Early Human Development xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Early Human Development

journal homepage: www.elsevier.com/locate/earlhumdev

How to improve sleep in a neonatal intensive care unit: A systematic review

ARTICLE INFO

Keywords:
Sleep
Neonate
NICU

ABSTRACT

There is increasing evidence that sleep plays a major role in the development of neural pathways in the neonatal brain. Several studies have suggested evidence-based approaches to improve sleep for infants admitted to the neonatal intensive care unit (NICU); however, in many neonatal centers very few of these strategies seem to be implemented in routine care.

Objective: To systematically review the literature to determine interventions promoting neonatal sleep on the NICU, in order to develop key guidelines to improve neonatal sleep.

Methods: A systematic search was conducted according to the criteria of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement for conducting and reporting systematic reviews. The search was performed in Pubmed, CINAHL and the Cochrane Library on 19 September 2016 and again on 28 January 2017.

Results: In total, fourteen studies were included (10 RCT's and three quasi-experimental study designs): four studies were of high quality, eight of moderate quality and two of low quality. Two studies investigating kangaroo care reported significant effect on infant sleep behavior, two studies comparing Yakson and Gentle Human Touch (GHT) found significant effect on behavioral states and one study reported an increase in sleep behavior using different sleep surfaces. One study showed a significant effect on sleep patterns using music as an intervention and one study showed no significant effect using music. Two studies showed no significant effect on infant sleep using cycled light and different types of LED-light and one study showed significant effect of cycled lightning. There were no effects of Neonatal Individualized Developmental Care Program (NIDCAP) or massage therapy.

Conclusion: Although many different interventions have been reported to promote sleep in infants who require intensive care, there is great heterogeneity across studies: the methods of sleep assessment, the targeted sleep behaviors, and the study populations vary significantly across published reports. Based on the results there seems to be insufficient evidence to recommend any new intervention to promote neonatal sleep on the NICU. However because of the importance of sleep for the development of the neonatal brain we do suggest some key guidelines based on moderate evidence, expert opinion and parental values to improve sleep on the NICU and to direct future neonatal sleep studies.

1. Introduction

Neonates spend most of their time sleeping. During late fetal and early neonatal stages of human development, the primary activity of the brain is to sleep. Sleep plays a predominant role in body temperature regulation and energy saving [1,2]. Furthermore spontaneous generated activity during neonatal rapid eye movement (REM) sleep, such as twitching [3], seems vital in self-organization of central nervous system circuits and somatotopic maps [4]. Hence, sleep at the behavioral level is a process of neuronal restitution and detoxification at the cellular level, and the most important behavioral state of neonates, particularly in preterm ones. The importance of (REM) for fetal and neonatal brain maturation has been shown in animal models, Mirmiran showed that a lack of (REM) sleep in the early stages of brain development leads to behavioral problems, sleep disturbances and reduced cerebral cortical size [5].

During neonatal sleep, different sleep/wake stages can be distinguished according to the American Academy of Sleep Medicine: wakefulness (W), wakefulness/sleep transitions, non-rapid eye movement (NREM) sleep (N), REM sleep (R), and transitional sleep (T) [6]. Other terminology used in studies include, active sleep (AS) the equivalent of REM sleep seen in older children and adults [7], quiet sleep (QS) resembling NREM sleep [8] and indeterminate sleep (IS) [9]. The percentage of time spent in each sleep stage differs throughout the development and follows a strict orderly sequence [10].

Critically ill neonates admitted to the neonatal intensive care unit (NICU), especially infants born preterm, are known to be at risk for abnormal brain development. Outside the protective surroundings of the mother's womb their rapid growing brains are especially vulnerable. The high incidence of brain injury is multifactorial (e.g. hypoxia, hyperoxia, inflammation, etc.) [11]. To enhance early neonatal development in the NICU

http://dx.doi.org/10.1016/j.earlhumdev.2017.07.002

surroundings, several care strategies have been investigated. Optimizing opportunities for sleep has been amongst these strategies. In the hectic NICU surroundings, light, invasive procedures, noise and care giving activities are known to disturb neonatal sleep and as such are hypothesized to have an additional negative impact on the vulnerable brain [12].

Since the rate of neonates in need of intensive care due to prematurity or other critical illnesses is increasing worldwide, meeting the developmental needs of such neonates is of utmost public health importance. In an intensive care setting, the need for treatment of critical illness with medications, procedures, and other interventions may supersede considerations of a newborn infant's sleep needs. Yet, prioritizing sleep whenever possible could provide a novel neuroprotective strategy for this vulnerable patient population. Our primary aim was to systematically analyze the current evidence on interventions regarding sleep in neonates who require intensive care. We performed a systematic literature review in order to determine evidence on interventions to promote neonatal sleep on the NICU. Our second aim was to deduce several 'key guidelines' based on the positive results, as well as the limitations of these studies.

2. Methods

2.1. Design

A systematic search was conducted according to the criteria of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement for conducting and reporting systematic reviews [13]. The search was conducted in Pubmed and CINAHL on the 19 September 2016 and again on 28 January 2017. The Cochrane library was searched for recent reviews on the promotion of sleep in neonates.

2.2. Search strategy

Medical subject headings (MeSH) 'Sleep', 'circadian rhythm', 'infant, newborn', 'intensive care, neonatal', 'intensive care units, neonatal' and 'neonatal nursing' and keywords 'sleep', 'circadian rhythm' or 'circadian rhythms', 24 h rhythm', 'ultradian rhythm', 'diurnal rhythm', 'nyctohemeral rhythm ', 'sleep wake state', 'sleep wake cycle', 'circadian rhythmicity', '24 h rhythmicity', 'newborn', 'neonate', 'premature', 'preterm' and 'low birth weight infant' were used to perform the search (see Appendix A for the full search strategy in all databases).

2.3. Inclusion criteria

The search results were screened by two researchers (CT and AvdH) on titles and abstract. The titles and abstract were screened after the removal of duplicates.

All articles in English, French, Spanish or Dutch were eligible. Studies were included when the study population consisted of neonates admitted to a NICU and if the primary or secondary outcome was related to sleep. Animal studies were excluded. The remaining articles were included based on study design and publication year, with only randomized controlled trials, randomized quasi-experimental trials and articles published after 1990 (since then major technological interventions were introduced in neonatal care).

2.4. Data extraction

It was not possible to perform a meta-analysis, due to the diversity in interventions and disparate primary outcomes. Therefore, study design, study population, aim, intervention, outcome and the methodological quality assessment were used and included as data.

2.5. Methodological quality

The methodological quality of each article was assessed based on the Cochrane handbook for Systematic Reviews [14]. Each article was assessed for selection bias, performance bias, detection bias, attrition bias and reporting bias (see Table 3 for full assessment). An article was assessed on a total of eight criteria where a maximum of eight points could be obtained. The criteria were scored with either a plus sign (+), minus sign (−), question mark (?) or 'NA'. A plus sign was scored if there was sufficient information present about the criterion, a minus sign was scored when there was no information available about a criterion and a question mark was scored when there was insufficient information about a criterion. When a criterion was not applicable 'NA' was noted. Two researchers each assessed all articles independently. The differences in the scores were discussed until consensus was reached. Given the types of interventions presented in these studies, it was never possible to blind the participants and personnel. Therefore, the decision was made to score the studies on a scale of 0 to 7, rather than 8. A score of 0–3 points is regarded as low quality, a score of 4–5 as moderate quality and a score of 6–7 as high quality.

2.6. Synthesis

Given the heterogeneity of outcome and interventions of the included studies it was not possible to pool the results in a meta-analysis and we therefore performed a best evidence synthesis to present a narrative summary of the data.

3. Results

3.1. Study selection

In total 7737 records were found in Pubmed and CINAHL. After removing the duplicates, 7713 articles were screened for eligibility based on language, study population, outcome or full text availability. This screening resulted in 54 articles. These articles were assessed on design and publication year. The remaining fifteen articles were randomized controlled trials published after 1990. The full text of one article could not be found and not obtained even when contacting the first author [15], so fourteen articles were ultimately included for this systematic review [16–29] (Fig. 1).