

Non-Pharmacological Interventions for Sleep in Pediatric Intensive Care Units: Current Evidence and Future Directions

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Abstract

Objective: Admission to the pediatric intensive care unit (PICU) frequently leads to significant sleep disturbances due to the combined effects of continuous monitoring alarms, artificial lighting, repeated bedside procedures, and nighttime care-related interruptions. Non-pharmacological interventions have gained increasing attention as practical, low-cost approaches to address these disruptions. This narrative review was conducted to synthesize current evidence on the effectiveness, feasibility, and clinical implications of non-pharmacological sleep interventions in the PICU.

Materials and Methods: Studies published between 2016 and 2026 were searched in the PubMed, Web of Science, and Scopus databases. A total of 20 studies addressing non-pharmacological sleep interventions and sleep-related outcomes in PICU populations, together with complementary evidence from other clinically relevant populations, were included in the narrative synthesis.

Results: The median number of nocturnal awakenings in children admitted to the PICU was nine. In a mixed pediatric inpatient study, PICU stay was associated with approximately 258 minutes less nighttime sleep than general pediatric unit stay. Available evidence suggests that care clustering and environmental modifications may help reduce sleep disruption, although direct evidence of clinical effectiveness remains limited. Music-based interventions appeared feasible in PICU populations, with no intervention-related adverse events reported in the available small studies, while favorable effects on subjective sleep quality were reported primarily in broader critically ill and surgical populations. Evidence supporting eye masks and earplugs was derived mainly from adult and broader ICU populations, where favorable sleep outcomes were reported. Massage and reflexology were associated with favorable sleep outcomes primarily in neonatal intensive care units and other pediatric inpatient populations. A structured PICU diary intervention was associated with shorter awakening times during PICU hospitalization and lower stress-related symptoms after discharge. Overall, the available evidence suggests that these interventions are generally feasible, although the certainty and directness of evidence vary across intervention modalities.

Conclusions: Non-pharmacological sleep promotion interventions may support sleep in critically ill children. However, current evidence is insufficient to determine whether improving sleep reduces the risk of delirium, Pediatric Post-Intensive Care Syndrome, or other long-term outcomes. As PICU-related sleep difficulties may persist for months after discharge, sleep promotion strategies should not be limited to the hospitalization period. Multicenter randomized controlled trials specifically designed for PICU populations and employing validated sleep outcome measures are needed to advance this field toward evidence-based clinical protocols.

Keywords: Pediatric intensive care unit, Sleep, Non-pharmacological interventions, Circadian rhythm, Sleep disturbance, Care clustering, Delirium

Çocuk Yoğun Bakım Ünitelerinde Uyku İçin Farmakolojik Olmayan Müdahaleler: Güncel Kanıtlar ve Gelecek Yönelimler

Özet

Amaç: Çocuk Yoğun Bakım Ünitesi (ÇYBÜ)'de yatış, sürekli monitör alarmları, yapay aydınlatma, sık tekrarlanan yatak başı girişimler ve gece saatlerinde gerçekleştirilen bakım uygulamaları gibi faktörlerin birleşimi sıklıkla uyku sorunlarına yol açar. Uykuyu düzenlemede non-farmakolojik müdahaleler, bu sorunların üstesinden gelmek için pratik ve düşük maliyetli yaklaşımlar olarak giderek daha fazla önem kazanmaktadır. Bu narrative derleme, ÇYBÜ'de non-farmakolojik uyku müdahalelerinin etkinliğini, uygulanabilirliğini ve klinik uygulamalara yansımalarını inceleyen güncel kanıtları sentezlemek amacıyla gerçekleştirildi.

Gereç ve Yöntem: Bu narrative sentezde 2016-2026 yılları arasında PubMed, Web of Science ve Scopus veri tabanlarında yayımlanan çalışmalar incelendi. ÇYBÜ popülasyonlarında non-farmakolojik uyku müdahaleleri ve uyku ile ilişkili sonuçları ele alan çalışmalar ile klinik açıdan ilgili diğer popülasyonlardan elde edilen tamamlayıcı kanıtlar dahil olmak üzere toplam 20 çalışma senteze dahil edildi.

Bulgular: ÇYBÜ'ye yatırılan çocukların gece uyanma sayısının ortancası 9'dur. Karma pediatrik yatan hasta örnekleminde gerçekleştirilen bir çalışmada, ÇYBÜ'de yatışın genel pediatri servisinde yatışa kıyasla yaklaşık 258 dakika daha az gece uykusuyla ilişkili olduğu bildirildi. Mevcut kanıtlar, bakım kümeleme ve çevresel düzenlemelerin uyku bölünmesini azaltmaya yardımcı olabileceğini düşündürmekle birlikte, doğrudan klinik etkinliğe ilişkin kanıtlar sınırlıdır. ÇYBÜ popülasyonlarında müzik temelli müdahalelerin uygulanabilir olduğu görülürken, mevcut küçük örneklemli çalışmalarda müdahaleyle ilişkili advers olay bildirilmedi. Subjektif uyku kalitesindeki olumlu etkiler ise ağırlıklı olarak daha geniş kritik hasta ve cerrahi popülasyonlardan elde edildi. Göz maskesi ve kulak tıkacı kullanımını destekleyen kanıtlar çoğunlukla yetişkin ve daha geniş YBÜ popülasyonlarından gelmekte olup, bu popülasyonlarda olumlu uyku sonuçları bildirildi. Masaj ve refleksoloji ise ağırlıklı olarak yenidoğan yoğun bakım ve diğer

pediatrik yatan hasta popülasyonlarında olumlu uyku sonuçlarıyla ilişkilendirildi. Yapılandırılmış ÇYBÜ günlüğü müdahalesi, ÇYBÜ yatışı sırasında daha kısa uyanma süreleri ve taburculuk sonrası daha düşük stresle ilişkilendirildi. Genel olarak mevcut kanıtlar, bu müdahalelerin uygulanabilir olabileceğini düşündürmekte, ancak kanıtların kesinliği ve doğrudanlığı müdahale türlerine göre değişmektedir.

Sonuç: Non-farmakolojik uyku teşvik müdahaleleri, kritik hastalığı olan çocuklarda uykunun desteklenmesine katkı sağlayabilir. Ancak mevcut kanıtlar, uykunun iyileştirilmesinin deliryum, Pediatrik Yoğun Bakım Sonrası Sendromu veya diğer uzun dönem sonuçların riskini azaltıp azaltmadığını belirlemek için yetersizdir. ÇYBÜ'ye bağlı uyku sorunları taburculuk sonrasında aylarca sürebildiğinden, uyku teşvik stratejileri hastanede yatış süreciyle sınırlı kalmamalı ve taburculuk sonrasını da kapsamalıdır. Alanın kanıta dayalı klinik protokollere kavuşabilmesi için ÇYBÜ'ye özgü, geçerli uyku sonuç ölçütleri kullanan çok merkezli randomize kontrollü çalışmalara ihtiyaç duyulmaktadır.

Anahtar kelimeler: Çocuk yoğun bakım ünitesi, Uyku, Farmakolojik olmayan müdahaleler, Sirkadyen ritim, Uyku bozukluğu, Bakım kümeleme, Deliryum

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INTRODUCTION

Sleep is a fundamental physiological requirement for growth hormone secretion, neuronal plasticity, immune function, tissue repair, and memory consolidation, and this need is particularly critical in children (1,2). During childhood, a period of active brain development, REM and deep sleep stages support essential biological processes including synaptic pruning, neurogenesis, and cognitive maturation. Children also spend a greater proportion of sleep in these restorative stages than adults, making them particularly vulnerable to the physiological consequences of repeated sleep disruption (3). The pediatric intensive care unit (PICU), however, is structurally at profound odds with this critical physiological requirement. Children admitted to the PICU experience significant sleep disturbances due to continuous monitoring, elevated noise levels, uninterrupted artificial lighting, invasive procedures, and frequent nighttime care activities (3,4). Observational studies have demonstrated that children in the PICU experience a median of nine awakenings per night, with 44% of these awakenings attributable to care activities performed by healthcare personnel (5). Sleep fragmentation—characterized by recurrent awakenings and incomplete sleep cycles—represents a clinically distinct pattern from total sleep deprivation. Although total sleep time may appear

preserved, sleep fragmentation results in non-restorative sleep with consequences comparable to outright sleep loss (3,6).

The clinical consequences of PICU-related sleep disturbances are profound. Sleep fragmentation and sleep disturbances have been associated with delirium and have been discussed as potential contributors to adverse neurodevelopmental and post-intensive care outcomes. However, causal relationships remain uncertain (3,7). Pharmacological sedation, while commonly employed, disrupts the neurotransmitter systems regulating the sleep-wake cycle and alters sleep architecture, and therefore cannot serve as an adequate substitute for restorative sleep (2,6). In this context, non-pharmacological sleep promotion interventions have attracted increasing clinical attention in the PICU (6,8,9). The aim of this review is to synthesize current evidence on non-pharmacological interventions for sleep promotion in critically ill children admitted to the PICU, while incorporating complementary evidence from clinically relevant populations where direct PICU evidence is limited, and to discuss the implications of these interventions for nursing practice.

MATERIALS AND METHODS

Design and Review Approach

This study was designed as a narrative review to synthesize current evidence on non-pharmacological sleep promotion interventions in pediatric intensive care units. Although a formal systematic review protocol was not employed, the literature search and selection processes were conducted in a structured and transparent manner consistent with established narrative review methodology.

Search Strategy

A comprehensive literature search was conducted in June 2026 across three electronic databases: PubMed (n=104), Web of Science (n=58), and Scopus (n=7), yielding a total of 169 records. The search strategy combined the following keywords individually and in combination: "pediatric intensive care unit," "PICU," "sleep," "sleep disturbance," "sleep promotion," "non-pharmacological interventions," "nursing intervention," "care clustering," "music therapy," and "circadian rhythm." The search was restricted to studies published between January 2016 and June 2026.

Eligibility Criteria

Studies were eligible for the primary PICU-focused evidence base if they: (1) included children aged 0–18 years admitted to a PICU; (2) examined sleep disturbances, sleep-related factors, or non-pharmacological interventions relevant to sleep promotion; (3) reported sleep-related outcomes, sleep-disrupting factors, sleep-promoting practices, or recommendations relevant to sleep promotion; and (4) were published in English between 2016 and 2026. Both primary research articles and review studies were eligible. Because direct PICU-specific evidence was limited for several non-pharmacological interventions, selected studies conducted in general pediatric wards, neonatal intensive care units (NICUs), and adult intensive care units (ICUs) were additionally included as complementary evidence when the interventions or sleep-related practices and their clinical implications were considered directly applicable to pediatric critical care practice. These studies were treated as indirect or complementary evidence and were not interpreted as direct evidence of effectiveness in critically ill children. Studies were excluded if they focused solely on pharmacological interventions, did not report sleep-related outcomes, or were conducted outside the PICU without findings considered relevant to the non-pharmacological sleep promotion strategies examined in this review.

Study Selection and Data Synthesis

The database search identified 169 records. After duplicate records were identified by comparing titles across the database search results, 6 duplicates were removed, leaving 163 unique records for screening.

Title and abstract screening, as well as full-text review, were conducted independently by two reviewers. Any disagreements between the reviewers were resolved through discussion. In cases where consensus could not be reached, a third reviewer was consulted to make the final decision. At this stage, 128 records were excluded because the population or setting was not relevant to the review scope (n = 62), no sleep-related outcome was reported (n = 42), or the study focused exclusively on pharmacological interventions (n = 24). The full texts of the remaining 35 articles were assessed for eligibility. Of these, 15 articles were excluded because the population or setting was not relevant to the review scope (n = 3), no sleep-related outcome was reported (n = 4), the study focused exclusively on pharmacological interventions (n = 2), the article did not meet the language criterion (n = 1), or because insufficient intervention- or sleep-specific data were available for inclusion in the narrative synthesis (n = 5). Ultimately, 20 studies met the inclusion criteria and were incorporated into the narrative synthesis. The study selection process is illustrated in Figure 1. Because the included studies varied considerably in terms of design, participant characteristics, and outcome measurement, findings were organized thematically and interpreted narratively rather than subjected to statistical pooling.

To account for differences in methodological strength, the included studies were categorized according to study design and evidence type. Primary studies, randomized trials, observational studies, consensus studies, narrative reviews, systematic reviews, meta-analyses, and evidence summaries were interpreted according to their methodological characteristics rather than being treated as equivalent sources of evidence. Because some secondary evidence sources may have included primary studies that were also represented separately in this review, findings from review-level evidence were used primarily to contextualize and support the narrative synthesis rather than being counted as independent confirmatory evidence.

RESULTS

A total of 20 studies were included in this narrative review; their key characteristics and findings are presented in Table 1.

Table 1. Characteristics and Key Findings of Studies on Non-Pharmacological Sleep Interventions in the PICU

Author / Year	Country	Setting	Study Design	Evidence Category	Intervention	Age / Sample	Key Findings
Stremler et al., 2021 (4)	Canada	Mixed pediatric inpatient (PICU/general ward)	Prospective cross-sectional study	Observational evidence	Objective sleep measurement; environmental factors	1–18 years; n=69 (PICU n=11); pediatric inpatients	General pediatric unit stay was associated with 258 min more nighttime sleep than PICU stay; sound >80 dB and light >150 lux were associated with 35% and 17% higher hazards of waking, respectively.
Nenningsland et al., 2025a (5)	Norway	Direct PICU	Observational cross-sectional study	Observational evidence	Identification of sleep-disrupting factors; care clustering recommendations	5 months–5 years; n=21; two PICUs	Median 9 awakenings per night; 44% caused by healthcare personnel; median sound level 55.79 dBA; 63% slept below recommended durations and all participants experienced fragmented sleep.
Hassinger et al., 2023 (6)	USA	Direct PICU	Focused narrative review	Narrative review evidence	Review of PICU sleep and circadian dysregulation literature	Critically ill children; 16 studies, 312 children	Consistent evidence of deranged sleep-wake cycling, reduced N3 and REM sleep; sedatives disrupt sleep architecture; melatonin levels may be elevated
Edvardsen & Hetmann, 2020 (8)	Norway	Adult ICU	Evidence-based review	Evidence-based review	Eight nursing care recommendations for sleep promotion in ICU	Adult ICU patients	Recommendations: noise reduction, earplugs/eye masks, music, pain management, quiet time, circadian rhythm support, care clustering, ventilator optimization
Stenkjaer et al., 2022 (9)	International	Direct PICU	Delphi consensus study	Consensus evidence	Non-pharmacological delirium management bundle for PICU	PICU experts; n=74	Consensus on age-specific non-pharmacological bundle: daily routine, light adjustment, sleep scheduling, sensory aids, parental presence
Gomez-Merino et al., 2025 (10)	Spain	Direct PICU	Multicenter cross-sectional descriptive study	Observational evidence	Night-time nursing interventions in 10 Spanish PICUs using NIC taxonomy	PICU nurses; 100 records; 5,017 interventions	Vital signs monitoring most frequent (100% records); sleep enhancement documented in 94% records; none of participating PICUs had a sleep protocol
Kalvas & Harrison, 2024 (11)	USA	Direct PICU	Observational pilot study (secondary analysis)	Pilot observational evidence	Examination of screen time and sleep relationship (24-hour video + actigraphy)	1–4 years; n=8; PICU	All children exceeded AAP screen time recommendations; screen time negatively associated with nocturnal sleep duration ($r_s = -0.5$)
Kalvas et al., 2023 (12)	USA	Direct PICU	Observational pilot study	Pilot observational evidence	PICU environmental exposures, sleep, and delirium relationships	1–4 years; n=10; PICU	Children with delirium experienced 1.1 more awakenings/sleep hour and 42 fewer minutes of sleep/episode at night; clinician caregiving frequency and duration associated with worse sleep and delirium
Wang et al., 2026 (13)	China	Direct PICU	Longitudinal observational study	Longitudinal observational evidence	Sleep trajectory monitoring post-PICU discharge using CSHQ	3–12 years; n=237; PICU	Sleep disturbance peaked at 83.5% at 1-week post-discharge; remained >50% at 3 months; three distinct trajectories identified; age and surgical history as independent predictors
Zhang et al., 2025 (14)	China	Mixed ICU	Evidence summary	Evidence synthesis	Best evidence for non-pharmacological management of sleep disturbances in ICU	ICU patients; 18 sources (4 guidelines, 2 expert consensuses, 11 systematic reviews)	25 evidence items across 4 domains: risk factors, sleep monitoring, non-pharmacological intervention, education and training

Table 1. Continued

Author / Year	Country	Setting	Study Design	Evidence Category	Intervention	Age / Sample	Key Findings
Nenningsland et al., 2025b (15)	Norway, Sweden, Denmark	Direct PICU	Cross-sectional survey	Survey evidence	PICU physical layout and sleep promotion; nurse perceptions	PICU nurses; n=79	Most nurses perceived the PICU layout as suboptimal for sleep promotion; monitors and alarms were major contributors to noise; multibed layouts were perceived as less conducive to sleep and environmental control.
Johnson et al., 2023 (16)	USA	PICU-focused/mixed pediatric inpatient	Systematic review	Systematic review evidence	Safe sleep guideline development for PICU; included as complementary evidence because recommendations concerning the sleep environment and bedtime care practices overlap with sleep-promoting care	PICU infants and children	Safe sleep education and role modeling effective in reducing harm; evidence-based safe sleep algorithm developed for PICU implementation
Garcia Guerra et al., 2021 (17)	Canada	Direct PICU	Pilot RCT (3-arm)	Pilot randomized evidence	Music (classical) vs. noise-blocking vs. control; 3×30 min/day via headphones	1 month–16 years; n=60; mechanically ventilated PICU patients	The intervention was feasible, with >80% protocol adherence and no study-related adverse events; 73% of parents reported that their child appeared more settled during the intervention.
Kakar et al., 2021 (18)	Netherlands	Adult/Surgical	Meta-analysis	Meta-analytic evidence	Recorded music intervention	Critically ill and surgical patients	Music intervention significantly improved subjective sleep quality and sleep onset latency
Rennick et al., 2018 (19)	Canada	Direct PICU + post-PICU ward follow-up	Pilot RCT	Pilot randomized evidence	Multicomponent PICU Soothing: parental touch + reading aloud + music	2-14 years; n=20; PICU and ward	PICU Soothing was feasible and acceptable. Parents and nurses reported calming effects of reading and music; however, pilot actigraphy data did not demonstrate a clear improvement in nighttime sleep duration or arousals.
Karimi et al., 2021 (20)	Multicenter	Adult ICU	Systematic review and meta-analysis	Systematic review/meta-analytic evidence	Eye masks and/or earplugs	ICU patients; 35 studies, 2,687 participants	Combined use significantly increased total sleep time, sleep efficiency, and REM duration; reduced number of awakenings
Belpınar et al., 2025 (21)	Turkey	NICU	RCT	Randomized evidence	Massage and foot reflexology on sleep in newborns	30–37 weeks premature infants; n=108; NICU	Both massage and foot reflexology significantly improved sleep duration, sleep efficiency, and reduced nocturnal awakenings compared to control; effects were comparable between the two intervention groups
Kudchadkar et al., 2022 (22)	Multicenter	Mixed pediatric inpatient	Cochrane systematic review	Systematic review evidence	Non-pharmacological sleep interventions (music, environmental modifications, massage, relaxation)	1 month–18 years; 10 RCTs, 528 children	Interventions inconsistent but low-to-very-low certainty evidence in improving sleep duration and quality; high feasibility; no evidence of harm
He et al., 2026 (23)	China	Direct PICU	Single-blind RCT	Randomized evidence	PICU diary intervention (patient-parent-staff collaborative diary)	3–14 years; 94 dyads randomized; 83 analyzed; PICU	Experimental group showed significantly shorter total awakening time (27.65 vs. 41.17 min; p=0.006) and mean awakening duration (3.67 vs. 4.37 min; p=0.032); CSDC scores were significantly lower at 1 and 3 months post-discharge.

Table 1. Continued

Author / Year	Country	Setting	Study Design	Evidence Category	Intervention	Age / Sample	Key Findings
Witte et al., 2023 (24)	USA	Direct PICU	Pilot observational study	Pilot observational evidence	Caregiver and nursing staff perceptions of PICU sleep	0–18 years; n=31; PICU	No significant difference between caregiver and nursing ratings of sleep quality; room entries most impactful environmental factor; caregivers rated PICU sleep lower quality than home sleep (p=0.009)

PICU = Pediatric Intensive Care Unit; NICU = Neonatal Intensive Care Unit; RCT = Randomized Controlled Trial; REM = Rapid Eye Movement; PICS-p = Pediatric Post-Intensive Care Syndrome; AAP = American Academy of Pediatrics; CSDC = Childhood Stress Disorder Checklist; CSHQ = Children's Sleep Habits Questionnaire; NIC = Nursing Interventions Classification; dBA = A-weighted decibels. The setting column distinguishes studies conducted directly in PICU populations from evidence derived from adult ICU, NICU, mixed ICU, or other pediatric inpatient populations.

Sleep Disturbances in the PICU: Contributing Factors and Clinical Consequences

Environmental and care-related factors

Children admitted to the PICU are exposed to persistent noise, artificial lighting throughout the night, frequent bedside procedures, and repeated care-related interruptions, each of which may interfere with normal sleep patterns. Nenningsland et al. (2025a) reported that children aged 5 months to 5 years admitted to two Norwegian PICUs experienced a median of nine awakenings per night, with 44% of these awakenings attributable to healthcare personnel performing assessments or procedures. The study further demonstrated that median continuous sound levels reached 55.79 dBA, substantially exceeding the WHO-recommended indoor nighttime level of 30 dBA for continuous noise (5). Sound levels above 80 dB have been associated with a 35% increase in the hazard of waking, while light events exceeding 150 lux increase this risk by 17%. Furthermore, in a mixed pediatric inpatient study, PICU stay was associated with approximately 258 minutes less nighttime sleep than general pediatric unit stay (4).

Gomez-Merino et al. (2025) identified nursing interventions performed between 11:00 PM and 7:00 AM in ten Spanish PICUs. A total of 100 patient records encompassing 5,017 interventions were analyzed. Vital signs monitoring was the most frequently performed intervention, identified in 100% of records. Notably, "sleep enhancement" was documented in 94% of records. None of the participating PICUs had an established sleep protocol (10). These findings describe the frequency of documented sleep-related nursing care and the absence of formal sleep protocols in the participating units but do not provide information about changes in clinician awareness over time.

Screen time represents a potentially modifiable factor associated with PICU sleep disruption. Kalvas and Harrison (2024) demonstrated in a secondary analysis of a pilot observational study that all eight children aged 1-4 years admitted to a PICU exceeded American Academy of Pediatrics screen time recommendations, with screen time negatively associated with nocturnal sleep duration ($r_s = -0.5$) (11).

Clinical consequences of sleep disruption

Sleep disruption in the PICU has been associated with clinically relevant outcomes. Kalvas et al. (2023) found in an observational pilot study of ten critically ill children aged 1-4 years that children with delirium experienced an average of 1.1 more awakenings per nighttime sleep hour and 42 fewer minutes of sleep per sleep episode compared to children without delirium. Increased clinician caregiving frequency and duration were associated with both worse sleep quality and delirium (12). Given the small sample size and observational design, these findings should be interpreted as preliminary evidence of an association rather than evidence of a causal relationship between sleep disruption and delirium.

Sleep disturbances may persist beyond the PICU hospitalization period. Wang et al. (2026) followed 237 critically ill children from PICU admission to three months post-discharge using the Children's Sleep Habits Questionnaire (CSHQ). Sleep disturbance prevalence peaked at 83.5% at one-week post-discharge and remained at approximately 50% at three months (51.7%). Three distinct sleep disturbance trajectories were identified: a High Sleep Disorder Group (6.3%), a Moderate Sleep Disorder Group (45.2%), and a No Sleep Disorder Group (48.5%). Child age and surgical history were

identified as independent predictors of post-PICU sleep disturbance (13).

Pharmacological sedation cannot substitute for restorative sleep. Sedative agents such as benzodiazepines act on GABAergic receptors, increasing light sleep stages while suppressing slow-wave and REM sleep (2, 6). This underscores the critical importance of non-pharmacological approaches in PICU sleep promotion.

Non-pharmacological sleep promotion interventions

Non-pharmacological sleep promotion interventions have gained increasing clinical attention in the PICU, with available evidence derived from observational studies, randomized controlled trials, and evidence-based reviews (8, 9). Zhang et al. (2025) summarized the best available evidence for non-pharmacological management of sleep disturbances in ICU patients, incorporating 18 sources including 4 clinical guidelines, 2 expert consensuses, and 11 systematic reviews, and identifying 25 actionable evidence items across four domains (14).

Environmental modifications

Environmental modifications targeting noise and light represent a commonly recommended non-pharmacological approach to PICU sleep promotion. Direct PICU evidence is provided by Nenningsland et al. (2025b), who surveyed 79 PICU nurses across three Scandinavian countries and found that noise and light were consistently identified as the primary sleep disruptors, with single-patient rooms perceived as more conducive to sleep promotion compared to multibed units (15). Complementary evidence from broader ICU populations is provided by Zhang et al. (2025), who recommend reducing nighttime noise levels to approximately 30 dBA and dimming or turning off central lighting between 24:00 and 6:00 to support the natural circadian rhythm (14).

Care clustering and circadian rhythm strategies

Care clustering - the deliberate grouping of nursing activities to minimize unnecessary nighttime interruptions - has been proposed as a practical strategy for PICU sleep promotion. Nenningsland et al. (2025a) reported that healthcare personnel were responsible for 44% of documented nocturnal awakenings, indicating that care-related activities were an important source of sleep interruption (5). Zhang et al. (2025) recommend concentrating

nursing and medical interventions during nighttime hours to ensure that patients have at least one uninterrupted 90-minute sleep cycle (14).

Johnson et al. (2023) conducted a systematic review of 19 inpatient safe sleep studies and developed evidence-based safe sleep clinical guidelines specifically adapted for PICU patients, providing clinicians with a structured framework for individualizing sleep-promoting care (16). Safe sleep primarily refers to practices aimed at reducing sleep-related harm, whereas sleep promotion focuses on improving sleep duration, quality, and continuity. Although these concepts are distinct, the Johnson et al. study was included because its PICU-specific recommendations concerning the sleep environment and bedtime care practices overlap with aspects relevant to the implementation of sleep-promoting care.

Music-Based and Multicomponent Soothing Interventions

Music has been used as a non-pharmacological intervention to promote relaxation and potentially support sleep in critically ill patients (17). Complementary evidence from critically ill adult and surgical populations was reported by Kakar et al. (2021), who demonstrated in a meta-analysis of five randomized controlled trials that recorded music intervention significantly improved subjective sleep quality in critically ill and surgical patients, corresponding to a 27.1% increase in sleep quality scores (18). In contrast, direct PICU evidence is provided by Garcia Guerra et al. (2021), who conducted a three-arm pilot randomized controlled trial involving 60 mechanically ventilated children aged 1 month to 16 years, randomized to music, noise-blocking, or control groups. The intervention was feasible, with 73% of parents reporting their child appeared more settled during the music intervention and no study-related adverse events were reported (17). Rennick et al. (2018) reported in a pilot randomized controlled trial that a multicomponent PICU Soothing intervention combining parental touch, reading, and music was acceptable and feasible in critically ill children aged 2–14 years, with COMFORT scores decreasing during the intervention period and pilot data suggesting reduced parental anxiety following ward transfer (19). Because the intervention combined touch, reading, and music, these findings cannot be attributed specifically to the music component.

Collectively, these findings support the feasibility and acceptability of music-based or multicomponent soothing interventions in PICU populations. However, direct evidence that these interventions improve sleep outcomes in critically ill children remains limited, as the available PICU trials were small pilot studies and did not provide definitive sleep-specific efficacy data.

Sensory aids: eye masks and earplugs

Direct evidence for eye masks and earplugs in pediatric PICU populations remains limited. Evidence supporting these interventions is derived primarily from adult and broader ICU populations. Karimi et al. (2021) conducted a systematic review and meta-analysis of 35 studies involving 2,687 ICU participants and demonstrated that the combined use of eye masks and earplugs significantly increased total sleep time, sleep efficiency, and REM sleep duration while reducing nocturnal awakenings (20). Similarly, complementary evidence from broader ICU populations is provided by Zhang et al. (2025), who include eye mask and earplug use as a strong evidence recommendation (Level 1a, Grade A), noting that combined use is more effective than either intervention alone (14). These findings should therefore be considered indirect evidence for PICU practice rather than direct evidence of efficacy in critically ill children.

Massage and Touch-Based Interventions

Direct PICU-specific evidence for massage and touch-based interventions is limited, and the available findings are derived primarily from other pediatric inpatient populations. Belpinar et al. (2025) conducted a randomized controlled trial among 108 premature infants in the NICU and reported significant improvements in sleep duration and sleep efficiency, together with fewer nocturnal awakenings, compared with the control group (21). As complementary pediatric evidence, Kudchadkar et al. (2022) reported low-to-very-low certainty evidence on the effects of massage and other behavioral interventions on sleep in hospitalized children, with high feasibility and no evidence of harm (22). Accordingly, these findings provide indirect support for potential applicability in the PICU but should not be interpreted as direct evidence of efficacy in PICU patients.

Screen Time Management

Screen time represents a potentially modifiable factor in PICU sleep disruption. In a secondary analysis of a pilot observational study involving eight children aged 1–4 years, Kalvas and Harrison (2024) found that screen time was negatively associated with nocturnal sleep duration. Given the very small sample size, these findings should be considered preliminary and require confirmation in larger PICU populations (11).

PICU diary intervention

He et al. (2026) investigated the effect of a structured PICU diary intervention - in which medical staff, parents, and children collaboratively maintained daily records - on sleep quality and psychological outcomes in critically ill children aged 3-14 years. The experimental group had significantly shorter awakening times during PICU hospitalization, while Childhood Stress Disorder Checklist scores were significantly lower at one and three months post-discharge compared with controls (23).

Sleep Assessment Tools in the PICU

Accurate and standardized sleep assessment is the foundation of effective sleep management in the PICU (14). Polysomnography remains the gold standard for characterizing sleep architecture but is resource-intensive and operationally challenging in critically ill children. Actigraphy provides a more feasible alternative, measuring sleep-wake patterns through wrist or ankle-worn accelerometers (14). Kalvas et al. (2023) utilized actigraphy combined with continuous bedside video recording as a visual sleep diary to validate sleep data in the PICU, a methodological approach identified as a study strength despite actigraphy's known tendency to overestimate total sleep time (12).

Witte et al. (2023) investigated the agreement between caregiver and nursing staff perceptions of PICU patient sleep quality in a pilot study of 31 pediatric patients. No significant differences were found between caregiver and nursing staff ratings of sleep quality, sleep duration, or number of naps. Both groups identified room entries as the environmental factor most influencing sleep. Caregivers consistently rated their child's sleep in the PICU as lower quality than sleep at home ($p = 0.009$). These findings suggest that caregiver and nursing reports of sleep may serve as complementary, low-cost tools to support clinical decision-making (24).

Validated subjective tools for pediatric populations include the Sleep Disturbance Scale for Children (SDSC) and the Children's Sleep Habits Questionnaire (CSHQ), both of which have been applied in recent PICU outcome studies (13, 23).

The role of the nurse and barriers to implementation

Nurses, as the healthcare professionals most continuously present at the bedside, hold a central role in planning, implementing, and evaluating sleep promotion interventions in the ICU (8). Gomez-Merino et al. (2025) demonstrated that sleep enhancement was among the most frequently documented nursing interventions across ten Spanish PICUs, present in 94% of records and ranked third after vital signs monitoring and environmental management. These findings indicate frequent documentation of sleep-related nursing care but do not establish clinicians' level of awareness or changes in awareness over time (10).

Witte et al. (2023) found that nursing staff reported significantly more room entries per night than caregivers perceived ($p = 0.01$), indicating a difference between nursing staff and caregiver perceptions of nighttime room entries (24). This difference highlights the potential value of objective monitoring when evaluating nocturnal care-related disruptions (24).

Stenkjaer et al. (2022) developed an international, multidisciplinary non-pharmacological delirium management bundle for the PICU through a two-round Delphi study, identifying sleep support as one of three core domains alongside cognitive and physical activity support (9). Zhang et al. (2025) recommend that ICU nurses receive dedicated training on sleep disturbance risk factors, sleep hygiene management, and strategies to moderate communication and voice levels within the ICU environment (14).

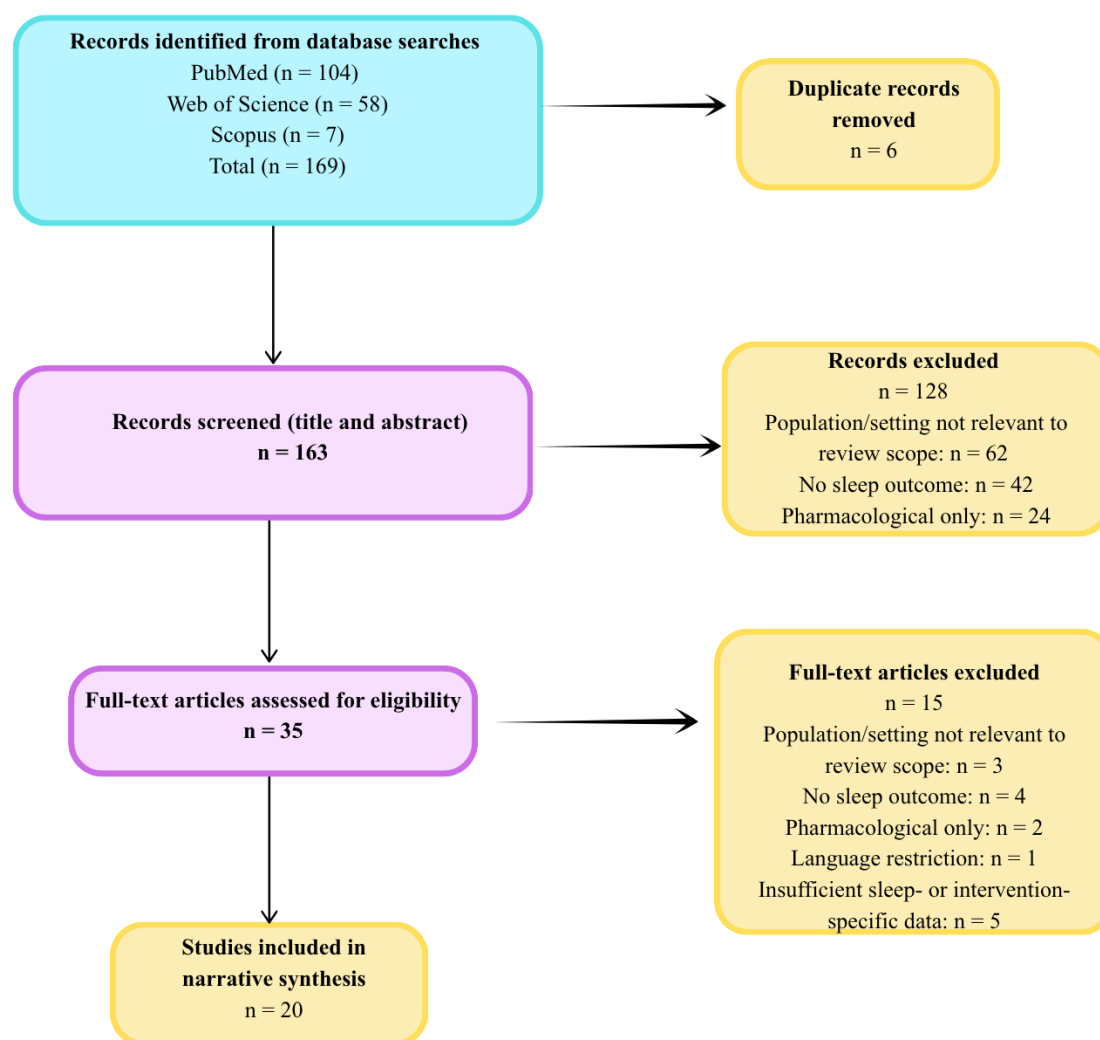


Figure 1. Simplified flowchart of the literature identification and study selection process

DISCUSSION

This narrative review synthesized current evidence on non-pharmacological interventions for sleep promotion in critically ill children admitted to pediatric intensive care units. Collectively, the available literature suggests that sleep disruption in the PICU is a clinically important problem and that some contributing environmental and care-related factors may be modifiable. Consequently, preserving restorative sleep in the PICU may represent an important component of supportive care beyond patient comfort, although its effects on short-term recovery and long-term neurodevelopmental outcomes have not yet been established (6).

The available evidence consistently indicates that sleep disruption in the PICU is characterized by alterations in sleep quality rather than quantity alone. Objective polysomnographic studies have demonstrated marked reductions in REM sleep, suppression of slow-wave sleep, frequent awakenings, loss of normal diurnal sleep-wake organization, and persistent sleep fragmentation despite prolonged periods of apparent sleep (6, 25). More recently, sleep fragmentation has been proposed as one of the most clinically meaningful characteristics of PICU sleep because repeated arousals impair sleep continuity even when total sleep duration appears relatively preserved (3). This distinction is particularly important because fragmented sleep may affect neuroplasticity, immune regulation, hormonal secretion, and cognitive recovery and has been associated with adverse outcomes, including delirium. However, its causal contribution to PICS-p and long-term neurodevelopmental outcomes remains uncertain (3, 6). Collectively, these findings suggest that future sleep promotion strategies should prioritize protecting restorative sleep architecture rather than focusing solely on increasing total sleep duration.

Current evidence further suggests that sleep disruption in the PICU is not solely a consequence of critical illness itself but also reflects the cumulative effects of the care environment and the organization of clinical practice. Environmental noise, artificial light, continuous monitoring, bedside procedures, and frequent room entries interact to disrupt normal sleep-wake regulation and repeatedly interrupt restorative sleep (6,11). Importantly, caregiving activities should not be regarded merely as unavoidable interruptions but as modifiable

environmental exposures that influence sleep continuity (11). This perspective represents a conceptual shift from viewing sleep disruption as an inevitable consequence of intensive care toward recognizing that many contributing factors are potentially modifiable.

Nenningsland et al. (2025a) reported that 44% of nocturnal awakenings in young PICU patients were attributable to healthcare personnel performing assessments or procedures, indicating that routine care activities represent an important source of sleep interruption (5). Similarly, differences between nurses' and caregivers' reports of nighttime room entries indicate that perceptions of nocturnal care-related disruptions may differ between healthcare professionals and families (24). Although sleep promotion was frequently documented in the study by Gomez-Merino et al. (2025), none of the participating PICUs had a formal sleep protocol (10). Taken together, these observations indicate that improving sleep requires not only optimizing environmental conditions but also reconsidering how nighttime care is organized, coordinated, and delivered within the PICU.

The multifactorial nature of sleep disruption also explains why no single non-pharmacological intervention is likely to provide a complete solution. Rather than supporting isolated interventions, the contemporary literature increasingly favors integrated, multicomponent approaches that simultaneously address environmental, behavioral, organizational, and educational determinants of sleep (14). This conceptual transition reflects the recognition that sleep disruption in critically ill children arises through multiple interacting mechanisms, including environmental stimulation, circadian dysregulation, caregiving patterns, illness severity, and developmental vulnerability (3, 6). Consequently, successful sleep promotion is more likely to depend on coordinated strategies than on any individual intervention implemented in isolation.

When the intervention modalities are considered comparatively, environmental modifications and care clustering may offer relatively greater implementation practicality because they can be incorporated into routine PICU care without specialized equipment and directly target common sources of sleep disruption. Music-based and family-centered interventions also appear feasible and acceptable, although the available pediatric evidence

is derived largely from small pilot studies. Sensory aids such as eye masks and earplugs have been associated with favorable sleep outcomes, although much of the supporting evidence originates from adult ICU populations, limiting direct inference to critically ill children. Massage and touch-based interventions may offer additional benefits, particularly in younger patients, but require individualized application and appropriate staff or caregiver involvement. Structured PICU diary interventions have shown promising effects extending beyond hospitalization, although evidence is currently limited to a small number of studies. Overall, no single intervention can presently be considered superior across feasibility, clinical efficacy, and implementation practicality. The available evidence instead favors developmentally appropriate, individualized, and potentially multicomponent approaches to sleep promotion in the PICU.

The evidentiary strength of the included studies varied substantially across intervention modalities. Evidence derived from systematic reviews, meta-analyses, and randomized trials was distinguished from findings based on small pilot, observational, or survey-based studies, several of which provided the available PICU-specific evidence. Consensus and narrative review evidence contributed primarily to clinical interpretation and implementation considerations rather than direct estimates of intervention effectiveness. Accordingly, consistency across studies should be interpreted in light of differences in study design, sample size, methodological rigor, and directness to the PICU population.

Although the certainty of pediatric evidence remains limited, existing studies suggest that several non-pharmacological interventions may be feasible and clinically acceptable. Few intervention-related adverse events have been reported; however, the generally small sample sizes and limited safety-focused assessment preclude firm conclusions regarding safety. Music-based interventions, family-centered comforting strategies, tactile therapies such as massage and reflexology, and sensory approaches including eye masks and earplugs have all shown potential to improve different aspects of sleep or enhance patient comfort (17,19–21). However, the available evidence remains heterogeneous with respect to study populations, intervention protocols,

outcome measures, and methodological quality, limiting direct comparisons and preventing recommendations for a single superior intervention (22). Therefore, current evidence supports tailoring combinations of developmentally appropriate non-pharmacological interventions to individual patient needs within structured sleep promotion protocols rather than relying on isolated therapeutic approaches.

Limitations

This narrative review has several limitations. First, although the literature search was conducted using predefined eligibility criteria across three major databases, a formal systematic review protocol and risk-of-bias assessment were not employed. Accordingly, the methodological quality of individual studies was considered descriptively according to study design and reported limitations rather than through a standardized appraisal tool. Second, the included studies were heterogeneous in terms of study design, patient populations, intervention characteristics, and sleep outcome measures, limiting direct comparisons across interventions. The methodological strength of the evidence also varied considerably, ranging from small pilot and observational studies to randomized controlled trials, systematic reviews, meta-analyses, consensus studies, and evidence summaries. These sources should therefore not be interpreted as having equivalent evidentiary weight, and the inclusion of both primary studies and secondary evidence syntheses may have resulted in some overlap in the underlying evidence base. In addition, pediatric-specific evidence remains limited for some intervention modalities, and selected findings from adult ICU populations were included when considered directly applicable to pediatric critical care. Finally, the restriction to English-language publications may have resulted in the exclusion of relevant evidence.

CONCLUSION

Sleep represents a critical but frequently under addressed dimension of PICU care. This review suggests that non-pharmacological sleep interventions are promising approaches for supporting sleep in critically ill children. However, PICU-specific evidence remains limited, with several studies involving small sample sizes and some intervention modalities supported primarily by indirect evidence from adult ICU, NICU, or general

pediatric populations. Therefore, the effectiveness of these interventions in PICU populations cannot yet be considered established. Current evidence does not establish that improving sleep prevents delirium, PICS-p, or long-term neurodevelopmental problems.

Future research should prioritize larger, well-designed PICU-specific randomized controlled trials using standardized and validated sleep outcome measures. The effectiveness of multicomponent sleep bundles, the relationship between PICU sleep disruption and PICS-p trajectories, the role of screen time management, and the development of age-specific intervention protocols represent urgent research directions. Nursing education programs should integrate sleep science and sleep promotion competencies as core components of PICU-specific training curricula.

Ethics Committee Approval

Ethical approval from an institutional review board was not required for this review, as it involved only the analysis of previously published studies and did not include direct human participants.

Author Contributions

Conception - M.N. Temuçin, E. Kızıler, D. Küçük Alemdar; Design - M.N. Temuçin, E. Kızıler, D. Küçük Alemdar; Supervision - E. Kızıler, D. Küçük Alemdar; Data Collection and/or Processing - M.N. Temuçin; Analysis and/or Interpretation - M.N. Temuçin, E. Kızıler, D. Küçük Alemdar; Literature Search - M.N. Temuçin; Writing - M.N. Temuçin; Critical Review - E. Kızıler, D. Küçük Alemdar.

Conflict of Interest

The authors declare that they have no conflict of interests.

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