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Sleep of preterm neonates under developmental care or regular environmental conditions

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Abstract Sleep is the main behavioral state of the premature infant. In adult intensive care units, sleep deprivation has been reported as one of the major stressors. Developmental care (DC) aims to decrease stressful events in neonatal intensive care unit and support well-being.
Aim: To assess whether DC is accompanied by changes in sleep in preterm neonates.
Methods: A prospective cross-over study included 33 preterm neonates [mean (S.D.): gestational age: 29.3 (1.8) weeks; birth weight: 1245 (336) g]. Polysomnography was performed in two randomly ordered 3-h periods with and without DC. A blinded electrophysiologist analyzed sleep. The total sleep time (TST) was the primary outcome, duration of active (AS), quiet (QS) and indeterminate sleep, and latency before sleep were the secondary outcomes. Non-parametric Wilcoxon tests and ANOVA were used.
Results: In DC condition vs. control: TST increased [in minutes, mean (S.E.M.): 156.2 (2.9) vs. 139.2 (4.6), p=0.002], with increase in AS [86.6 (3.7) vs. 77.0 (4.2), p=0.024] and in QS [47.1 (4.1) vs. 36.9 (4.2), p=0.015], and sleeping latency decreased (2.1 (0.7) vs. 10.5 (2.0), p=0.0005].
Conclusion: DC promoted sleep in our study. The impact of DC on the neuro-behavioral outcome needs futures studies.

1. Introduction

Sleep is the main behavioral state of the premature infant. Three states are distinguished: active sleep (AS), quiet sleep (QS) and indeterminate sleep (IS). The presumptive roles of AS or rapid-eye-movement (REM) sleep include CNS maturation and differentiation, consolidation of memory and learning and support for emotional behavior patterns [1,2]. The QS or non-REM sleep is associated with energy maintenance, increase in the synthesis of proteins and release of growth hormone [1].

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In adult and pediatric intensive care units (ICU), sleep deprivation has been reported as one of the major stressors by patients, families and staff [3,4]. In fact, severe sleep fragmentation has been observed, with a high frequency of arousals and awakenings and daytime sleepiness [5,6]. Moreover, animal studies suggest that sleep deprivation in the neonatal period has short- and long-term negative impact on breathing patterns, brain development and behavior [7—9]. Thus, it is hypothesised that sleep deprivation in the neonatal period could be associated with medical and developmental disturbances.

Neonatal developmental care (DC) includes environmental and behavioural strategies aimed to decrease environmental stressful events and to promote harmonious neurobehavioral maturation, including protection of sleep periods [10]. Nevertheless, the impact of DC on sleep in preterm neonates is unknown.

The objective of this study was to determine the impact of developmental care on sleep in preterm neonates hospitalized in a neonatal ICU (NICU).

2. Methods

This prospective study was conducted in a level-III, 12 single room NICU. The entry criteria for this study were gestational age lower than 32 weeks, hospitalization in the NICU and spontaneous ventilation without CPAP support. The exclusion criteria were congenital abnormalities, abnormal neurological findings including intraventricular hemorrhage greater than grade II, fetal drug exposure and administration of sedating agent (midazolam, fentanyl) in the last 24 h.

The study was a prospective and cross-over design, each infant serving as his own control for two consecutive 180-min periods with and without developmental care. Each infant was randomly assigned to receive either developmental care or no developmental care during the first experimental period. Each infant stayed in his own room and incubator during the experimental period. Each experimental period started at 8:00 a.m. at the end of the tube feeding. Tube feeding was time-based and not on demand. Lateral posture was used and the thermal environment was constant in both conditions. No parents were present during the experimental period.

The developmental cares were provided by regular nurses using components of the Neonatal Individualized Developmental Care and Assessment Program (NIDCAP®) described by Als et al. [11]: decreasing direct light by covering the incubator, decreasing environmental noise by closing the room door, using supportive bedding for head, back and feet, and promoting state transition to sleep by hand swaddling, non-nutritive sucking, or grasping. The control method was modeled on the approach used before the implementation of NIDCAP in the NICU (2000): no specific protection from the natural light of the day, opened room door (sound level depending of the unit's activity), no supportive bedding and no individualized attention to the behavioral cues of the baby.

The study was approved by the Institutional Research Ethics Committee and written informed consent was obtained from all parents of studied infants.

Sleep states were recorded using a computer polysomnographic recording (Nicolet® Alliance TM NT; France) with eight channels for the electroencephalography, two channels for the electro-oculography, one channel for the heart rate and one channel for the respiratory rate. Transducers were set up on the newborn before the tube feeding and sleep recording started just after feeding. Sleep states were analyzed and coded by 20-s epoch by a trained electrophysiologist (DM) unaware of the experimental condition. Sleep states were defined as [12]:

- Active sleep (AS): continuous EEG pattern and presence of eye movements;
- Quiet sleep (QS): discontinuous EEG pattern and absence of eye movement;
- Indeterminate sleep (IS): incomplete criteria or belonging to the two states.

Latency before sleep was characterized by the time between the starting of sleep monitoring and the first sleep state. Awakening was defined as change from a sleep state (AS, QS or IS) to a wake state of more than 60 s. Apnea was defined as the absence of breathing movement for at least 3 s and symptomatic apnea as apnea associated with bradycardia (heart rate below 90 beats/min) or hypoxemia (oxygen saturation lower than 90%).

The primary outcome measure was the total sleep time duration (TST). Secondary outcome measures were the duration of each specific sleep states (QS, AS, IS), the relative duration of QS, AS and IS, the duration of the longest period of uninterrupted QS, the latency before sleep, the number of transition between sleep states, the number of awakening and the number of apneas. To