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Evaluating Non-Pharmaceutical Sleep Hygiene Interventions for the Prevention of Delirium and Improvement in Sleep Quality in Critical Care

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EVALUATING NON-PHARMACEUTICAL SLEEP HYGIENE INTERVENTIONS FOR THE PREVENTION OF DELIRIUM AND IMPROVEMENT IN SLEEP QUALITY IN CRITICAL CARE

by

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ABSTRACT

Patients admitted to an adult intensive care unit (ICU) are at risk of developing an acute condition known as ICU delirium, which can impact patients' length of hospital stay and increase their odds of death. The cause of ICU delirium is multifactorial, and lack of quality sleep is a known risk factor. Patients' sleep in the ICU is frequently interrupted by clinicians involved in their care and equipment alarms. Sleep hygiene interventions to minimize these interruptions for the patient are one strategy to reduce the risk of ICU delirium. Examples of sleep hygiene interventions include eye masks, earplugs, and grouping patient care to minimize nighttime interruptions. The primary purpose of this thesis was to review the available evidence on non-pharmacological sleeping interventions and how they can prevent the development of ICU delirium in adults hospitalized with a critical illness. A secondary aim of this thesis was to study the impact of non-pharmacological interventions on sleep quality. Seven studies conducted in critical care units were included in this scoping review, which examined how non-pharmacological sleep hygiene interventions impacted both the prevention of ICU delirium, and sleep quality. Study results were analyzed to determine their effectiveness in relation to the two outcome measures. Although this review identified many benefits of non-pharmacological sleep interventions, the results on which are most effective in preventing delirium and improving sleep quality are inconclusive. Additional research is needed to evaluate which sleep-promoting intervention(s) will benefit critical care patients most in preventing or lowering their risk of delirium. The feasibility of executing intervention(s) outside of research conditions, and the rate of patient compliance with the interventions needs to be further studied. Additionally, future

intervention studies should measure sleep quality with polysomnography rather than subjective written/oral reports in order to obtain quantifiable results.

DEDICATION

For my Grandma, who imbedded in me the importance of a college education for as long as I can remember,
and did everything she could to make this possible for me.

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I would like to first thank my Thesis Committee Chair, Dr. Brian C. Peach, and Thesis Committee Member, Ms. Charlotte Neubauer, for their time spent and support in guiding me through this process from when I didn't know where to begin all the way to the finished product. I would also like to acknowledge Mr. Andy Todd, UCF's very resourceful College of Nursing Librarian, for his guidance in the search and methodology portion of this thesis. Thank you to my family, close friends and significant other, who have endured me talking about my thesis time and time again, and who have been my biggest supporters from start to finish.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

Delirium is an acute disruption in attention characterized by an impaired ability to direct, sustain, and transition attention. This is coupled with an interruption of cognition in the form of a memory deficit, disorientation, language visuospatial ability or perceptual disturbance not accounted for by a baseline neurocognitive disorder (Diagnostic and Statistical Manual of Mental Disorders, 2013, p. 596). While there are known risk factors for delirium in intensive care unit (ICU) settings, limited data exists on which influence the development of delirium more than others. Some iatrogenic risk factors for developing delirium in the ICU include immobilization, the use of certain medications together, and sleep disturbances. There is an association between poor sleep and the incidence of delirium (Girard et al., 2008). Though the mechanism underlying how poor sleep quality leads to ICU delirium is not fully understood, the association between the two are evident across numerous studies (Boesen et al., 2016; Sun et al., 2021; Watson et al., 2012). One study done on the association of ICU delirium and sleep disturbance found that the prevalence of poor sleep quality of patients while in the ICU was significantly associated with increasing days of ICU delirium (Altman et al., 2018).

Pharmacological therapies have been used by healthcare professionals to prevent ICU delirium, but to date, there are no medications approved by the Food and Drug Administration (FDA) for prevention (American Delirium Society, 2016). Ongoing research about the prophylactic use of antipsychotics such as haloperidol has uncovered mixed results about its efficacy in the prevention of delirium. One study found that haloperidol could pose a serious risk to the patients' health with the possibility of causing a prolonged QTC interval which induces ventricular arrythmias, extrapyramidal symptoms, and akathisia (Alvarez & Skowronski, 2003; Hatta et al., 2001). One study reported that the use of haloperidol as prevention for delirium is

associated with 5% higher odds of developing delirium the following day with each additional milligram of haloperidol administered (Pisani et al., 2015). Haloperidol has emerged as the "standard" pharmacological treatment for delirium in the critical care settings and is the most frequently prescribed medication in delirium treatment, despite a paucity of data showing haloperidol will shorten the number of delirium days for ICU patients (Ely et al., 2004).

Sleep is interrupted in the ICU by machine alarms and rounding nurses, putting patients' health at risk (Medrzycka et al., 2018). A review examining sleep deprivation in the ICU found evidence supporting the idea that critically ill patients may be more sensitive to the environmental noise of the ICU when in recovery as compared to healthy subjects (Kamdar et al., 2012). An earplugs intervention was found to improve patient sleep by 67.6% when assessed by polysomnography (Yazdannik et al., 2014). Another study introducing periods of quiet time to enhance sleep hygiene of patients in an ICU found that 19% of delirious patients have resolution of delirium after periods of quiet time were imposed (McAndrew et al., 2016). These findings suggest controlling the environment to promote the sleep of critically ill patients can be an effective intervention in the prevention of delirium in the ICU. Delirium is preventable for up to 40% of adults in the hospital (Robinson, 2019), though there is a clinician knowledge gap on which interventions best prevent delirium in critically ill patients (Hermes et al., 2018).

SIGNIFICANCE

The occurrence of delirium in intensive care units is a preventable and increasingly prevalent issue worldwide, with an estimated incidence of 2 out of every 3 adult ICU patients, including 80% of ventilated ICU patients (Critical Illness, Brain Dysfunction and Survivorship Center [CIBS], 2021). Patients who experience delirium in critical care settings are at increased risk of harming themselves and medical personnel. These patients are susceptible to tearing off their intravenous lines and bandages as well as falling (Levin, 2007). Delirium in the ICU puts those who experience it at increased risk of a prolonged ICU stay, prolonged mechanical ventilation, and mortality (Salluh et al., 2015). After adjusting for influential factors like age, severity of illness and co-morbidities, ICU patients with delirium are at a threefold increased risk for 6-month mortality (Ely et al., 2004). ICU delirium also has adverse consequences for survivors including dementia-like cognitive impairment, post-traumatic stress disorder and depression (CIBS, 2021). Long term complications of delirium include pneumonia and thrombosis, which increase the odds of mortality (Collier, 2012). The development of delirium is also costly to the patient, as it is associated with 31% higher hospital costs (Milbrandt et al., 2004). Preventing delirium can improve mortality and long-term outcomes for patients as well as reduce hospitalization costs.

PROBLEM STATEMENT

The primary aim of this thesis was to review the available evidence on non-pharmacological sleeping interventions and how they can prevent the development of ICU delirium in adults hospitalized with a critical illness. A secondary aim of this thesis was to study the impact of non-pharmacological interventions on sleep quality.

METHODOLOGY

The study design for this thesis was a scoping review. A search in the CINHAL, APA PsycInfo, and Medline databases was completed for literature pertaining to sleep hygiene interventions as a prevention method for ICU delirium. Assistance for the search was enlisted from the University of Central Florida (UCF) College of Nursing Librarian who has expertise in literature reviews. The review of literature took place on 6/28/21 to 7/8/21. Inclusion criteria included: a) research studies or quality improvement projects b) completed in an ICU, c) examining a nonpharmacological sleep promoting intervention, and d) assessment of delirium as an outcome. Search terms used are as follows; “ICU Psychosis,” or Delirium or psychosis or deliri* or confusion or sleep or awake* AND “Intensive Care Units" or "Critical Care Nursing" or "Critical Care" or "intensive care" or "critical care" or ICU AND earplug* or "ear plug*" or "eye mask" or "sleep hygiene" or "sleep bundle" or "sleep shade*" or sleep-promot* intervention* or "Noise Cancel* Headphone*" NOT dissertation* or PT dissertation*. Exclusion criteria: a) studies completed in pediatric settings, b) studies not in English, c) dissertations and conference abstracts and d) duplicate studies. Two members of the UCF College of Nursing research team reviewed inclusion and exclusion criteria for this thesis and assisted with compiling the final list.

Tools used throughout the studies to measure the sleep quality of patients included the Richards Campbell Sleep Questionnaire (RCSQ) and polysomnography (PSG). PSG is widely recognized among medical professionals as the gold standard for both scoring and interpretation of sleep. PSG is a credible, objective sleep measurement tool as it uses technology to record physiologic data of the patient during sleep to quantify sleep time, differentiate sleep stages and identify periods of sleep fragmentation (Jafari et al., 2013). RCSQ is a validated, 5-item visual

analogue scale for critically ill patients which measures sleep quality. When its effectiveness was compared in a clinical study to that of PSG, internal consistency reliability of the questionnaire was 0.90 (Richards et al., 2000).

To measure delirium in patients, the articles examined in this review utilized the following tools: Confusion Assessment Method for the ICU (CAM-ICU), Neelon and Champagne Confusion Scale (NEECHAM), and the Richmond Agitation Sedation Scale (RASS). The CAM-ICU is recommended by the 2018 clinical practice guidelines for Pain, Agitation, Delirium, Immobility and Sleep Disruption (PADIS) as an accurate tool for regular assessment of delirium in Adult-ICU patients (Devlin et al., 2018). Having also been validated by the DSM-5, the CAM-ICU has a sensitivity of 83%, and a specificity of 100% (Chanques et al., 2018). In a study that compared the effectiveness of the NEECHAM scale to the CAM-ICU in identifying delirium in patients, the sensitivity of the NEECHAM scale in identifying delirium was 87% and specificity was 95% (Rompaey et al., 2008). RASS is an observational scale that associates a numerical value to the level of consciousness in a patient. It is an alternative measurement tool for delirium with an 82% sensitivity and an 85.1% specificity when the score given by physicians is anything other than 0. When the RASS score given is $> +1$ or < -1 the specificity and sensitivity climbs to 99% effectiveness in diagnosing delirium (Han et al., 2015).

RESULTS

The search yielded 280 results. After application of exclusion criteria, 6 articles remained. One article was not captured by our search terms but was found on another reference list and met criteria for inclusion. Seven articles remained for the review (see figure 1 of PRSIMA search flow diagram). Two of seven studies were conducted in the United States (US) and 5 were international studies from Singapore, France, Belgium, and the United Kingdom (UK). Of the seven studies, three were randomized controlled trials and one a prospective randomized controlled trial. The remaining three studies were quality improvement (QI) projects. See table 1 for study characteristics.

Delirium Prevention

There was a 5%-53% reduction in delirium incidence or risk observed in patients after applying sleep promoting interventions (see table 1) in four of the seven studies (Rompaey et al., 2012; Kamadar et al., 2013; Patel et al., 2014; Tonna et al., 2021). Three of the seven studies observed no significant differences in incidence or risk of delirium after sleep hygiene interventions (p-value >0.05) (Obanor et al., 2021; Demoule et al., 2017; Leong et al., 2021).

In Rompaey et al. (2012), risk of delirium was significantly lower for the group receiving intervention (earplugs) than the control group (HR 0.47, CI 0.27-0.82), and was sustained over time. There was a significant delay in time until first delirium or mild confusion after application of earplugs seen in the intervention group (p-value=0.006) (Rompaey et al., 2012).

In the Patel et al. (2014) quality improvement project using a sleep bundle intervention, there was a 33% incidence of delirium pre-intervention for all patients admitted to the ICU, and

14% post-intervention for patients in the ICU at the time of data collection (p-value= <0.001). Pre-intervention, patients were delirious 3.4 days on average, and post-intervention there was a decrease in delirium time to 1.2 days (p=0.021) (Patel et al., 2014).

In the pre-intervention period of Kamadar et al. (2013) study, 43% of patient days were delirium-free, and 48% of patient days after sleep quality interventions were implemented (p=0.04). Preintervention, 69% of patients had an incident of delirium during their ICU stay which reduced to 49% after sleep quality interventions (p=0.001) (Kamadar et al., 2013). The Tonna et al. (2021) study found a significant reduction in proportion of days with more than one positive CAM-ICU results per patient with a mean of 17 before and 13 during the intervention phase (p=0.02). The percentage of days with positive CAM-ICU results reduced from 20% in the preintervention to 15% during intervention (p=0.02) Tonna et al., 2021).

Sleep Quality

Four of the seven studies found sleep hygiene interventions improved sleep quality for patients. One study reported an improvement in sleep quality for the group receiving an ear plugs and eye mask intervention (Obanor et al., 2021). Patients in the intervention arm of the Rompaey et al. (2012) study reported better sleep quality after the first night, than those in the control arm (p= 0.042). The second and third night did not show a significant difference in overall in self-reported sleep quality between the two groups.

Compared to the pre-intervention group, Patel et al. (2014) found an increase in mean sleep efficiency (p=<0.001), sleep quality (p=<0.001) and reduced daytime sleepiness for the intervention group receiving the sleep hygiene intervention bundle. There was also a difference

in reduced noise ratings (p=<0.001) and reduced light exposure for patients who received intervention (p=0.011).

Demoule et al. (2017) reported patients given an ear plug and eye mask intervention experienced fewer prolonged awakenings (>1 minute) than patients without intervention (p=0.02). No significant difference was observed between the two groups in regard to total sleep time, time spent in N1, N2 or N3 sleep stages, REM sleep, incidence of arousals, or short awakenings (<1 minute) (Demoule et al., 2017).

Three of the seven studies found no significant results correlating sleep hygiene interventions with improved sleep quality. In Leong et al. (2021), patient sleep quality was not improved with the use of earplugs and eye mask intervention over the 3 postoperative days (p>0.05). Of note, there were no significant differences between the intervention and control groups in terms of noise levels, light exposure, and nurse interruptions.

Kamadar et al. (2013) found that mean ratings between the baseline and quality-improvement groups for overall sleep quality, did not differ significantly (p=0.46). However, the mean noise rating was significant between the two groups with less noise reported by the sleep quality improvement intervention group (p=0.002).

The Tonna et al. (2021) study reported no significant difference found in mean overall sleep quality ratings between the preintervention and intervention period (p=0.43). Patients in the intervention group reported higher perceived noise ratings than those in the preintervention group (p=0.02).

DISCUSSION

In this scoping review examining the efficacy of sleep hygiene interventions on delirium prevention and sleep quality, we found mixed results both on its effect in reducing the risk or incidence of delirium, and sleep quality. After application of non-pharmacological sleep interventions, four out of the seven articles did find a significant decrease in the risk or incidence of delirium (Rompaey et al., 2012; Kamadar et al., 2013; Patel et al., 2014; Tonna et al., 2021). In Similarity to our findings, a systematic review and meta-analysis examining eye masks and earplugs as interventions reducing ICU-Delirium concluded their association with a significantly reduced risk of delirium (Litton et al., 2016). More evidence to support or negate the use of sleep hygiene interventions to prevent delirium has become available only in more recent years, as the earliest study to assess this was the Rompaey et al., 2012 study.

Though not all articles remained consistent in significant findings for both factors, four of seven articles also found an improvement in sleep quality for patients (Rompaey et al., 2012; Patel et al., 2014; Demoule et al., 2017; Obanor et al., 2021). Two articles held constant between the two factors, reporting both a decrease in risk or incidence of delirium and an improvement in sleep quality (Rompaey et al., 2012; Patel et al., 2014). These findings have remined consistent to that of older reviews, which held that sleep quality significantly improved in critically ill patients with the use of non-pharmacological sleep interventions (Scotto et al., 2009; Xie at al., 2009).

Earplugs Intervention

Noise in the ICU is not uncommon during sleeping hours with beeping of alarms and machines, and nurse/staff interruptions. Past studies found noise to be the most disruptive factor for patients in sleeping in the ICU (Hilton, 1976; Hweidi, 2007; Richardson et al., 2007). ICU-delirium is a problem in critical care settings, in which sleep deprivation and fragmentation is known to be a major risk factor. Rompaey et al. (2012) found earplugs decreased the risk of delirium and confusion in patients by 53% and delayed its onset. A review examining whether earplugs would reduce a patient's risk of delirium reported that the use of earplugs reduced the risk of delirium in intensive care unit patients by 41% compared to patients who were not using them (Litton et al., 2016). Notably, one, cost-effective and easily compliable intervention was more efficacious than two or more interventions (bundles).

Earplugs and Eye Mask Intervention

Three of the studies included in this review used both earplugs and eye masks as interventions and evaluated their effect on delirium (Demoule et al., 2017; Leong et al., 2021; Obanor et al. 2021). All three of these studies found no significant impact of the interventions on delirium prevention. These studies hypothesize patient non-compliance may be a confounding factor impacting the results. The Demoule et al. (2017) study noted the main reasons for participants' non-compliance were anxiety and discomfort. Earplugs and eye masks used in combination may provoke anxiety in patients as it blocks out two modes of human perception in

a relatively unfamiliar place. Limited evidence supporting earplugs or eye masks to prevent delirium in critical care settings exists, making drawing conclusions about effectiveness difficult.

Bundle Interventions

Three of the studies included in this review tested sleep promoting intervention bundles (see table 1) on patients in critical care settings and measured the incidence of delirium as an outcome (Kamadar et al., 2013; Patel et al., 2014; Tonna et al., 2021). All three of these studies found a reduction in the incidence of delirium in patients after application of the bundle interventions. In support of these findings, the 2018 Clinical Practice Guidelines for Pain, Agitation, and Delirium (PAD) suggest the use of nonpharmacological, multicomponent interventions that aimed at optimizing sleep to reduce the risk of delirium (Devlin et al., 2018). In congruency with updated PAD guidelines, sleep-bundle interventions of minimizing light and noise, grouping patient care, and decreasing stimuli at nighttime are still recommended to reduce patients' risk of ICU-delirium (Barr et al., 2013). All three of the sleep-bundle studies in this review utilized these interventions to promote sleep.

The Kamadar et al. (2013) and Patel et al. (2014) studies reported reductions in delirium incidence of 20% and 19% respectively. The Patel et al. (2014) study found a significant reduction in the duration of time patients spent in a delirious state after interventions ($p= 0.021$). Kamadar et al. (2013)'s bundle included 15 interventions, versus 18 in the Patel et al. (2014) study. These findings suggest sleep bundle with 15 or more interventions may be the best approach to preventing delirium. Tonna et al. (2021) study, using 5 interventions, found a 5% reduction ($p= 0.02$) in the number of days with a positive assessment of ICU-delirium and also a delay in time to first delirium ($p= 0.008$) after using sleep-bundle interventions.

Limited literature exists examining non-pharmacologic sleep-promoting bundles to reduce ICU delirium. Two Doctorate of Nursing Practice DNP projects offer conflicting results to the studies described above. Both DNP projects implemented non-pharmacological sleep intervention bundles in a critical care setting and measured incidence of ICU-delirium as an outcome. One DNP project found the incidence of delirium increased from 22% to 51% ($p= 0.001$) after intervention (Turnbaugh, 2019). The second DNP project found no significant results of the interventions on reducing ICU-delirium (Thomas, 2021).

Though these sleep bundle interventions are a cost-effective means (see table 1 for interventions) to prevent delirium in patients, the burden of an additional 6+ step practice for already busy health care staff may not be practical. Patel et al. (2014) suggested that without the endorsement incentives for staff to participate in the intervention bundles, the beneficial results might not hold outside of the research conditions (Patel et al., 2014). The feasibility of staff in a critical setting sustaining large bundles of interventions to effect one outcome needs to be considered.

Sleep Quality

Earplugs Intervention

Rompaey et al. (2012) is the only study in this review which used earplugs only as an intervention and measures sleep quality. The study found that patients sleeping with earplugs demonstrated significantly better sleep quality than those without earplugs in the first two nights of ICU admission, but that the effect was not sustained over time. No other literature exists to date which measures sleep quality in critical care settings using only earplugs as an intervention. The results of Rompaey et al. (2012)'s study serve as a good reference indicator to compare the

isolation of the earplugs intervention to that of the studies which use eye masks in addition to earplugs.

Earplugs and Eye Mask Intervention

Three studies in this review examined the effect of earplugs and eye masks on sleep quality (Demoule et al., 2017; Leong et al., 2021; Obanor et al. 2021). Two of the three studies found no significant results on patient sleep quality after intervention ($p = >0.05$) (Demoule et al., 2017; Leong et al., 2021). Demoule et al. (2017) is the only study that used polysomnography, the gold standard for measuring sleep. Obanor et al. (2021) found improvement in patient sleep quality after provision of earplugs and eye masks with a 17.2-point difference in patient sleep scores ($p = 0.0007$). The different findings between the 3 studies makes for inconclusive assumptions about the effectiveness of earplugs and eye masks on sleep quality.

Bundle Interventions

The 3 sleep-bundle intervention studies used in this review also measure sleep quality as an outcome (Kamadar et al. 2013; Patel et al., 2014; Tonna et al., 2021). The Kamadar et al. (2013) and Tonna et al. (2021) studies both found no significant improvement in overall patient sleep quality after implementation of the sleep-promoting intervention bundle. However, both studies did report improved noise perception by patients receiving intervention ($p = 0.001$ and $p = 0.02$ respectively). A study examining the relationship between noise and sleep quality in the ICU concluded increased noise levels to be negatively associated with sleep quality (Simons et al., 2018).

Patel et al. (2014) study did find a significant improvement in patient sleep quality with intervention ($p< 0.001$). Patients receiving the intervention versus control spent an average of 2 more hours sleeping per night ($p< 0.001$) and reported more 3-hour windows of uninterrupted sleep. A systematic review and metanalysis examining sleep quality in studies using non-pharmacological bundles of interventions versus single sleep interventions likewise found 82% of the experimental studies using sleep bundles reported improved sleep (Jeehye et al., 2021).

LIMITATIONS

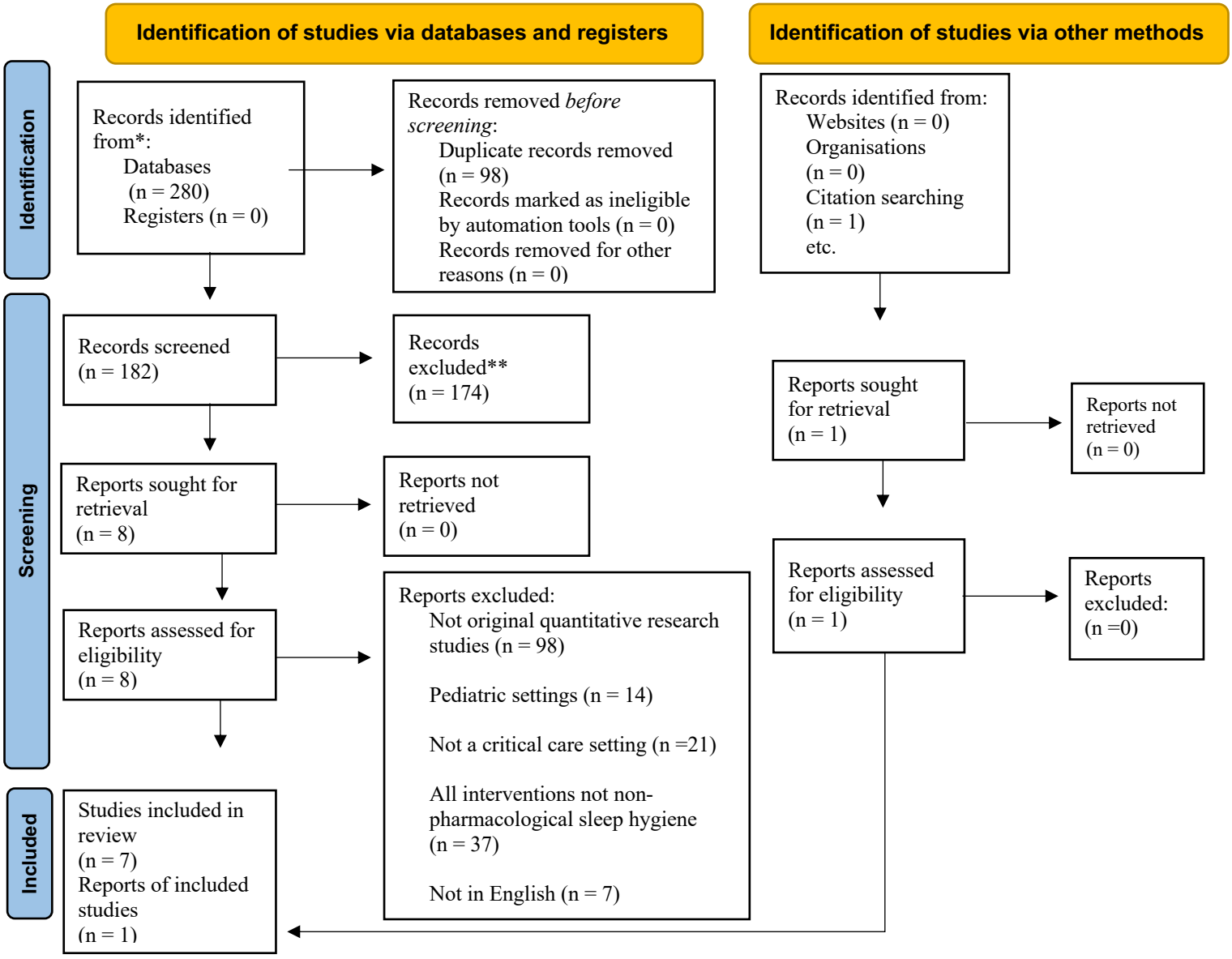
There were limitations in conducting this scoping review which could have impacted the results. The number of original, empirical research that met the inclusion and exclusion criteria was limited. The search results (outlined in methods) yielded 7 articles which fit the specific criteria; only 4 of which were empirical studies.

The articles used within the review used different tools to measure both delirium and sleep (see table 1) which makes comparison and synthesis of results difficult. While some of the studies used the same sleep interventions as each other, others used a different number of interventions (e.g. 1 intervention, 2 interventions, sleep promoting bundles). This lack of consistency in interventions makes it difficult to accurately compare the results of studies. Some of the studies reported a lack of adherence to interventions from patients that may have impacted their results. This makes it hard to accurately report findings and compare those to findings from other reviews where adherence was higher or was not measured.

CONCLUSION

Upon examination of sleep hygiene interventions for the prevention of ICU-delirium used by the studies in this review, a firm conclusion cannot be made as to whether the interventions are beneficial to the patients. There is inconclusive data to support a conclusion that non-pharmacological interventions for sleep do reduce the incidence and risk of delirium in critical care patients. ICU delirium is a preventable complication that is both costly to the hospital and has long term consequences for patients. Although lack of sleep/poor sleep is a recognized risk factor in the development of ICU-delirium, limited literature exists to date on sleep hygiene practices to improve ICU-delirium as an outcome. Future research needs to be done to evaluate which sleep-promoting intervention(s) will benefit critical care patients most in preventing or lowering their risk of delirium. The feasibility of both health care staff consistently and effectively executing the intervention(s) outside of research conditions, and patient compliance with the interventions needs to be further studied. Additionally, future studies measuring sleep quality as a result of sleep promoting interventions should use PSG rather than subjective written/oral reports in order to obtain objective, reliable results.

Figure 1: Prisma 2020 Flow Diagram



*Consider, if feasible to do so, reporting the number of records identified from each database or register searched (rather than the total number across all databases/registers).
**If automation tools were used, indicate how many records were excluded by a human and how many were excluded by automation tools.

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71. For more information, visit: http://www.prisma-statement.org/

Table 1. Table of Evidence

Source	Country	Design Type	Population	Interventions	Assessment Tools	Key Findings
Rompaey, et. al (2012)	Belgium	Randomized Clinical trial	N=136 (69 in intervention group; 67 in control group) Patients admitted to adult cardiac-surgical, surgical, or medical ICUs in a large tertiary care center	Earplugs at nighttime	NEECHAM Self-reported sleep quality questionnaire	There was a significant difference between groups in first time in the ICU admissions (control group 44.8%; intervention group 65.2%). A significant difference in mean hours of observation per patient occurred, with an average of 32.6 hours for patient in the control group, and 42.8 hours for patients in the intervention group. 35% of patients in the intervention group (who slept with earplugs) displayed cognitive disturbances while 60% of the control group exhibited cognitive disturbances. The use of earplugs reduced the risk of delirium for the intervention group by 53% as compared to the control group. Patients in the intervention group who had delirium displayed a later onset as compared to the control group. Nearly half of the intervention group reported good sleep after the first night whereas one third of the control group did.

Kamadar, et al. (2013)	USA	QI project (pre-intervention and intervention)	n= 122 (pre-intervention)/178 intervention Patients admitted to a adult medical ICU in a large tertiary care center	Stage 1- Nighttime interventions: reducing noise and light, grouping patient care, Daytime interventions: raising blinds, prevent excessive napping Stage 2- (in addition to stage 1 interventions) Provision of earplugs, eye masks and soothing music Stage 3- (Implemented only for patients unable to sleep despite stage 1 and 2 interventions) discouragement of sedation medications known to alter sleep patterns and cause delirium, but instead administration of zolpidem for patients without delirium and haloperidol or other atypical antipsychotic for patients with delirium.	RCSQ CAM-ICU RASS	There were no significant patient characteristic differences observed between the baseline patients and the sleep hygiene (minimizing noise, light, and prebedtime caffeine, usage of earplugs and eye masks and discouragement of commonly prescribed sedate use) intervention patients. The baseline patients observed a 43% daily delirium/coma free status versus 48% for the sleep hygiene intervention group. The incidence of delirium/coma in the baseline group was 69%, while the sleep hygiene intervention group observed 49%. Mortality for the baseline group was 16% and 14% in the sleep hygiene intervention group.
Patel, et al. (2014)	UK	QI project (pre-intervention and intervention)	n= 167 (pre-intervention)/171 intervention Mixed medical-surgical ICU patients in a tertiary care center	Efforts to noise level and light at night including provision of earplugs and eye masks, restructuring and timing patient care to reduce the frequency of	RASS CAM-ICU RCSQ	There were no significant differences in patient characteristics between the control and intervention group. Patient with pre-existing sleep pathologies, cognitive

	individual disturbances	dysfunctions, previous ICU admission within same hospital admission, neurosurgical patients, patients receiving sedatives, or with active delirium were not included in this project. No significant differences between the preintervention and post intervention groups' median sleep quality before admission. Before the introduction of the sleep bundle intervention (reduction of noise and light, use of earplugs and eye masks), patients had a 33% incidence of delirium, and 14% after intervention. Preintervention patients spent an average of 3.4 days in a state of delirium, and 1.2 days after the intervention was introduced. After implementation of the sleep bundle intervention, patients spent more time asleep per night on average (8.6 h) as compared to preintervention (6.6 h). There was in increase in mean sleep efficacy index following the implementation of the sleep bundle intervention (75.9) as compared to the

						pre-intervention group (60.8). Patients with high sleep efficiency scores had a reduced odds of delirium (OR 0.90; CI 0.84-0.97).
Demoule, et al. (2017)	France	Randomized controlled trial	n= 64 patients (32 in each group) Patients admitted to a adult general ICU in a large tertiary care center	Earplugs and eye mask at nighttime	CAM-ICU Polysomnography	The LOS in the ICU for the control group ranged from 5-26 days, while the stay for the intervention group who received earplugs and eye masks ranged from 4-11 days. The duration of N3 sleep in the intervention group was 74 minutes as compared to 31 minutes per night in the control group. There were no significant differences in the incidence of delirium between the control and intervention group.
Tonna, et al. (2021)	USA	Staggered, pre-post QI project (pre-intervention and intervention)	n=646 Surgical patients admitted into a SICU or CVICU	Minimization of sound and light and earplugs and eye masks at night, raising blinds and promoting physical activity during the daytime.	CAM-ICU RCSQ	Patients in the preintervention period had fewer existing comorbidities, reported less history of sleep problems (28% in the preintervention versus 37% in the intervention group), and were less likely to use a television to sleep at home (16% in the preintervention group versus 24% in the intervention group). Patients in the preintervention group included

						more general or trauma surgery patients (45% versus 36% in the intervention group) and observed fewer cardiovascular patients (47% versus 58% in the intervention group). 20% of the patients in the preintervention group observed incidences of delirium, which reduced to 15% with the implementation of sleep hygiene interventions (minimizing unnecessary sound and light, allocation of ear plugs and eye masks). Within the first 14 days of the sleep hygiene intervention period, the proportion of days with positive CAM-ICU assessments was 13 as compared to 17 in the preintervention period. No significant difference was found in the overall ICU sleep quality rating between the two periods.
Obanor, et al. (2021)	USA	Prospective Randomized Controlled Trial	n= 87 patients (44 in intervention group; 43 in control group) Female patients admitted to a surgical ICU after breast-free flap surgery in a	Earplugs and eye masks at nighttime	RCSQ CAM-ICU	There was a difference in mean BMI with the control group averaging 30.6 and the intervention group averaging 28.9 (p=0.05). Patients in the intervention group

			tertiary care hospital			(receiving eye mask and earplugs) reported higher quality sleep (CI 58.3-70.7, p= 0.0007). There was no difference in the incidence of delirium between the control and intervention group.
Leong et al. (2021)	Singapore	Randomized Controlled Trail	n= 93 patients (48 in intervention group; 45 in control group) Patients admitted to surgical ICU after colorectal surgery in a tertiary care hospital	Earplugs and eye masks at nighttime	RSCQ NEECHAM	There was better baseline sleep quality reported by the control group (sleep quality index score of 4) as compared to the intervention group (sleep quality index score of 5.5). There was no difference in the perceived sleep quality between the control group and the intervention group that received ear plugs and eye masks. There was no difference in the incidence of delirium between the control group and the group that received ear plugs and eye masks.

Note. CAM-ICU= Confusion Assessment Method for the Intensive Care Unit; RCSQ= Richards-Campbell Sleep Questionnaire; RASS= Richmond Agitation Sedation Scale; NEECHAM= Neelson and Champagne Confusion Scale; *N3 Sleep= regenerative period of sleep in which the body performs maintenance repairs and healing at the cellular level; *BMI= Body Mass Index

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