep logs; aligns well with ICU workflow
Subjective sleep experience	Patient-reported perception of sleep adequacy, restfulness, and satisfaction	• Richards–Campbell Sleep Questionnaire (RCSQ): poor sleep commonly defined as <50/100 • Perceived unrefreshing or insufficient sleep	Highly feasible when patients are awake and communicative; limited in delirium or deep sedation
Physiological correlates	Autonomic and neuroendocrine responses associated with sleep quality	• Heart rate variability (reduced nocturnal parasympathetic activity) • Cortisol rhythm disruption (elevated nocturnal levels)	HRV is increasingly feasible via ECG monitoring; cortisol useful for research but limited for routine bedside use

Table 2. Summaries antecedent, consequence, and empirical referents

Category	Description
Antecedents	- Noise from medical equipment, staff activities, and other patients disrupts circadian rhythms and hinders sleep (Foster, 2020). - Exposure to constant lighting suppresses melatonin secretion, further disrupting sleep patterns (Telias & Wilcox, 2019). - Pain, sedation, and frequent medical procedures interfere with uninterrupted sleep (Knauert et al., 2019). - Anxiety, fear, and disorientation contribute to poor sleep quality (Telias & Wilcox, 2019).
Consequences	- Prolonged ICU stays and increased risk of delirium (Devlin et al., 2018) - Impaired immune function, delayed wound healing, and reduced recovery (Jakowski et al., 2023). - Long-term health issues like cardiovascular disease and metabolic syndrome (Medic et al., 2017). - Persistent sleep disturbances lead to fatigue and compromised mental health post-discharge (Agyapong et al., 2025).
Empirical Referents	- Patients self-report using tools like the Richards-Campbell Sleep Questionnaire (Naik et al., 2018). - PSG for objective sleep architecture measurements (Tiruvoipati et al., 2020). - Actigraphy to monitor rest-activity cycles (Iyengar et al., 2020). - Nurses' observations of restlessness and sedative use (Macdowell et al., 2024). - Environmental assessments of noise, lighting, and interventions (Aparício & Panin, 2020).

Supplementary Table 1. Full Electronic Search Strategies

Database	Full Search String
PubMed	(“sleep quality” OR “sleep disturbance” OR “sleep pattern” OR “deep sleep”) AND (“postoperative” OR “post-surgery” OR surgical) AND (“intensive care unit” OR ICU OR “critically ill”)
Scopus	TITLE-ABS-KEY (“sleep quality” OR “sleep disturbance” OR “sleep pattern” OR “deep sleep”) AND TITLE-ABS-KEY (“postoperative” OR “post-surgery” OR surgical) AND TITLE-ABS-KEY (“intensive care unit” OR ICU OR “critically ill”)
ScienceDirect	(“sleep quality” OR “sleep disturbance” OR “sleep pattern” OR “deep sleep”) AND (“postoperative” OR “post-surgery” OR surgical) AND (“intensive care unit” OR ICU OR “critically ill”)
ProQuest	(“sleep quality” OR “sleep disturbance” OR “sleep pattern” OR “deep sleep”) AND (“postoperative” OR “post-surgery” OR surgical) AND (“intensive care unit” OR ICU OR “critically ill”)

It includes day function, sleep duration, depth, and restfulness, often evaluated using self-reporting tools like the Pittsburgh Sleep Quality Index (Knutson et al., 2017).

Conceptual definition — Multiple factors influence the quality of sleep among postoperative patients in the ICU, including subjective sleep quality, sleep latency, sleep length, pre-sleep activities, sleep disturbances, daytime functional impairments, and the use of sleeping aids (Oren et al., 2020).

Attribute

Four defining attributes of sleep quality among postoperative ICU patients were identified: sleep architecture and continuity, sleep disruption patterns, subjective sleep experience, and physiological correlates. Each attribute is operationalized using measurable indicators that are feasible within ICU settings. Where available, clinically relevant thresholds (e.g., RCSQ <50, sleep efficiency <85%) are provided to enhance bedside applicability. Environmental and care-related factors (e.g., noise, lighting, staff activities) are treated as antecedents, not defining attributes, to maintain conceptual clarity (Table 1).

Sleep architecture

Sleep latency — The amount of time it takes to fall asleep is referred to as sleep latency, and it is a significant predictor of both the quality of sleep and the level of drowsiness that occurs during the daytime. The multiple sleep latency test is a standard that is extensively used for a variety of objectives, including the evaluation of drowsiness and the identification of sleep disorders within the population. In addition, sleep latency is influenced by genetic factors and polymorphisms in the RBFOX3 gene have been associated with this characteristic, which is predominantly expressed in the brain and makes a significant contribution to the neurotransmitter release cycles that are necessary for the initiation of sleep (Oxlund et al., 2023).

Total duration of sleep-in bed — Sleep patterns vary significantly across populations due to factors like race, sex, and socioeconomic status (Lollies et al., 2022). For example, individuals with intellectual disabilities spend about 10 hours in bed but have lower sleep efficiency (Arık et al., 2020). Sleep duration decreases with age, from 14.2 hours at six months to 8.1 hours by 16 years (Ghani et al., 2020). Furthermore, generational shifts show later bedtimes and consistent wake times, leading to reduced total sleep duration. Longer preoperative sleep durations may increase the risk of postoperative psychosis in heart surgery patients (Shanmugasundaram & Dhanasekaran, 2022). Actigraphy studies confirm significant reductions in actual sleep time after surgery (Phansila et al., 2022). Extended sleep duration (≥9 hours) and prolonged time in bed are associated with a greater decline in physical function in older adults (Lin et al., 2022).

Sleep depth — Sleep depth is a complex concept that differs from traditional sleep stages. Those experiencing sleep misperception perceive rapid eye movement (REM) sleep as lighter. In previous studies, the conventional belief challenged that major surgical procedures can disrupt sleep patterns, resulting in a drop in overall sleep time, a decrease in slow-wave sleep, and an increase in non-REM stage 2 sleep. Therefore, both subjective and objective measurements are crucial when assessing sleep depth.

Back to sleep — The time taken to fall back asleep after waking follows a U-shaped pattern throughout the night and can be significantly reduced with medications like pentobarbital and flurazepam (Wolff et al., 2024). Brief awakenings may lead to longer subsequent episodes of slow-wave sleep (SWS) and REM sleep, influencing sleep stage progression (Campbell, 1987). In older adults, sleep disturbances are primarily linked to increased awakenings from non-rapid eye movement sleep, making it harder to return to sleep (van Wyk et al., 2019). REM sleep plays a critical role in distinguishing fear-related and neutral stimuli, consolidating fear-associated memories, and facilitating their extinction. However, remaining awake after extinction enhances the differentiation between neutral and extinguished stimuli, a process linked to activity in the ventromedial prefrontal cortex and amygdala.

Sleep efficiency — Sleep efficiency is a crucial measure of sleep quality and overall health. Factors like pain, nocturia, and sleep medication use are commonly associated with poor sleep efficiency in older adults, who often experience inefficiencies in their sleep (Desjardins et al., 2019). Research also indicates that sleep efficiency plays a role in determining the quality of life in individuals with heart failure and preserved ejection fraction (Ahmed & Zargaran, 2020). Additionally, low sleep efficiency (below 85%) is linked to reduced nocturnal dips in systolic blood pressure and heart rate in normotensive young individuals, potentially increasing cardiovascular disease risk.

Sleep disturbances

Noise — Environmental noise, particularly from transportation, significantly disrupts sleep and poses health risks. Nighttime noise levels above 55 dB are associated with insomnia symptoms and can lead to endocrine and metabolic perturbations, as well as cardiometabolic, psychiatric, and social issues in both adults and children (Yao et al., 2023). The effects of noise on sleep are not limited to nighttime disturbances but can also result in daytime sleepiness, decreased cognitive performance, and long-term adverse health outcomes (Basner & McGuire, 2018).

Lighting — Light exposure significantly influences sleep patterns and quality. Bright morning light can advance sleep timing, while evening light exposure can delay it and negatively impact sleep outcomes (Delaney et al., 2021). Later circadian phases are associated with lower light intensity and later light exposure, leading to more awakenings during sleep. Light affects sleep in two ways: first, it causes shifts in circadian rhythms, which in turn affects sleep in nocturnal animals and alertness in humans (Santhi & Ball, 2020). The impact of light on slumber can be described in two ways. Research has shown that both objective and subjective sleep outcomes are improved by exposure to bright light (more than 1000 lux) as opposed to dim light (less than 100 lux) or moderate light (100-1000 lux) (Dautovich et al., 2019).

Bedtime activities — Consistent bedtime routines established early in life can lead to better sleep outcomes, including longer sleep duration and fewer sleep problems (Fiese et al., 2021). Early postoperative mobilization within 24 hours of caesarean section can reduce hospital stay, pain scores, and complications like ileus and infection. Pain levels associated with postoperative activities, such as coughing and moving in bed, tend to be higher in the early days following cardiac surgery (Christodoulidis et al., 2023).

Frequency of waking up at night — Nocturnal awakenings are a prevalent sleep disturbance affecting approximately one-third of the general population. Patients typically wake up more often during the first postoperative night compared to preoperatively (48%), along with other contributing factors, including noise from staff and other patients and bathroom use (Yao et al., 2023). A higher risk of postoperative delirium may be linked to sleep disruption, especially increasing wake time after sleep initiation. Postoperative sleep alterations include an increase in stage 2 sleep and a decrease in slow-wave sleep since the magnitude of surgery and opioid administration may influence the extent of sleep disturbances (Ding et al., 2016).

Frequency of sleep disturbances during the day — Postoperative results can be severely affected by sleep disorders, which affect a large percentage of surgical patients. These disruptions typically linger and become worse following surgery, especially in the initial week (Ding et al., 2016). The likelihood of postoperative delirium is higher in patients who have a history of sleep disorders, with odds ratios reported in meta-analyses ranging from 3.73 to 5.24 (Díaz-Alonso et al., 2018). According to Díaz-Alonso et al. (2018), this heightened risk is caused by both sleep disruptions before and after the operation.

Use of sleeping pills — The use of sleeping pills is a significant clinical issue due to the high prevalence of insomnia, affecting approximately 35% of adults (Culver et al., 2020). The rational use of sleeping pills demands individual patient evaluation, specific treatment goals, and careful consideration of the chosen medication (Culver et al., 2020). There is a higher probability of negative postoperative outcomes when benzodiazepines and Z-drugs are used before surgery, especially when opioids are also recommended (Garland et al., 2023). Improving postoperative sleep through both pharmaceutical and non-pharmacological therapies has the potential to enhance patient recovery (Zhang et al., 2023). However, there are concerns about opioid overprescription for postoperative pain management. Studies show that patients typically use fewer opioids than prescribed after discharge, with most consuming 15 pills or less (Seixas, 2021). Despite this, many patients retain excess medication, raising concerns about improper disposal and potential misuse (Seixas, 2021).

Subjective sleep

Patient-reported measures of sleep satisfaction and restfulness are critical components of assessing sleep quality.

Sleep satisfaction — Sleep pleasure is a concept in sleep research that emphasizes the positive emotions experienced during sleep (Díaz-Alonso et al., 2018). Factors affecting sleep satisfaction include the amount of sleep, depth of sleep, frequency of awakenings, and number of awakenings per night. Moreover, older individuals with depression may report less satisfaction with their sleep (Soeding et al., 2024). Sleep quality is influenced by how you feel before, during, and after sleep, and environmental factors like bedding quality, bedroom temperature, and noise levels influence the following day. Sleep satisfaction indices include ease of falling asleep, ability to return to sleep after waking up, and sleep duration on both weekdays and weekends (Ohayon et al., 2017).

Physiological indicators

Postoperative patients in the ICU require good sleep quality for recovery. HRV and cortisol levels are crucial indicators. HRV indicates the autonomic nervous system's balance, with reduced variability often linked to stress and poor sleep. On the other side, elevated cortisol disrupts sleep patterns, reducing sleep quality.

HRV is a non-invasive measure of autonomic nervous system function that is monitored in ICU settings to enhance the understanding of patients' sleep architecture and autonomic function (Ganglberger et al., 2023; Ho et al., 2024). Increased HRV during sleep is associated with restorative sleep and heightened parasympathetic activity, whereas lower HRV may indicate sympathetic dominance, stress, and poor sleep quality. HRV derived from electrocardiogram signals has been shown to assess sleep stages and fragmentation in critically ill patients, offering a practical alternative to traditional PSG, which is often impractical in ICU settings (Ganglberger et al., 2023). The use of deep learning models to classify sleep stages in ICU patients based on HRV and respiratory variability reveals the potential of these biosignals to provide insights into sleep phases, quality, and fragmentation (Ganglberger et al., 2023). Additionally, HRV has been investigated for its potential role in predicting perioperative neurocognitive outcomes, with findings suggesting its relevance in evaluating neurocognitive risk in non-cardiac surgical patients (Liu et al., 2024).

Cortisol levels — Cortisol, a glucocorticoid hormone secreted by the adrenal glands, follows a diurnal pattern, peaking in the early morning and gradually declining throughout the day (Lightman, 2010). Sleep disruptions can alter this rhythm, leading to elevated nocturnal cortisol levels, which are associated with stress and poor sleep quality. In postoperative ICU patients, increased cortisol levels may result from surgical stress, pain, and environmental disturbances. A study by Hu et al. (2015) found that interventions such as earplugs, eye masks, and soothing music improved perceived sleep quality among ICU patients. However, despite these improvements, no significant differences were observed in urinary cortisol levels between the intervention and control groups. This suggests that while these interventions enhance subjective sleep experiences, their impact on physiological stress markers like cortisol may vary based on factors such as surgery timing and individual differences.

Identification of Cases

Model Case — After undergoing abdominal surgery, a 55-year-old patient was admitted to the ICU for postoperative care. Her sleep quality was monitored over 48 hours, revealing an extended sleep latency of 45 minutes and a total sleep duration of 4.5 hours. Her sleep was fragmented, with a 60% sleep efficiency. She struggled to transition into deep sleep stages, but could return to light sleep after brief awakenings. Frequent nighttime awakenings were influenced by noise from medical equipment and staff conversations, and daytime rest periods were interrupted by nursing care. A low-dose sedative was given to aid her sleep, but only slightly improved sleep continuity. Mrs A described her sleep as "unrefreshing" and "disrupted," expressing frustration over her inability to achieve restorative sleep. Her HRV analysis showed reduced parasympathetic activity at night, indicating poor autonomic recovery. Elevated morning cortisol levels suggested increased stress, likely due to sleep deprivation.

Borderline case — A 68-year-old postoperative patient recovering from abdominal surgery in the ICU is experiencing inconsistent sleep quality. The patient falls asleep slightly longer than average, with only about 5 hours of actual sleep. The sleep monitoring system shows a predominance of light sleep with minimal deep sleep phases, resulting in a low sleep efficiency of 50%. Despite frequent awakenings, the patient can return to sleep within 15-20 minutes. Nursing interventions and routine vital sign monitoring also contribute to delayed sleep onset. The patient wakes 3-4 times at night due to discomfort from surgical drains and alarm sounds. Frequent daytime naps also interfere with nighttime sleep patterns. Although feeling somewhat rested, the patient's sleep is fragmented and shallow, leading to dissatisfaction with the overall sleep experience. HRV data indicates mild stress levels, and slightly elevated morning cortisol levels suggest increased stress or inadequate nighttime rest.

Contrary case — Mrs A, a 45-year-old postoperative patient in the ICU following abdominal surgery, experiences severely impaired sleep quality. Her sleep is characterized by prolonged latency exceeding an hour, fragmented periods totaling less than three hours, and an absence of restorative deep sleep. Even daytime rest is compromised by the busy ICU setting. Despite being offered prescribed sleep aids, she refuses them due to concerns about side effects, leaving her without effective interventions. Subjectively, Mrs A describes her sleep as "non-existent," expressing frustration and exhaustion, with physical discomfort, environmental stressors, and emotional strain exacerbating her perception of poor sleep. Objective assessments indicate significant physiological stress, including reduced HRV and persistently high cortisol levels, markers of sleep deprivation and stress. These findings highlight the profound impact of her disrupted sleep on both her physical and psychological well-being.

Table 2 presents summaries of the antecedent, consequence, and empirical reference, and detailed explanations are below:

Antecedents

Understanding the factors that impact the quality of sleep experienced by postoperative patients in the ICU is crucial for encouraging patient recovery and well-being. The events or circumstances that take place prior to the manifestation of an idea are referred to as antecedents (Yuan et al., 2021). The analysis identified the following antecedents contributing to sleep quality: Noise from medical equipment, staff activities, and other patients, as well as constant lighting, disrupt circadian rhythms and hinder sleep. High noise levels from equipment alarms and conversations have been reported to disturb sleep in ICU patients (Sathvik et al., 2023). Additionally, exposure to light during nighttime can suppress melatonin secretion, further disrupting sleep patterns (Telias & Wilcox, 2019). Pain, sedation, and frequent medical procedures interfere with uninterrupted sleep. Moreover, the use of mechanical ventilation and other medical interventions can contribute to sleep fragmentation (Telias & Wilcox, 2019). Anxiety, fear, and disorientation in ICU settings contribute to poor sleep. Patients may feel unsafe or anxious, leading to difficulty falling asleep or maintaining sleep (Sathvik et al., 2023).

Consequences

Poor sleep quality in postoperative ICU patients is associated with several adverse outcomes, including prolonged ICU stays, increased delirium risk, impaired immune function, delayed wound healing, and diminished overall recovery and quality of life. Sleep disturbances contribute to extended hospitalizations due to their impact on physiological recovery and healing processes (Devlin et al., 2018). Additionally, sleep disruptions are linked to delirium, characterized by cognitive deficits, hallucinations, and disorientation, affecting nearly half of ICU patients and potentially leading to long-term cognitive impairments. Poor sleep quality is also associated with reduced quality of life, increased stress, emotional distress, and cognitive impairments (Medic et al., 2017).

Moreover, inadequate sleep in ICU patients increases susceptibility to infections and sepsis due to impaired cytokine production and cellular immunity (Lollies et al., 2022). Sleep deprivation is also correlated with delayed tissue repair and wound healing, complicating postoperative outcomes. Furthermore, chronic sleep disturbances can lead to long-term health risks such as cardiovascular disease, metabolic syndrome, and type 2 diabetes, conditions often associated with stress (Medic et al., 2017). Daily psychosocial stressors, including lack of leisure time and work-family conflicts, can further affect sleep latency and quality (Lee et al., 2017). The long-term ramifications of recurrent sleep disturbances during ICU stays include persistent fatigue, reduced physical function, and impaired mental health, negatively affecting patients' quality of life even after hospital discharge (Naik et al., 2018).

Empirical referents

Empirical referents are observable and measurable indicators used to assess the presence of a concept (Naik et al., 2018). In the context of postoperative ICU patients, sleep quality is a key empirical referent, evaluated through multiple approaches. Self-reports, such as the Richards–Campbell Sleep Questionnaire (RCSQ) is a simple, patient-reported tool used to assess perceived sleep quality, particularly in intensive care unit (ICU) settings. It consists of five items that evaluate key aspects of sleep: sleep depth, sleep latency, number of awakenings, ability to return to sleep, and overall sleep quality. Each item is rated using a visual analog scale (0–100), with higher scores indicating better sleep (Naik et al., 2018). PSG is the gold standard for sleep assessment, objectively measuring sleep architecture and stages, but its use in ICU settings is limited due to technical complexity and patient care constraints (Tiruvoipati et al., 2020). Actigraphy, a non-invasive method using wristwatch-like devices, helps track rest-activity cycles and sleep patterns in ICU patients (Iyengar et al., 2020). Nurses' observations of restlessness, sedative use, and sleep periods serve as practical indicators, highlighting sleep disturbances as a major concern (Macdowell et al., 2024). These empirical referents enable systematic evaluation and intervention to enhance postoperative ICU patients' sleep quality and recovery outcomes.

Discussion

The findings of this conceptual analysis highlight sleep quality as a clinically relevant yet under-integrated component of postoperative care in the ICU. Rather than implying direct causality, the present analysis demonstrates that sleep quality is consistently associated with key recovery-related outcomes in postoperative ICU patients, including delirium risk, physiological stress responses, and prolonged ICU stay. By applying the Walker and Avant framework, this study clarifies sleep quality as a multidimensional concept shaped by definable attributes and influenced by modifiable antecedents within the ICU environment, thereby supporting its relevance for nursing assessment and care planning.

The findings of this study underscore the critical importance of addressing sleep quality as a fundamental component of postoperative care for patients in ICUs. Despite its significant impact on recovery, sleep quality is often overlooked in these high-stress environments. ICU patients frequently encounter sleep disturbances due to environmental factors, pain, and psychological distress. Utilizing Walker and Avant's (2011) conceptual framework provides a structured approach to understanding sleep quality by identifying key antecedents, attributes, and consequences, leading to actionable interventions that enhance patient care.

Environmental factors such as noise and light exposure are repeatedly identified in postoperative ICU literature as antecedents that disrupt sleep continuity and circadian regulation, rather than direct causes of adverse outcomes (Ho et al., 2024). Excessive alarm noise, staff communication, and continuous illumination may increase arousal frequency and reduce restorative sleep phases, which in turn are associated with fatigue, stress responses, and impaired cognitive recovery (Stewart et al., 2017). Interventions including noise reduction strategies, dimming lights during nighttime hours, earplugs, and eye masks have been shown to improve subjective sleep outcomes in ICU populations, although evidence for downstream clinical effects remains variable (Delaney et al., 2019). Framing these interventions as sleep-protective strategies rather than curative measures aligns more closely with the current postoperative ICU evidence base.

Postoperative pain and anxiety represent critical clinical antecedents that may interfere with sleep initiation and maintenance in ICU patients. Inadequately controlled pain can prolong sleep latency and increase nocturnal awakenings, while anxiety and hyperarousal may limit progression into restorative sleep stages (Delaney et al., 2019). Multimodal analgesia and individualized anxiolysis may therefore support sleep quality indirectly by reducing physiological and psychological arousal. Importantly, this analysis does not suggest that analgesic or anxiolytic interventions directly improve sleep outcomes; rather, their timing, dosing, and selection may influence sleep–wake stability and delirium risk (Sadler et al., 2020). Aligning analgesia and anxiolysis schedules to minimize nighttime arousal represents a feasible, nursing-sensitive strategy within postoperative ICU care.

Sleep disruption has been repeatedly linked to delirium in critically ill populations, including postoperative ICU patients, although causal pathways remain complex and bidirectiona (Zhang et al., 2021). Fragmented sleep and circadian misalignment may exacerbate neuroinflammatory responses and impair cognitive resilience, thereby increasing vulnerability to delirium. Within this context, nursing-led interventions such as care clustering, reduction of non-urgent nighttime procedures, and alignment of monitoring activities with patients' sleep–wake cycles may reduce unnecessary sleep interruptions. These strategies target mechanistic contributors to sleep disruption and align with delirium prevention bundles commonly used in ICU practice (Lee et al., 2017). Research in the future should look at how sleep-focused therapies affect recovery trajectories over the long run and what factors particular to individual patients affect the quality of their sleep-in different types of ICU.

Clinical implication

As a conceptual analysis, this study does not establish causal relationships but instead provides a structured framework for understanding how sleep quality operates within the postoperative ICU context. Incorporating sleep assessment into routine ICU nursing practice using feasible tools such as patient-reported measures, actigraphy, or HRV-derived indicators may enhance early identification of patients at risk for poor recovery trajectories. Future ICU-focused longitudinal and interventional studies are needed to clarify the extent to which sleep-targeted interventions influence postoperative outcomes and to determine which patient subgroups derive the greatest benefit. Such research should prioritize postoperative ICU-specific populations, standardized sleep measures, and clearly defined intervention mechanisms.

Limitations

The concept analysis method proposed by Aparício and Panin (2020) offers a structured framework for defining and analyzing concepts, but it has limitations. It relies on existing literature and theoretical constructs, which may not fully capture the complexities of clinical practice. Sleep quality assessment often relies on subjective self-reported data, which can introduce bias and affect study validity. Sleep in ICUs is often disrupted by environmental factors, making it difficult to isolate their specific impact on sleep quality. Variability in postoperative patients' medical histories and recovery trajectories complicates generalizability. Measurement tools for sleep quality may also have inherent biases or limitations, affecting data accuracy and reliability. Small sample sizes can reduce statistical power, and findings may not be generalizable. The dynamic nature of ICU environments further complicates sleep assessment, necessitating longitudinal research. Ethical and practical challenges, such as obtaining informed consent from critically ill patients, can also impact study design and execution.

Conclusions

Sleep quality is a critical but complex component of recovery among postoperative patients in intensive care units. The findings of this concept analysis suggest that sleep quality is influenced by a combination of environmental, physiological, and care-related factors; however, causal relationships cannot be definitively inferred due to heterogeneity in study designs and measurement approaches. While biomarkers such as cortisol levels and heart rate variability offer valuable insights into stress and autonomic regulation, their clinical interpretation in ICU settings is constrained by confounding factors including critical illness severity, pharmacological interventions, and circadian disruption. Therefore, these indicators should be considered complementary rather than standalone measures of sleep quality. Based on the synthesized evidence, a tiered sleep quality assessment approach is proposed, integrating (1) routine subjective screening using validated tools, (2) targeted objective monitoring when clinically feasible, and (3) contextual clinical judgment that accounts for ICU-specific constraints. Implementation should occur in a stepwise manner, beginning with low-burden environmental and scheduling modifications, followed by individualized pain and anxiety management strategies, and progressing to selective use of physiological indicators where appropriate. This pragmatic, layered approach supports clinical decision-making while acknowledging measurement limitations and resource variability, and it provides a feasible pathway for integrating sleep quality assessment into routine postoperative ICU care.

Declaration of Conflicting Interest

No conflict of interest to declare.

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Author's Contribution

JG contributed to the study's conception and design, data acquisition, and data analysis, wrote the first draft of the manuscript, revised the final draft, and gave final approval of the version to be published.

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