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Review article

Sleepless in the hospital: A systematic review of non-pharmacological sleep interventions

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ABSTRACT

Objective: Poor sleep is highly prevalent in inpatient medical settings and has been associated with attenuated healing and worsened outcomes following hospitalization. Although nonpharmacological interventions are preferred, little is known about the best way to intervene in hospital settings.
Method: A systematic review of published literature examining nonpharmacological sleep interventions among inpatients in Embase, PsycINFO and PubMed in accordance with PRISMA guidelines.
Results: Forty-three of the 1529 originally identified manuscripts met inclusion criteria, encompassing 2713 hospitalized participants from 18 countries comprised of psychiatric and older adult patients living in hospital settings. Main outcomes were subjective and objective measures of sleep duration, quality, and insomnia.
Conclusions: Overall, the review was unable to recommend any specific intervention due to the current state of the literature. The majority of included research was limited in quality due to lack of controls, lack of blinding, and reliance on self-reported outcomes. However, the literature suggests melatonin and CBT-I likely have the most promise to improve sleep in inpatient medical settings. Additionally, environmental modifications, including designated quiet time and ear plugs/eye masks, could be easily adopted in the care environment and may support sleep improvement. More rigorous research in nonpharmacological sleep interventions for hospitalized individuals is required to inform clinical recommendations.

1. Introduction

Sleep, which is essential for proper physiological functioning and healing, is often interrupted in hospital settings. Prevalence rates of poor sleep in hospitalized patients range from 47 to 67%, depending on both the care population and setting [1,2]. For example, an estimated 50% of all medical inpatients report difficulty sleeping through the night [3] and sleep on average an hour and a half less than while they are at home [4].

This high prevalence is alarming, given the growing literature suggesting an association between poor sleep and both short- and long-term adverse consequences in hospitalized patients. Sleep disruption impairs immune function [5], which is crucial for healing. Poor sleep is associated with hypertension and other cardiovascular risk factors, poor glycemic control, cognitive decline, and increased vulnerability to mental health problems [6–9], all of which may be compounded in medically and psychiatrically vulnerable populations. Furthermore, poor, altered, and/or fragmented sleep while hospitalized is linked with greater disability ratings at time of discharge, poorer healthcare satisfaction, greater short- and long-term functional impairments, increased medical complications, and increased mortality rates in a variety of medical and psychiatric patients [10–15].

Interventions to improve sleep in a hospital setting would likely have a wide range of positive outcomes. Although interest in sleep [16], and interventions to improve sleep, has increased in the past two decades, few studies have focused on interventions in hospital settings. Of those that have, most have focused on pharmacological intervention [17]. However, such interventions are limited and may be contraindicated, as certain medications have negative side effects in vulnerable hospitalized patients [18,19], and hypnotics and benzodiazepines are best avoided in older adults because of increased risk for delirium, falls, and fractures [20]. Therefore, nonpharmacological interventions are considered the most appropriate first-line treatment in hospitalized patients [17]. However, two reviews [21,22] investigating

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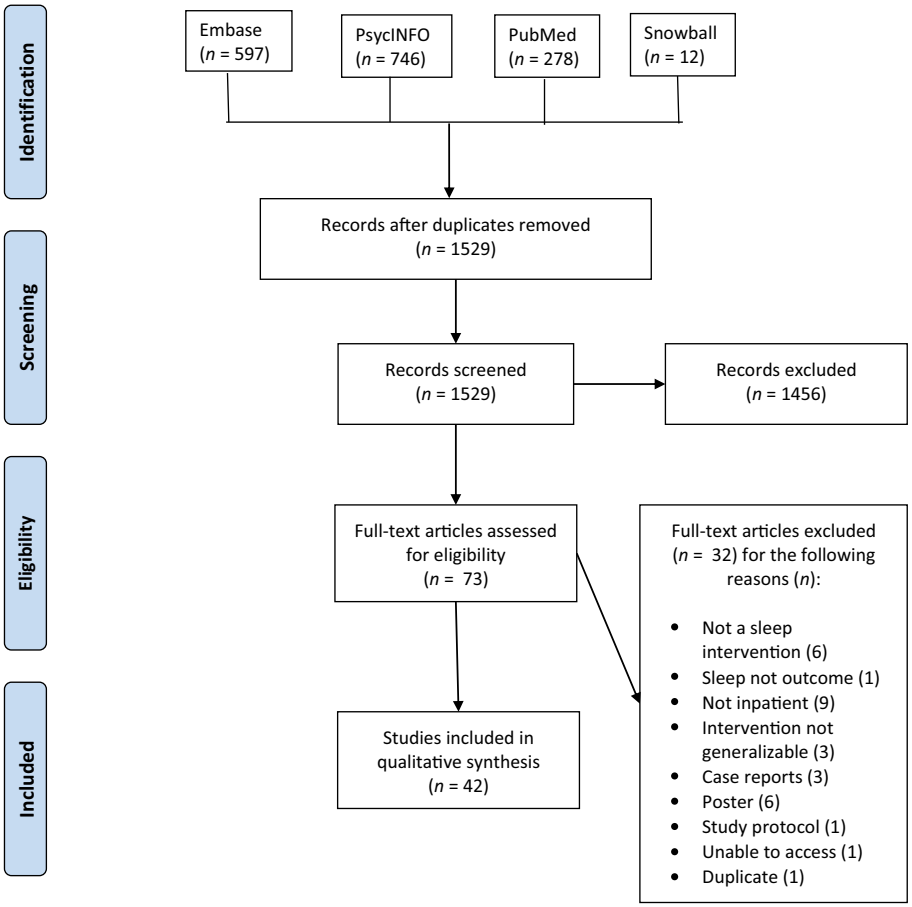

Fig. 1. Flow chart of included articles. The flow chart is based on PRISMA guidelines.

nonpharmacological interventions in hospital settings concluded that existing evidence was of low or very low quality. It is thus unclear which nonpharmacological interventions may improve sleep in hospitalized patients. Therefore, the objective of the current review was to investigate the current state of the literature and summarize the clinical evidence for nonpharmacological sleep intervention efficacy and/or effectiveness for patients in hospital settings.

2. Methods

2.1. Literature search

A systematic search of the published literature was conducted in Embase, PsycINFO and PubMed in December 2017 by a health sciences librarian (FC). The literature was searched for the following concepts (with synonyms, closely related words, and controlled vocabulary): inpatients or hospitalized patients, sleep disorders, and interventions. To limit publication bias, we also conducted a search in the World Health Organization's clinical trials search portal (http://apps.who.int/trialsearch), which allowed a search across multiple registries. Searches were restricted to those conducted in human adults (18 years and above) available in the English language. This systematic review was conducted in accordance with the recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses [23].

2.2. Article screening and selection

Following the literature search, titles and abstracts were independently reviewed by a reviewer (MAM). In order to be included, articles were required to be a full original research paper published in a peer-reviewed journal, include an intervention that targeted sleep, occur in a medical or psychiatric inpatient, or residential settings with adults, and report sleep as an outcome measure. Articles were excluded from further review if they did not include a sleep intervention, were not performed in an inpatient setting, included only pharmacological (excluding over-the-counter) interventions, were not in adult samples, or were case studies or review articles. Articles investigating treatment for obstructive sleep apnea (e.g., continuous positive airway pressure [CPAP]) were also excluded.

Full text review of articles meeting inclusion criteria at title/abstract screen were divided between three authors (MAM, BNR, NDT); each manuscript was independently reviewed by two of these three reviewers. In the case of a disagreement between the two reviewers, the third reviewer was used to decide inclusion. Full text articles were excluded if they represented a conference or oral poster, lacked generalizability (i.e., one study was not included as it targeted neck position during sleep in those with cervicobrachialgia), or were not accessible as an original manuscript.

Further articles were identified for inclusion using a snowball search strategy, in which reference lists of included papers were scanned for other relevant articles. Manuscripts identified in this way were screened in the same format described above.

2.3. Data extraction

Information regarding sample size, study design, average sample age, setting, intervention, and summary of outcome was extracted from each included paper (MAM).

Table 1
Included literature in non-pharmacological sleep interventions in hospital settings.

Article	Country	Sample size total (Int.)	Population	Setting	Average age	Study design	Type of control	Intervention type	Sleep measure	Result	Quality rating[a]
Alparslan et al., 2016	Turkey	282 (235)	Patients with Medical Conditions	Internal Medicine Unit	53	Nonrandomized Control Trial	No Relaxation Exercises	Relaxation Exercise	Sleep Questionnaire	+	0
Ancoli-Israel et al., 2002	USA	72	Older Adults	Nursing Home	85	RCT	Red Light, Daytime Sleep Restriction	AM or PM Bright Light Therapy	Actigraphy	No Impact	3
Andrade et al. 2001	India	33 (18)	Patients with Medical Conditions	General Ward	55	RCT	Placebo	Melatonin	Sleep Questionnaire	+	3
Bartick et al., 2010	USA	106	Patients with Medical Conditions	Medical-Surgical Unit	63	Pre/Post	N/A	Quiet Time, Limit Night Care	Sleep Questionnaire	+	0
Biancosino et al., 2006	Italy	36	Patients with Psychological Disorders	Psychiatry Hospital	47	Pre/Post	NA	Psychoeducation	Sleep Questionnaire, Sedative use	+	0
Borji et al., 2017	Iran	60 (30)	Patients with Medical Conditions	Cardiac Unit	52	RCT	TAU	Quiet Time Protocol	Sleep Questionnaire	+	1
Connell et al., 2001	England	43	Older Adults	Geriatric Care Wards	Not Reported	Pre/Post	N/A	Aromatherapy	Nurse Recordings of Sleep	+	0
Dave et al., 2015	India	25 (5)	Patients with Medical Conditions	ICU	40	RCT	TAU	Ear Plugs and Eye Masks	Sleep Questionnaire	+	1
De Rui et al., 2015	Italy	12 (5)	Patients with Medical Conditions	ICU	59	Nonrandomized Control Trial	Patient Controlled Lighting	Bright Light Therapy in Controlled Rooms	Actigraphy, Melatonin, Sleep Questionnaire	No Impact	1
Dowling et al., 2008	USA	50 (17)	Older Adults	Nursing Home	86	RCT	Lighting as Usual, Bright Light Therapy without Melatonin	Bright Light Therapy and Melatonin	Actigraphy	No Impact	2
Dowling et al., 2005	USA	46 (29)	Older Adults	Nursing Home	84	RCT	Lighting as Usual	Bright Light Therapy	Actigraphy	No Impact	2
Ducloux et al., 2013	Switzerland	18	Patients with Medical Conditions	Palliative Care	66	RCT	Waitlist	Relaxation Therapy	Sleep Questionnaire	No Impact	3
Engwall et al., 2015	Sweden	100 (48)	Patients with Medical Conditions	ICU	61	Nonrandomized Control Trial	Lighting as Usual	Lighting Controlled Rooms	Sleep Questionnaire	N/A	0
Fetveit & Bjorvatn, 2005	Norway	11	Older Adults	Nursing home	86	Pre/Post	N/A	Bright Light Therapy	Actigraphy, Nurses Report	No Impact	0
Fukuda et al., 2001	Japan	4	Patients with Medical Conditions	General Medical Inpatient	85	Pre/Post	N/A	Bright Light Therapy	PSG	N/A	0
Greeff & Conradie, 1998	South Africa	22	Patients with Psychological Disorders	Inpatient Alcohol Rehabilitation	46	RCT	Waitlist	Progressive Relaxation Training	Sleep Questionnaire	+	1
Hajibagheri et al., 2014	Iran	60 (30)	Patients with Medical Conditions	Coronary Care Unit	62	RCT	TAU	Rosa damascene aromatherapy	Sleep Questionnaire	+	3
Haynes et al., 2011	USA	19	Patients with Psychological Disorders	Psychiatry Inpatient	55	Pre/Post	N/A	CBT-i (group format)	Sleep Questionnaire	+	1
Jones et al., 2012	England	100	Patients with Medical Conditions	Critical Care Unit	58	Pre/Post	N/A	Ear Plugs and Eye Masks	Sleep Questionnaire	+	0
Kamdar et al., 2013	USA	300	Patients with Medical Conditions	ICU	54	Pre/Post	N/A	Environmental Changes; Earplugs; Eye Masks	Sleep Questionnaire	No Impact	0
Kim et al., 2004	Korea	30 (15)	Patients with Medical Conditions	Neurological Diseases Department	67	RCT	Sham Acupuncture	Acupuncture	Sleep Questionnaire	No Impact	3

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Table 1 (*continued*)

Article	Country	Sample size total (Int.)	Population	Setting	Average age	Study design	Type of control	Intervention type	Sleep measure	Result	Quality rating[a]
Kobayashi et al., 2001	Japan	10	Patients with Medical Conditions/Older Adults	General Medical Inpatient	81	Pre/Post	N/A	Bright Light Therapy	Nurse Reported Improvements in Sleep	+	0
Kuck et al., 2014	Germany	85 (32)	Older Adults	Nursing Home	84	RCT	TAU	Physical and Social Activation Program	Sleep Questionnaire Actigraphy, Nurses Report of Sleep	+ Self Report; No Impact Actigraphy	3
Lee et al., 2009	Korea	52 (27)	Patients with Medical Conditions	Stroke Center	66	RCT	Sham Acupuncture	Acupuncture	Sleep Questionnaire	+	4
Levitt et al., 1975	New Zealand	13 (5)	Patients with Psychological Disorders	Psychiatric Hospital	Included 23 to 63 (no avg. reported)	Nonrandomized Control Trial	Simulated Treatment Group	Electrosleep	Sleep Questionnaire, Nurse Reported Changes in Sleep	No Impact	0
Liu et al., 2015	China	317 (120)	Patients with Medical Conditions	Inpatient units	44	RCT	TAU	Lavender Hot-Bath, Foot-soaking, and/or Progressive Relaxation	Sleep Questionnaire	+	1
Mashayekhi et al., 2013	Iran	30	Patients with Medical Conditions	Coronary Care Unit	51	Crossover	No Ear Plugs	Earplugs	Sleep Questionnaire	+	1
McDowell et al., 1998	USA	111	Patients with Medical Conditions/Older Adults	General Medical Unit	79	Pre/Post	N/A	Back Rub, Warm Drink and/or Relax Tapes	Patient Interview, Nursing Report, and Chart Review, Sedative Use	+	0
Mishima et al., 1994	Japan	24 (14)	Older Adults	Geriatric Ward of Psychiatry Hospital	75	Nonrandomized Control Trial	Patients without Dementia	Bright Light Therapy	Melatonin, Nurse Reported Sleep Time	+	0
Otaghi et al., 2017	Iran	60 (30)	Patients with Medical Conditions	Cardiac Care Unit	Included 18–75 (no avg. reported)	RCT	TAU	Lavender Oil	Sleep Questionnaire	No Impact	1
Philip et al., 1991	France	21 (10)	Patients with Psychological Disorders	Psychiatry Ward	41	Nonrandomized Control Trial	Device Placement without Stimulation	Electrosleep	Sleep Questionnaire, Sleep Diary	+	2
Satlin et al., 1992	USA	10	Older Adults	Inpatient VA Dementia Ward	70	Pre/Post	N/A	Bright Light Therapy	Actigraphy, Nurse Ratings of Sleep	+	0
Shilo et al., 2000	Israel	8	Patients with Medical Conditions	Pulmonary ICU	62	RCT	Placebo	Melatonin	Actigraphy	+	2
Smith et al., 2002	USA	41 (20)	Patients with Medical Conditions	Oncology Ward	62	Nonrandomized Control Trial	Nurse Interaction	Massage	Sleep Questionnaire	+	1
Soden et al., 2004	England	42 (29)	Patients with Medical Conditions	Palliative Care Unit	Median = 73	RCT	TAU	Massage, Massage/ Aromatherapy	Sleep Questionnaire	+	2
Sun et al., 2010	Taiwan	44 (23)	Older Adults	Long Term Care facility	70	RCT	Light Touch	Acupressure	Sleep Questionnaire	+	3
Toth et al., 2007	USA	23 (11)	Patients with Medical Conditions	Hospital	54	RCT	Quiet Time	Guided Imagery	Sleep Questionnaire	No Impact	2
Wakamura& Tokura, 2001	Japan	7	Patients with Medical Conditions	Chest Disease Ward	67	Pre/Post	N/A	Light Therapy	Actigraphy, Melatonin	+	0
Walker, 1984	USA	42 (14)	Patients with Psychological Disorders	Psychiatry Inpatient	33	RCT	Waitlist	CBT-i (group format)	Sleep Questionnaire and Diary	+	2
Wang et al., 2014	China	142 (103)	Patients with Medical Conditions	Cardiovascular Units	62	RCT	TAU	Biofeedback Assisted Relaxation Training	Sleep Questionnaire, Sedative Use	+	3

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Table 1 (*continued*)

Article	Country	Sample size total (Int.)	Population	Setting	Average age	Study design	Type of control	Intervention type	Sleep measure	Result	Quality rating[a]
Yamadera et al., 2000	Japan	27	Older Adults	Hospital	80	Pre/Post	N/A	Bright Light Therapy	Actigraphy	+	0
Yang et al., 2010	China	79 (24)	Patients with Medical Conditions	Cancer Inpatient Unit	50	RCT	TAU	Calligraphy/Relaxation group	Sleep Questionnaire	+	3
Zimmerman et al., 1996	USA	96 (64)	Patients with Medical Conditions	Hospital	67	RCT	Scheduled Rest Group	Music, Music Video	Sleep Questionnaire	+	1

Note. 11 of the 13 studies included in the Tamarat et al., 2013 are included in the current review. Two studies were not included due to differences in inclusion criteria. Fourteen of the papers included in this study were published following the Tamarat study. "No impact" indicates that there was no impact of intervention on night time sleep, N/A in outcome variable indicates no statistical comparison.

[a] Quality rating based on Jadad et al., 1996 criteria, TAU = Treatment as usual, RCT = Randomized controlled trial, + = positive impact on night time sleep by intervention.

2.4. Article organization

Included studies were organized by inpatient population and then by type of sleep intervention for ease of synthesis. Hospitalized patient populations identified in the review fell into one of three broad groups: 1) patients with psychological disorders including serious mental illness and substance use disorders; 2) older adult patients with or without dementia who lived in a variety of inpatient geriatric care settings; and 3) patients with medical conditions were inpatient on hospital care units.

2.5. Quality assessment

The quality of included manuscripts was assessed using the Jadad rating scale [24]. Higher scores indicate better quality, with scores ≥ 3 considered high quality [25]. All identified manuscripts that were not RCTs were automatically scored a 0.

3. Results

3.1. Included studies and study characteristics

The search resulted in 1622 titles/abstracts; after removal of duplicates, 1529 titles/abstracts were screened. From these, 74 studies were deemed potentially eligible and underwent full-text review. A total of 43 manuscripts met inclusion criteria and were ultimately included in the review. See Fig. 1 for a flowchart of search process and results.

Table 1 depicts study information, including sample size, study design, average sample age, setting, intervention, and summary of outcome. This sample consisted of 43 studies from 18 countries assessing a total of 2713 participants with an average age ranging from 33 to 86. Studies examined 14 different nonpharmacological interventions across three care settings. Twenty-three studies were randomized controlled trials (RCTs), 7 were nonrandomized controlled trials (i.e., study design included an intervention and control group but no mention of random assignment to groups), and 13 were non-controlled, observational study designs. Quality scores ranged from 0 to 4. The majority of the included studies (n = 32; 74.4%) used self-report questionnaires or relied on nurse report to measure sleep outcomes. Only 11 (25.6%) used at least one objective measure (e.g., actigraphy or polysomnography).

3.1.1. Patients with psychological disorders

Six of the included studies investigated sleep interventions in psychiatric hospitals and drug and alcohol rehabilitation programs. Interventions largely consisted of psychoeducation [26], progressive muscle relaxation exercises [27], and electrostimulation [28,29]. Two of these six studies implemented a group form of cognitive behavioral therapy for insomnia (CBT−I) [30,31]. All interventions had positive effects on sleep quality and/or duration with the exception of electrostimulation. Electrosleep, or electrostimulation of the cerebral cortex, administered twice a day was shown to have no effect on sleep relative to placebo in a nonrandomized study [28], though improved sleep duration relative to placebo (5.2 h vs. 3.2 h) during a drug washout period in a psychiatric inpatient setting [29]. CBT-I was the only intervention tested in this population that was the focus of more than one study and had consistently positive findings. Both studies that investigated CBT-I [30,31] were administered in group format and found improvements in insomnia symptoms and in sleep quality.

Importantly, however, the studies have critical weaknesses. First, two of the six studies did not include control groups. Those that did were limited in quality of design (quality scores 0–2) due to lack of randomization, lack of blinding to intervention, and/or lack of information regarding dropouts. In addition, objective outcome measures were limited to tracking sedative use and most of the studies relied on self-report on sleep duration and quality. These limitations and lack of

current replication studies suggests results should be interpreted cautiously.

3.1.2. Older adults

Ten studies included older adult patients with or without dementia in a variety of inpatient geriatric care settings, including long-term care settings, geriatric psychiatry, and geriatric acute care wards. Of those, the majority (n = 7; 70%) investigated light therapy in individuals with dementia. Most of these studies did not find a statistically significant increase in nighttime sleep [32–35] after intervention, although many reported improved circadian entrainment [32,34] and decreased daytime sleep [33,36,37]. Of note, a single paper compared light therapy to the use of combined light therapy and melatonin and found the combined treatment was effective at entraining rhythms while light therapy alone was not [33]. Timing of light therapy differed between studies. Morning light was the most common timing of the intervention and had the strongest entraining effect [32], though evening light was shown to improve nurse reports of sleep [35] and increase circadian amplitude [32]. Interestingly, several studies found that those with the most severe insomnia and dementia symptoms benefited the most from light therapy relative to those with less severe symptoms [34,35,38]. Overall, the evidence suggests that light therapy in older adults living in inpatient geriatric care settings with dementia is effective for entraining circadian rhythms, though may not directly increase sleep during the night time period. Although the overall quality of these studies is similar to those described in previous sections (quality scores 0–3), the studies more often included objective measures (i.e., actigraphy) and control groups, which strengthens the evidence supporting light therapy for older patients with dementia in these settings.

The remaining studies investigated social and physical activity, aromatherapy, and acupressure in older adult inpatients. One study implementing social and physical activity in a group format in nursing home residents (including those with mild-to-moderate cognitive impairments) found an improvement in self-reported insomnia in the active intervention group [39]. Interestingly, there was no difference in objective actigraphy measures between intervention and control groups, which suggests that the perception of sleep improved without any improvement in sleep duration or quality. An aromatherapy study found that Roman chamomile oil used on patient bed pillows improved nurse-documented sleep duration among patients (including those with dementia) on inpatient geriatric care settings [40]. One study investigated acupressure study found an improvement in self-reported insomnia severity among long-term care residents who received acupressure treatment relative to patients who received light touch [41]. Two studies had moderate quality ratings due to lack of double blinding (quality scores = 3) [39,41]. The aromatherapy study had a low-quality rating (0) due to the lack of control group.

3.1.3. Patients with medical conditions

Twenty-seven of the articles included patients with medical conditions. Six of the articles investigated relaxation techniques on sleep quality. Of the two studies that implemented progressive muscle relaxation, both found an increase in self-reported sleep quality. However, one of these two studies had several design flaws including nonrandomization and a significant difference in baseline sleep measures between controls and those receiving the intervention [42]. The other study's sleep measure was one question regarding sleep quality, which greatly limits interpretation of the findings [43]. Two studies implemented guided imagery with one study finding a significant effect on self-reported sleep quality [44] and the other reporting null findings [45]. The study with positive findings also included biofeedback, which may have provided an opportunity for patients to adjust their imagery technique to increase the effectiveness of relaxation. Duxloux et al. [46] found no improvement in self-reported sleep satisfaction with the use of deep breathing techniques. Zimmerman et al., [47] found a positive impact of watching relaxing music videos on self-reported sleep quality. Overall, the studies teaching relaxation techniques were limited in quality (0–3) but offer some evidence supporting the use of progressive muscle relaxation in hospitalized patients with medical conditions.

Aromatherapy was used in three of the intervention articles, with mixed results. In patients in cardiology hospital units, nightly rose essential oil on patients' bed pillows improved average Pittsburgh Sleep Quality Index scores by 3.07 points while control scores worsened by less than a point [48]. In contrast, cardiology inpatients did not self-report improved sleep after use of lavender oil [49]. Other studies have shown massage and lavender oil [50], as well as massage alone, to improve self-reported sleep in cancer inpatients [50,51]. Overall, studies investigating aromatherapy and/or massage were limited in quality (quality scores 1–3) due to lack randomization [51] and the use of the self-report questionnaires [48–51].

Two studies implemented multiple interventions including combinations of relaxation techniques, aromatherapy, and massage. In a randomized study utilizing lavender essential oils, progressive muscle relaxation, and foot soaking reported an improvement in self-reported sleep quality in patients hospitalized with liver disease [52]. Similarly, an intervention including backrub, a warm drink before bed, and relaxation tapes had a positive, dose-wise effect on self-reported and chart-documented sleep [53]. Although promising, both studies were limited in quality (ratings 0–1) and used self-report sleep measures, which restricts interpretation and generalization of results.

Acupuncture was used in two studies from the same research group investigating sleep interventions among post-stroke patients with insomnia. Both studies found an improvement in self-reported sleep following acupuncture [54,55]. These studies received relatively high-quality ratings due to blinding, randomization and report of reasons for withdrawal (3–4).

Six of the articles focused on improving the sleep environment for medical inpatients, including creating quiet time protocols on units and providing eye masks and ear plugs to patients. Quiet time protocols improved self-reported sleep quality and sleepiness ratings in a sample of patients on a cardiovascular hospital unit after three nights [56]. However, Bartick et al. [57] investigated quiet time in a group of general medical inpatients and found limited effects on sleep medication use and no effect on sleep quality. Differing results may be due to the lack of controls in the negative study [57]. Of those studies investigating ear plug and eye mask use, two studies found an improvement in self-reported sleep quality [58,59] while one study found an improvement in sleep duration but not in sleep quality [60]. One quality improvement investigation included a large sample (n = 300) assessing both modifications to the environment, the option for earplug and eye mask use, and an option for pharmacological intervention, with no significant change in self-perceived sleep quality [61]. These studies had low quality ratings (0–1) with most lacking blinding and reporting of withdrawals.

Chronobiological interventions (namely, melatonin and light therapy) were included in seven of the articles. After taking melatonin at night for at least two days, objectively-assessed duration and quality of sleep improved in patients with respiratory failure [62]. Melatonin also improved self-reported sleep quality and decreased sleep onset latency in general medical inpatients [63]. Together, preliminary evidence suggests a positive impact of melatonin on sleep in medical inpatients, although study design and quality (scores 2–3) suggest further investigation is necessary. Two of the five studies investigating light therapy found qualitatively positive effects on sleep (e.g., patient interviews and consecutive case studies), but did not report quantitative findings [64,65]. Light exposure during the afternoon was shown to delay bedtime and increase immobile time at night measured by actigraphy [66] and improve nurse-reported sleep in general medicine inpatients [67]. Although both studies found promising results of afternoon light therapy on sleep, they both lacked controls and should be interpreted with caution. Further, in the only light therapy study that included a control group, the intervention did not significantly alter

actigraphy-measured sleep relative to controls [68]. Evidence supporting the use of light therapy in medically hospitalized patients is more tenuous than the melatonin literature and suggests a need for more rigorous light therapy investigations in these populations.

4. Discussion

This review investigated nonpharmacological interventions for the prevalent problem of poor sleep among hospitalized individuals. Overall, the majority of the 43 reviewed studies were RCT designs with low quality ratings, mostly reporting subjective measures of sleep improvement, with few attempts to replicate findings. Among inpatients with psychiatric disorders, a group format of CBT-I was the only intervention type to be tested in more than one study; findings suggested an improvement in both sleep quality and insomnia symptoms after such treatment. This is consistent with a recent meta-analysis which indicated that CBT-I had a medium-to-large effect size on sleep quality improvement in outpatients with comorbid insomnia [69]. CBT-I is likely a fruitful avenue for further research in inpatients with psychiatric disorders and perhaps other categories of hospitalized patients as well. However, active ingredients of CBT−I, such as stimulus control and sleep restriction, can be difficult in certain hospitalized populations, particularly among those confined to their bed or with contraindications for sleep restriction (i.e., individuals with bipolar disorder).

Among older adults, most of the studies assessed light therapy and environmental lighting in inpatient geriatric care settings. Although these studies did not necessarily find a direct effect of such interventions on sleep quality or nightly sleep duration, some found improved circadian entrainment [32,33]. This is consistent with the known mechanisms of light therapy to entrain and synchronize the circadian system (for Review see [70]). As such, timing of light administration is important. Given that older adults with dementia are thought to have delayed circadian rhythms [71], and light exposure in the morning is known to advance circadian rhythms [72], it is unsurprising that the most successful timing of light therapy in older patients with dementia is in the morning [32]. In addition to improving entrainment, light therapy also has the added benefit of decreasing daytime sleep [33,36,37]—an important benefit given that more napping predicts less functional recovery for older individuals in post-acute rehabilitation setting [73]. Of all the interventions reviewed, light therapy for older adults has the most evidence to support its use in inpatient geriatric care settings and hospital settings.

Hospital inpatients with medical conditions were the most frequently represented population in the articles reviewed. Although several interventions were investigated, few studies used objective measures of sleep and, as with the psychiatric population, few studies have replicated intervention effects on sleep quality or duration. Acupuncture and melatonin had the most consistently positive effects on subjective and objective measures of sleep. A meta-analysis investigating acupuncture in the general population found a marginal increase in sleep quality and concluded that there was limited high-quality clinical evidence of acupuncture to treat insomnia [74]. This is consistent with the current literature in inpatients with medical conditions and highlights the importance of further research testing acupuncture for sleep improvement. In the same vein, melatonin has been shown to have a modest effect on sleep onset latency and quality on both medical inpatients and outpatients with insomnia [62,63,75], though limited investigation in the hospitalized setting indicates the need for further research.

4.1. Limitations of the literature

A limitation of the majority of the research included in this review is the lack of objective measures of sleep. In general, individual self-report of sleep duration and quality differs from those measured with objective procedures, such as polysomnography and actigraphy [76–78]. Together, some studies suggest that self-reported sleep duration and quality may not accurately reflect a participant's sleep experience. It is therefore possible that the change in self-reported sleep quality or duration described by studies in the current review may not represent a significant change in actual sleep quality or duration. However, it is important to highlight that self-report sleep quality questionnaire scores have been correlated with quality of life ratings, such that poorer sleep quality is related to lower quality of life [79,80], suggesting that changes in subjective measures of sleep may provide important information on overall functioning.

In addition, less rigorous study design and inclusion criteria may have muted the potentially positive outcomes of the included studies. As indicated above, several studies measured pre- and post-intervention changes in sleep quality or duration in an open trial, without the use of a control group for comparison. Given the expected improvement in health over hospital stays, as well as general regression to the mean, the relative contribution of the intervention to sleep changes during a hospital stay remains unclear in many of these trials. Differences in the inclusion criteria for participants across studies may limit generalizability, including whether the individuals were required to have sleep problems prior to the initiation of the intervention. It is likely that the studies that did not require individuals to have sleep problems prior to treatment had limited potential for sleep change relative to those that restricted inclusion to those with sleep problems. Overall, inclusion of controls and inclusion criteria were all design factors that limited the interpretation of the current review's results.

4.2. Limitations of the current review

One limitation of the current review is our limited ability to quantify the quality of the included studies. Because the review aimed to represent the current state of the literature investigating sleep interventions in medical and other inpatient facilities, all study designs otherwise meeting study inclusion criteria were included in the review. Unfortunately, assessing quality across study designs can be difficult because each design has different standards. The current review utilized the Jadad approach because it evaluates clinical trials, the gold standard of establishing intervention efficacy and effectiveness. However, this approach does not provide a robust method of quantifying the quality of non-RCTs; therefore, included non-RCT studies did not undergo a nuanced quality assessment and were awarded zeros. In addition, under the Jadad rating system, studies utilizing a double-blind approach are awarded a higher score. Many nonpharmacological interventions are inherently resistant to blinding (e.g., aromatherapy; using ear plugs). Therefore, one criticism of this rating system is that it favored easily blinded interventions (e.g., pharmaceutical interventions, such as melatonin).

4.3. Recommendations for future research

Despite these limitations, this review updates and expands previous work in this area [21]. The review highlights the continuing paucity of research investigating sleep interventions among inpatients in medical, psychiatric, and inpatient geriatric care settings. Concrete suggestions for future research will provide a focused path forward for the literature and support more clear and effective clinical recommendations.

4.3.1. Interventions for focus of future research

The review has highlighted that those interventions that have the most evidence for sleep improvement in the community dwelling population (light therapy, melatonin, and CBT−I) also have the most promise in medical and inpatient geriatric care settings. Adapting these approaches, such as CBT−I, to medical populations and settings may lead to more effective and accessible interventions. In addition, a number of interventions included in the review did not require specialist care and therefore are likely the most accessible and easily

assimilated into current medical treatment For instance, environmental modifications like implementing a “quiet time” for staff and patients or limiting the number of patients sharing a room may have important positive effects on sleep with relatively little financial investment or risk of negative side effects. Given the heterogeneity of sleep difficulties in hospital settings, multimodal interventions that combine approaches (e.g., behavioral, circadian, and environmental) into a flexible, modularized intervention may be a novel way to address individual patient sleep difficulties.

4.3.2. Study designs to support more definitive clinical recommendations

Well-designed studies are necessary to provide the most robust clinical guidance to providers. Research should first focus on establishing intervention efficacy using RCT designs, ideally using active comparators to determine the best treatment for a specific settings and populations. Next, pragmatic effectiveness trials are needed to ascertain treatment effect in real world practice, using typical patients and providers. Such research should include measures of treatment fidelity and adverse effects of the targeted intervention to better understand the effect and ramifications of the intervention. In addition, collecting objective measures of sleep improvement will be an important extension of the current literature. Inclusion of polysomnography (PSG), the gold standard of sleep measurement, will provide more accurate outcome data and replicable results. Concurrently, actigraphy, which is a cheaper and more participant-friendly sleep measure, has been shown to accurately reflect PSG measures and would provide a more convenient objective measure of sleep in a hospital setting [81]. This enhanced rigor will be an important foundation for building consistent and effective clinical recommendations for sleep interventions in a hospital setting.

4.4. Conclusions

Overall, the review is unable to recommend any specific intervention based on the current literature, mostly due to the limited quality of research currently investigating sleep interventions in medical and inpatient geriatric care settings. Specifically, interpretation of current studies was limited by their use of subjective measures, lack of clarity or report on the randomization design, and/or the lack of control groups required to establish efficacy. Of the interventions included in the current review, melatonin and CBT-I likely have the most promise to improve sleep duration and quality in medical settings. Light therapy may also be helpful, though in an indirect pathway via improved entrainment of the circadian system. Environmental modifications will likely be relatively easily adapted into care and therefore are worth further investigation. Further research is required to provide stronger clinical recommendations for sleep interventions in those medical and geriatric care settings.

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References

[1] Meissner HH, Riemer A, Santiago SM, Stein M, Goldman MD, Williams AJ. Failure of physician documentation of sleep complaints in hospitalized patients. West J Med 1998;169:146–9.
[2] Talih F, Ajaltouni J, Ghandour H, Abu-Mohammad AS, Kobeissy F. Insomnia in hospitalized psychiatric patients: prevalence and associated factors. Neuropsychiatr Dis Treat 2018;14:969–75.
[3] Southwell MT, Wistow G. Sleep in hospitals at night: are patients' needs being met? J Adv Nurs 1995;21:1101–9.
[4] Dobing S, Frolova N, McAlister F, Ringrose J. Sleep quality and factors influencing self-reported sleep duration and quality in the general internal medicine inpatient population. PLoS One 2016;11:e0156735.
[5] Irwin MR, Olmstead R, Carroll JE. Sleep disturbance, sleep duration, and inflammation: a systematic review and meta-analysis of cohort studies and experimental sleep deprivation. Biol Psychiatry 2016;80:40–52.
[6] Lee SWH, Ng KY, Chin WK. The impact of sleep amount and sleep quality on glycemic control in type 2 diabetes: a systematic review and meta-analysis. Sleep Med Rev 2017;31:91–101.
[7] Li L, Wu C, Gan Y, Qu X, Lu Z. Insomnia and the risk of depression: a meta-analysis of prospective cohort studies. BMC Psychiatry 2016;16:375.
[8] Sofi F, Cesari F, Casini A, Macchi C, Abbate R, Gensini GF. Insomnia and risk of cardiovascular disease: a meta-analysis. Eur J Prev Cardiol 2014;21:57–64.
[9] Spira AP, Chen-Edinboro LP, Wu MN, Yaffe K. Impact of sleep on the risk of cognitive decline and dementia. Curr Opin Psychiatry 2014;27:478–83.
[10] Duclos C, Dumont M, Blais H, Paquet J, Laflamme E, de Beaumont L, et al. Rest-activity cycle disturbances in the acute phase of moderate to severe traumatic brain injury. Neurorehabil Neural Repair 2014;28:472–82.
[11] Ho A, Raja B, Waldhorn R, Baez V, Mohammed I. New onset of insomnia in hospitalized patients in general medical wards: incidence, causes, and resolution rate. J Community Hosp Intern Med Perspect 2017;7:309–13.
[12] Martin JL, Fiorentino L, Jouldjian S, Mitchell M, Josephson KR, Alessi CA. Poor self-reported sleep quality predicts mortality within one year of inpatient post-acute rehabilitation among older adults. Sleep 2011;34:1715–21.
[13] Vin-Raviv N, Akinyemiju TF, Galea S, Bovbjerg DH. Sleep disorder diagnoses and clinical outcomes among hospitalized breast cancer patients: a nationwide inpatient sample study. Support Care Cancer 2018;26:1833–40.
[14] Pace M, Camilo MR, Seiler A, Duss SB, Mathis J, Manconi M, et al. Rapid eye movements sleep as a predictor of functional outcome after stroke: a translational study. Sleep 2018;41.
[15] Stewart NH, Arora VM. Sleep in hospitalized older adults. Sleep Med Clin 2018;13:127–35.
[16] Ferrie JE, Kumari M, Salo P, Singh-Manoux A, Kivimaki M. Sleep epidemiology–a rapidly growing field. Int J Epidemiol 2011;40:1431–7.
[17] Lenhart SE, Buysse DJ. Treatment of insomnia in hospitalized patients. Ann Pharmacother 2001;35:1449–57.
[18] Berry SD, Lee Y, Cai S, Dore DD. Nonbenzodiazepine sleep medication use and hip fractures in nursing home residents. JAMA Intern Med 2013;173:754–61.
[19] Kolla BP, Lovely JK, Mansukhani MP, Morgenthaler TI. Zolpidem is independently associated with increased risk of inpatient falls. J Hosp Med 2013;8:1–6.
[20] American Geriatrics Society. Updated beers criteria for potentially inappropriate medication use in older adults. J Am Geriatr Soc 2015;2015(63):2227–46.
[21] Tamrat R, Huynh-Le MP, Goyal M. Non-pharmacologic interventions to improve the sleep of hospitalized patients: a systematic review. J Gen Intern Med 2014;29:788–95.
[22] Hu RF, Jiang XY, Chen J, Zeng Z, Chen XY, Li Y, et al. Non-pharmacological interventions for sleep promotion in the intensive care unit. Cochrane Database Syst Rev 2015(10):Cd008808.
[23] Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med 2009;6:e1000097.
[24] Jadad AR, Moore RA, Carroll D, Jenkinson C, Reynolds DJ, Gavaghan DJ, et al. Assessing the quality of reports of randomized clinical trials: is blinding necessary? Control Clin Trials 1996;17:1–12.
[25] Jadad AR. The merits of measuring the quality of clinical trials: is it becoming a byzantine discussion? Transpl Int 2009;22:1028.
[26] Biancosino B, Rocchi D, Donà S, Kotrotsiou V, Marmai L, Grassi L. Efficacy of a short-term psychoeducational intervention for persistent non-organic insomnia in severely mentally ill patients. A pilot study. Eur Psychiatry 2006;21:460–2.
[27] Greeff AP, Conradie WS. Use of progressive relaxation training for chronic alcoholics with insomnia. Psychol Rep 1998;82:407–12.
[28] Levitt EA, James NM, Flavell P. A clinical trial of electrosleep therapy with a psychiatric inpatient sample. Aust N Z J Psychiatry 1975;9:287–90.
[29] Philip P, Demotes-Mainard J, Bourgeois M, Vincent JD. Efficiency of transcranial electrostimulation on anxiety and insomnia symptoms during a washout period in depressed patients. A double-blind study. Biol Psychiatry 1991;29:451–6.
[30] Haynes PL, Parthasarathy S, Kersh B, Bootzin RR. Examination of insomnia and insomnia treatment in psychiatric inpatients. Int J Ment Health Nurs 2011;20:130–6.
[31] Walker AL. Cognitive-behavioral treatment of sleep disorders in inpatient Vietnam combat veterans. US: ProQuest Information & Learning; 1984. p. 2572.
[32] Ancoli-Israel S, Martin JL, Kripke DF, Marler M, Klauber MR. Effect of light treatment on sleep and circadian rhythms in demented nursing home patients. J Am Geriatr Soc 2002;50:282–9.
[33] Dowling GA, Burr RL, Van Someren EJW, Hubbard EM, Luxenberg JS, Mastick J, et al. Melatonin and bright-light treatment for rest-activity disruption in institutionalized patients with Alzheimer's disease. J Am Geriatr Soc 2008;56:239–46.
[34] Dowling GA, Mastick J, Hubbard EM, Luxenberg JS, Burr RL. Effect of timed bright light treatment for rest-activity disruption in institutionalized patients with Alzheimer's disease. Int J Geriatr Psychiatry 2005;20:738–43.
[35] Satlin A, Volicer L, Ross V, Herz LR, Campbell S. Bright light treatment of behavioral and sleep disturbances in patients with Alzheimer's disease. Am J Psychiatry 1992;149:1028–32.
[36] Fetveit A, Bjorvatn B. Bright-light treatment reduces actigraphic-measured daytime sleep in nursing home patients with dementia: a pilot study. Am J Geriatr Psychiatry 2005;13:420–3.
[37] Yamadera H, Ito T, Suzuki H, Asayama K, Ito R, Endo S. Effects of bright light on cognitive and sleep-wake (circadian) rhythm disturbances in Alzheimer-type dementia. Psychiatry Clin Neurosci 2000;54:352–3.
[38] Mishima K, Okawa M, Hishikawa Y, Hozumi S, Hori H, Takahashi K. Morning bright light therapy for sleep and behavior disorders in elderly patients with dementia.

Acta Psychiatr Scand 1994;89:1–7.
[39] Kuck J, Pantke M, Flick U. Effects of social activation and physical mobilization on sleep in nursing home residents. Geriatr Nurs 2014;35:455–61.
[40] Connell FEA, Tan G, Gupta I, Gompertz P, Bennett GCJ, Herzberg JL. Can aromatherapy promote sleep in elderly hospitalized patients? Geriatr today. J Canadian Geriatr Soc 2001;4:191–5.
[41] Sun JL, Sung MS, Huang MY, Cheng GC, Lin CC. Effectiveness of acupressure for residents of long-term care facilities with insomnia: a randomized controlled trial. Int J Nurs Stud 2010;47:798–805.
[42] Alparslan GB, Orsal O, Unsal A. Assessment of sleep quality and effects of relaxation exercise on sleep quality in patients hospitalized in internal medicine services in a university hospital: the effect of relaxation exercises in patients hospitalized. Holist Nurs Pract 2016;30:155–65.
[43] Yang X-L, Li H-H, Hong M-H, Kao HSR. The effects of Chinese calligraphy handwriting and relaxation training in Chinese nasopharyngeal carcinoma patients: a randomized controlled trial. Int J Nurs Stud 2010;47:550–9.
[44] Wang LN, Tao H, Zhao Y, Zhou YQ, Jiang XR. Optimal timing for initiation of biofeedback-assisted relaxation training in hospitalized coronary heart disease patients with sleep disturbances. J Cardiovasc Nurs 2014;29:367–76.
[45] Toth M, Wolsko PM, Foreman J, Davis RB, Delbanco T, Phillips RS, et al. A pilot study for a randomized, controlled trial on the effect of guided imagery in hospitalized medical patients. J Altern Complement Med 2007;13:194–7.
[46] Ducloux D, Guisado H, Pautex S. Promoting sleep for hospitalized patients with advanced cancer with relaxation therapy: experience of a randomized study. Am J of Hosp Palliat Med 2013;30:536–40.
[47] Zimmerman L, Nieveen J, Barnason S, Schmaderer M. The effects of music interventions on postoperative pain and sleep in coronary artery bypass graft (CABG) patients. Sch Inq Nurs Pract 1996;10:153–70. [discussion 171-4].
[48] Hajibagheri A, Babaii A, Adib-Hajbaghery M. Effect of Rosa damascene aromatherapy on sleep quality in cardiac patients: a randomized controlled trial. Complement Ther Clin Pract 2014;20:159–63.
[49] Otaghi M, Qavam S, Norozi S, Borji M, Moradi M. Investigating the effect of lavender essential oil on sleep quality in patients candidates for angiography. Biomed Pharm J 2017;10:473–8.
[50] Soden K, Vincent K, Craske S, Lucas C, Ashley S. A randomized controlled trial of aromatherapy massage in a hospice setting. Palliat Med 2004;18:87–92.
[51] Smith MC, Kemp J, Hemphill L, Vojir CP. Outcomes of therapeutic massage for hospitalized cancer patients. J Nurs Scholarsh 2002;34:257–62.
[52] Liu C, Xie H, Zhang X, Yu Y, Zhang X, Sun Y, et al. Health related management plans improve sleep disorders of patients with chronic liver disease. Int J Clin Exp Med 2015;8:9883–9.
[53] McDowell JA, Mion LC, Lydon TJ, Inouye SK. A nonpharmacologic sleep protocol for hospitalized older patients. J Am Geriatr Soc 1998;46:700–5.
[54] Kim YS, Lee SH, Jung WS, Park SU, Moon SK, Ko CN, et al. Intradermal acupuncture on shen-men and nei-kuan acupoints in patients with insomnia after stroke. Am J Chin Med 2004;32:771–8.
[55] Lee SY, Baek YH, Park SU, Moon SK, Park JM, Kim YS, et al. Intradermal acupuncture on shen-men and nei-kuan acupoints improves insomnia in stroke patients by reducing the sympathetic nervous activity: a randomized clinical trial. Am J Chin Med 2009;37:1013–21.
[56] Borji M, Otaghi M, Salimi E, Sanei P. Investigating the effect of performing the quiet time protocol on the sleep quality of cardiac patients. Biomed Res 2017;28:7076–80.
[57] Bartick MC, Thai X, Schmidt T, Altaye A, Solet JM. Decrease in as-needed sedative use by limiting nighttime sleep disruptions from hospital staff. J Hosp Med 2010;5:E20–4.
[58] Dave K, Qureshi A, Gopichandran L. Effects of earplugs and eye masks on perceived quality of sleep during night among patients in intensive care units. Asian J of Nurs Educ Res 2015;5:319–22.
[59] Mashayekhi F, Rafati F, Arab M, Abazari F, Rafiei H. The effects of earplug on perception of sleep in patients of coronary care unit (CCU) educators. Middle East J of Nurs 2013;7:3–8.
[60] Jones C, Dawson D. Eye masks and earplugs improve patient's perception of sleep. Nurs Crit Care 2012;17:247–54.
[61] Kamdar BB, Combs MP, Colantuoni E, King LM, Niessen T, Neufeld KJ, et al. The association of sleep quality, delirium, and sedation status with daily participation in physical therapy in the ICU. Crit Care 2016;20.
[62] Shilo L, Dagan Y, Smorjik Y, Weinberg U, Dolev S, Komptel B, et al. Effect of melatonin on sleep quality of COPD intensive care patients: a pilot study. Chronobiol Int 2000;17:71–6.
[63] Andrade C, Srihari BS, Reddy KP, Chandramma L. Melatonin in medically ill patients with insomnia: a double-blind, placebo-controlled study. J Clin Psychiatry 2001;62:41–5.
[64] Engwall M, Fridh I, Johansson L, Bergbom I, Lindahl B. Lighting, sleep and circadian rhythm: an intervention study in the intensive care unit. Intensive Crit Care Nurs 2015;31:325–35.
[65] Fukuda F, Kobayashi R, Kohsaka M, Honma H, Sasamoto Y, Sakakibara S, et al. Effects of bright light at lunchtime on sleep of patients in a geriatric hospital II. Psychiatry Clin Neurosci 2001;55:291–3.
[66] Wakamura T, Tokura H. Influence of bright light during daytime on sleep parameters in hospitalized elderly patients. J Physiol Anthropol Appl Human Sci 2001;20:345–51.
[67] Kobayashi R, Fukuda N, Kohsaka M, Sasamoto Y, Sakakibara S, Koyama E, et al. Effects of bright light at lunchtime on sleep of patients in a geriatric hospital I. Psychiatry Clin Neurosci 2001;55:287–9.
[68] De Rui M, Middleton B, Sticca A, Gatta A, Amodio P, Skene DJ, et al. Sleep and circadian rhythms in hospitalized patients with decompensated cirrhosis: effect of light therapy. Neurochem Res 2015;40:284–92.
[69] Okajima I, Inoue Y. Efficacy of cognitive behavioral therapy for comorbid insomnia: a meta-analysis. Sleep Biol Rhythms 2018;16:21–35.
[70] Duffy JF, Wright Jr. KP. Entrainment of the human circadian system by light. J Biol Rhythms 2005;20:326–38.
[71] Satlin A, Volicer L, Stopa EG, Harper D. Circadian locomotor activity and core-body temperature rhythms in Alzheimer's disease. Neurobiol Aging 1995;16:765–71.
[72] Khalsa SB, Jewett ME, Cajochen C, Czeisler CA. A phase response curve to single bright light pulses in human subjects. J Physiol 2003;549:945–52.
[73] Alessi CA, Martin JL, Webber AP, Alam T, Littner MR, Harker JO, et al. More daytime sleeping predicts less functional recovery among older people undergoing inpatient post-acute rehabilitation. Sleep 2008;31:1291–300.
[74] Cheuk DK, Yeung WF, Chung KF, Wong V. Acupuncture for insomnia. Cochrane Database Syst Rev 2012(9):Cd005472.
[75] Auld F, Maschauer EL, Morrison I, Skene DJ, Riha RL. Evidence for the efficacy of melatonin in the treatment of primary adult sleep disorders. Sleep Med Rev 2017;34:10–22.
[76] Girschik J, Fritschi L, Heyworth J, Waters F. Validation of self-reported sleep against actigraphy. J Epidemiol 2012;22:462–8.
[77] Lockley SW, Skene DJ, Arendt J. Comparison between subjective and actigraphic measurement of sleep and sleep rhythms. J Sleep Res 1999;8:175–83.
[78] Young T, Rabago D, Zgierska A, Austin D, Laurel F. Objective and subjective sleep quality in premenopausal, perimenopausal, and postmenopausal women in the Wisconsin sleep cohort study. Sleep 2003;26:667–72.
[79] Zeitlhofer J, Schmeiser-Rieder A, Tribl G, Rosenberger A, Bolitschek J, Kapfhammer G, et al. Sleep and quality of life in the Austrian population. Acta Neurol Scand 2000;102:249–57.
[80] Lou P, Qin Y, Zhang P, Chen P, Zhang L, Chang G, et al. Association of sleep quality and quality of life in type 2 diabetes mellitus: a cross-sectional study in China. Diabetes Res Clin Pract 2015;107:69–76.
[81] Marino M, Li Y, Rueschman MN, Winkelman JW, Ellenbogen JM, Solet JM, et al. Measuring sleep: accuracy, sensitivity, and specificity of wrist actigraphy compared to polysomnography. Sleep 2013;36:1747–55.