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Effects of the hammock method on preterm newborns: systematic review and meta-analysis


Abstract. Premature birth is caused by a diversity of factors and leads to respiratory, heart, motor, and metabolic disorders due to the immaturity of body organs. The proper positioning of a premature newborn is a highly beneficial non-pharmacological intervention. The hammock method is based on synactive theory and leads to improvements in physiological variables, behavioral organization, and the harmonization of movements. The aim of the present systematic review and meta-analysis was to evaluate the effects of the hammock method on vital signs, pain/stress, and behavioral state of preterm newborns. A search was performed for clinical trials that compared the hammock method to other techniques in preterm newborns. This review was conducted following the PRISMA guidelines and only included articles reporting clinical and quasi-experimental trials conducted in the neonatal intensive care unit with preterm newborns using the Hammock method as the main intervention. Eight articles composed the qualitative analysis and four of these articles composed the meta-analysis. The hammock method proved to be viable and promising for the reduction in pain/stress as well as improvements in the behavioral state of preterm newborns.

Keywords: premature newborn; neonatal intensive care unit; therapeutic position; review

Introduction

Children born with a gestational age of less than 37 weeks are considered preterm newborns1. Premature birth is caused by a diversity of factors and leads to respiratory, heart, motor, and metabolic disorders due to the immaturity of body organs. When intrauterine development is interrupted, premature children lose the containing protection of the womb and do not have the physiological maturity to counteract the force of gravity. Consequently, these infants adopt an extended position when in dorsal decubitus, which further hinders adaptation to the environment2,3.

There has been an increase in the survival rate of premature infants at neonatal intensive care units (NICUs), but these children are submitted to diverse interventions that have harmful effects, such as stress, pain, and exposure to both ambient noise and light, causing further clinical instability. The positioning of a preterm newborn is a highly beneficial non-pharmacological intervention when performed properly and makes up part of neuroprotective care. In contrast, inadequate positioning can increase stress and pain as well as delay neuromotor development4.

Proper positioning and the changing of decubitus has a series of benefits, such as the promotion of the adequate alignment of the body to the midline, improvements in lung function, the ventilation/perfusion ratio, motor development, and the flexor pattern, the prevention of muscle shortening, a reduction in stress and pain, the regulation of behavioral and sleep/awake states, and the adequate experience of gravitational pressure on the joints and muscles, facilitating coordinated, more symmetrical movements.

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Compared to the intrauterine environment, however, positioning does not provide all the sensory experiences necessary for adequate development, such as the vestibular experience. Thus, the hammock method can be employed.\(^1\)\(^,\)\(^5\)

The hammock method involves tying the corners of the fabric to the corners of the incubator, simulating intrauterine containment and movements to enable postural organization, harmonization of movements, as well as reductions in painful stimuli and energy expenditure. This is a humanized care strategy to enhance comfort and neuroprotection\(^5\)\(^,\)\(^6\).

The benefits of the hammock method are reported in the literature and there has been increasing use of this method for preterm newborns at NICUs. This technique improves the sleep/awake state, behavior, and both motor and respiratory development while minimizing the negative effects of physical handling, increasing the survival rate, and shortening the stay in the NICU\(^3\). The aim of the present study was to perform a qualitative (systematic) and quantitative (meta-analysis) evaluation of the effects of the hammock method on pain/stress, vital signs, and behavioral state in preterm newborns.

**Materials and methods**

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) were used to report the review process. Studies that evaluated the impact of the hammock method on preterm newborns in the NICU published since the inception of the database were identified. The published protocol can be accessed through the PROSPERO registry (CRD 42020187600). The quality of the evidence was appraised using the GRADE approach to determine the strength of the results and conclusions.

**Search strategy**

Searches were conducted in the Cochrane, Embase, SciELO, LILACS, PEDro, PubMed, and Scopus databases for clinical studies comparing the hammock method to other methods for preterm newborns. Searches were conducted between October 2019 and July 2020 by two independent researchers using the following combination search terms: “Hammock positioning” OR “patient positioning” OR “Hammocks” OR “Hammock” OR “Rede de Descanso”. After the reading of the titles and abstracts, only articles reporting randomized, controlled, clinical trials and quasi-experimental studies conducted in the NICU with preterm newborns using the Hammock method as the main intervention were included. No restrictions were imposed regarding the date of publication (Fig. 1).

**Eligibility criteria**

Articles that met the inclusion criteria were read in full and the following data were extracted: title, author, year of publication, and the hammock method on preterm newborns in the NICU published since the inception of the database were identified. The published protocol can be accessed through the PROSPERO registry (CRD 42020187600). The quality of the evidence was appraised using the GRADE approach to determine the strength of the results and conclusions.
cation, study design, outcomes, and main results. Articles that did not adequately specify the intervention and those with no information on the outcomes of interest were excluded.

**Appraisal of risk of bias**

The risk of bias of the selected articles was appraised with the aid of the PEDro tool. The following items were considered: eligibility criteria, randomized allocation, allocation concealment, compatibility of baseline data, blinding of patients, blinding of therapists, blinding of evaluators, adequate follow-up (acceptable loss up to 20 %), intention-to-treat analysis, inter-group comparison, point estimates and variability.

**Ongoing studies**

The following five randomized studies were ongoing:

Electromyographic Activity of Preterm Newborns Submitted to Hammock Positioning Brasilia, DF — BRAZIL. A randomized, clinical trial with the aim of analyzing the effects on electromyographic activity in premature newborns placed in a hammock compared to premature newborns not placed in this position with evaluations before and after the intervention. Predicted completion: Oct. 2017. https://ich-gcp.net/clinical-trials-registry/NCT02668107

Hammock Positioning’s Influence on the Electromyographic Activity in the Flexor Muscles in Newborn Preterm Recife, PE — BRAZIL. Randomized, double-blind study with 20 premature participants with the aim of analyzing the influence of hammock positioning in the incubator on muscle tone through the Dubowitz neurological examination and electrical activity of the rectus abdominis, biceps, and hamstring muscles through electromyography approximately 8 hours during the day for two days with three evaluations. Predicted completion: Jun/2016. https://clinicaltrials.gov/ct2/show/NCT02621996

Effects of Hammock Method in incubator on pain, sleep state and heart rate of premature newborns admitted to the Neonatal Intensive Care Unit — Pelotas, RS — BRAZIL. Randomized, controlled, triple-blind trial with 20 premature participants with the aim of assessing the effect of the hammock method. The infants were placed in lateral decubitus in one study and in the supine position in all other studies. The primary outcomes were pain, behavioral state, and vital signs.

**Results**

After the analysis of the eligibility of the articles retrieved during the searches of the databases, eight composed the final sample of the present systematic review, five of which were crossover studies. The studies involved samples of 15 to 40 premature infants (gestational age: 27 to 36 weeks) submitted to the hammock method. Five studies compared the hammock and nest methods (Table 1) and three compared the hammock method to other techniques, such as “kanga-roo mother” (Table 2). Daily interventions were performed ranging from 15 minutes to three hours per day. The infants were placed in lateral decubitus in one study and in the supine position in all other studies. The primary outcomes were pain, behavioral state, and vital signs.

**Studies included**

Eight clinical trials were included in the present review, only three of which were randomized. The articles reported one or more of the outcomes of interest defined in the protocol of the present systematic review. Three were parallel studies and five were crossover studies.

**Quantitative analysis**

After the establishment of similarities among the results of the randomized clinical trials, four significant outcomes related to the hammock method were selected: heart rate (HR), Brazelton’s Neonatal Behavioral Assessment Scale.
(NBAS), pain assessment (Neonatal Facial Coding System [NFCS]), and peripheral oxygen saturation (SpO₂).

**Heart rate**

Three studies composed the quantitative analysis of HR, with a total of 53 patients in the hammock group and nest group. No statistically significant difference in this outcome was found between groups.

**Brazelton’s Neonatal Behavioral Assessment Scale**

For the NBAS, 43 patients were in the hammock and nest groups. The hammock method achieved better results regarding behavioral state (Fig. 2).

### Pain assessment

For the NFCS, 33 patients were in the hammock and nest groups. The pain score was lower in the hammock group compared to the nest group (Fig. 3).

### Oxygen saturation

For SatO₂, 53 patients were in the hammock and nest groups. The forest plot shows no statistically significant difference between groups for this outcome.

### Risk of bias in studies

The risk of bias was appraised using the PEDro scale. The scores ranged from 3 to 7 points (out of a total of 10).

### Table 1. Characteristics of studies included in present systematic review comparing hammock to nest method (n = 5)

<table>
<thead>
<tr>
<th>Author/ year/type of study</th>
<th>Participants/PEDro score</th>
<th>Outcomes</th>
<th>Intervention</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keller et al., 2003 RCT</td>
<td>20 premature infants Hammock = 10 Nest = 10 (gestational age: 31 weeks)</td>
<td>— Heart rate — Respiratory rate — Weight gain — Neuromuscular</td>
<td>Hammock: Premature infants were placed in supine position for three hours daily in the morning period for 10 consecutive days; cloth cushions were used in the incubator to avoid back flexion and negative effects on gas exchange. Nest: Premature infants placed in ventral decubitus for same period of time as hammock group</td>
<td>No differences in clinical variables between groups. Hammock group had significantly lower HR and respiratory rate and exhibited greater progress in neuromuscular maturity compared to nest group. No significant difference between groups regarding weight gain</td>
</tr>
<tr>
<td>Costa et al., 2016 Quasi-experimental Crossover</td>
<td>30 premature infants All participants received hammock and nest interventions (gestational age: 32 to 35 weeks)</td>
<td>— Position — Stress — Behavioral organization</td>
<td>Intervention occurred in four phases: diaper change — Nest intervention (40 min) — new diaper change after three hours — hammock intervention (40 min). Hammock and nest: right lateral decubitus, head on midline, sensor of oximeter on right hand, pillow in scapular region, and reduction in light with cloth; duration: 40 minutes. Vital signs recorded 10, 20 and 40 minutes. Filming at 1 minute</td>
<td>Premature infants placed in hammock experienced less stress compared to nest group, had fewer defining characteristics indicating “disorderly infant behavior” (nursing diagnosis), and remained in more adequate position to receive intensive care</td>
</tr>
<tr>
<td>Queiroz et al., 2017 CCT</td>
<td>20 premature infants All participants received hammock and nest interventions (mean gestational age: 32 weeks)</td>
<td>— Vital signs — Pain</td>
<td>Performed in four phases with evaluations before and after each intervention. Hammock: Premature infants placed with rolls in neck and scapular region (duration: 40 minutes). Nest: In prone position, premature infants were positioned using cushions in form of rolls, hands close to face, upper and lower limbs flexed</td>
<td>In comparison of initial and final values for each variable between prone and hammock interventions, significant improvements were found in SpO₂ and pain, but no significant difference was found between interventions</td>
</tr>
<tr>
<td>Costa et al., 2019 Crossover RCT</td>
<td>20 premature infants All participants received hammock and nest interventions (gestational age: 32 to 36 6/7 weeks)</td>
<td>— Sleep/awake — Heart rate — SpO₂</td>
<td>Both interventions occurred after diaper change in six phases and involved scapular cushions. Hammock: Premature infants placed in hammock in incubator. Nest: Premature infants positioned in nest in “O” shape</td>
<td>No statistically significant difference between conditions studies. However, a difference was found in the hammock group between the phases of the study regarding the sleep variable</td>
</tr>
</tbody>
</table>
Among the clinical trials, two were non-randomized, three were randomized, one was non-controlled, and three were quasi-experimental. The risk of bias was due to the non-blinding of the subjects and therapists. Only two studies involved blinded evaluators. Two studies had losses during follow-up. Four studies presented baseline data. Two studies did not perform inter-group comparisons (Table 3).

**Discussion**

The use of a hammock in the premature infant incubator achieves better results in comparison to other decubitus positioning methods, especially the nest method, with regards to pain and neuromotor behavior outcomes.

The participants were in the NICU in all studies included in the present review. The exclusion criteria in most studies were hemodynamic instability, brain anomalies and neurological disorders, Grade II peri-intraventricular hemorrhage, apnea, fracture, having undergone painful procedures in the previous hour, congenital and facial malformations, congenital heart disease, being on ventilatory support, phototherapy, being in the immediate postoperative period, having received a surfactant in the previous 72 hours, and undergoing continuous sedation. These exclusion criteria may have been established to avoid secondary events during the course of the interventions.

Preterm newborns undergo diverse procedures in the NICU due to procedures and handling that cause pain and stress, which are associated with morbidity and can have a long-term negative impact on numerous aspects. The studies in the present review assessed the pain outcome in this population. Comparing the hammock method to prone positioning, Queiroz et al. found that both interventions were beneficial with regard to pain and vital signs. In another study, which analyzed the hammock method with no comparison to any other intervention, the authors found no change in pain scores among the premature infants, but reported that not having a control group constituted a limitation of the study. Ribas et al. analyzed pain comparing the hammock and nest methods in premature infants in lateral decubitus, concluding that the use of non-pharmacological methods, such as a hammock, relieves pain, promotes clinical stability, and improves homeostasis.

The tactile threshold and inhibitory pathways are immature in premature infants, making them more sensitive to pain. Responses to pain stimuli begin in peripheral nociceptive pathways that manifest with spontaneous movements generated by the processing of this stimulus in the cortex. Nociceptors respond to mechanical, thermal, and chemical stimuli after the birth of the child and undergo changes with age. However, this modulation of nociceptive inputs occurs in the spinal cord. At the onset of development in preterm newborns, there is excessive excitation and a delay in the development of local descending inhibition, which generates a neonatal spinal reflex with a very low threshold, meaning that the reflex response is evoked by a less intense stimulus.

Neonatal pain is directly associated with the repetitive stress to which premature infants are exposed in the NICU due to procedures and handling, which should

<table>
<thead>
<tr>
<th>Author/year/ type of study</th>
<th>Participants/ PEDro score</th>
<th>Outcomes</th>
<th>Intervention</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zanardo et al., 1995</td>
<td>15 premature infants</td>
<td>SpO₂</td>
<td>All participants had bronchopulmonary dysplasia and were placed in condition sleeping or awake without sedation in continuous flow nasal cannula; SpO₂ evaluated before, during, and after intervention. Each test lasted 15 minutes</td>
<td>Premature infants bronchopulmonary dysplasia exhibited worsening of SpO₂ in hammock positioning; pre-hammock and post-hammock posture comparable but no significant difference in confidence level</td>
</tr>
<tr>
<td>CT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not controlled</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pereira et al., 2018</td>
<td>40 premature infants</td>
<td>— Stay in NICU — Weight gain</td>
<td>Hammock: Premature infants in dorsal decubitus in cotton hammock in incubator once per day until discharge from NICU. MMC: Premature infants kept skin to skin with mother with little clothing</td>
<td>No statistically significant difference between groups regarding stay in NICU, but weight gain was greater in hammock group</td>
</tr>
<tr>
<td>Quasi-experimental</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jesus et al., 2016</td>
<td>28 premature infants</td>
<td>— Pain — Vital signs — Behavior</td>
<td>All participants were positioned in supine position on cloth hammock for 60 minutes with cushion in scapular region</td>
<td>Statistically significant reduction in HR and respiratory rate from two to 60 minutes in hammock group, which was maintained afterward. Regarding behavioral state, premature infants evolved progressively to light and deep sleep during hammock and SpO₂ remained within normal range; no significant changes in the pain score were found</td>
</tr>
<tr>
<td>Quasi-experimental</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Characteristics of studies included in present systematic review comparing hammock to other methods (n = 9)
be minimized in the first 72 h of life to avoid injuries and hemorrhages\textsuperscript{17}. Moreover, premature birth deprives the infant of a contained, flexor position with vestibular stimuli in a fluid medium\textsuperscript{1}. The less developed motor system has to overcome the gravity of the environment, which hinders adequate positioning\textsuperscript{8}. The maintenance of a proper position provides control of the sleep/awake state and self-regulation, improves cardiorespiratory function, and requires less energy expenditure, resulting in lower stress\textsuperscript{8}.

In preterm newborns, muscle tone evolves from a global state of hypotonus to hypertonus. The onset of flexion occurs with the increase in age — always in the caudocranial direction, with the flexors developing later than the extensors.

Table 3. Appraisal of methodological quality of articles included in present systematic review using PEDro scale

<table>
<thead>
<tr>
<th>Study</th>
<th>Keller et al., 2003</th>
<th>Costa et al., 2016</th>
<th>Queiroz et al., 2017</th>
<th>Costa et al., 2019</th>
<th>Jesus et al., 2016</th>
<th>Pereira et al., 2018</th>
<th>Ribas et al., 2019</th>
<th>Zanardo et al., 1995</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eligibility criteria were specified</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received)</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Allocation was concealed</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>The groups were similar at baseline regarding the most important prognostic indicators</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>There was blinding of all subjects</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>There was blinding of all therapists who administered the therapy</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>There was blinding of all assessors who measured at least one key outcome</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Measures of at least one key outcome were obtained from more than 85 % of the subjects initially allocated to groups</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>All subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analysed by “intention to treat”</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>The results of between-group statistical comparisons are reported for at least one key outcome</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>The study provides both point measures and measures of variability for at least one key outcome</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Total/10</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>7</td>
<td>7</td>
<td>3</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

Figure 2. Forest Plot — Brazelton’s Neonatal Behavioral Assessment Scale (NBAS)

Figure 3. Forest Plot — Pain assessment (NFCS)
The state of behavioral organization was evaluated by disorganized infant behavior in the study by Costa et al. (2016)\(^9\), which is based on synaesthetic theory considering five subsystems: autonomic/physiological, regulation problems, attention/interaction system, organization system, and behavioral state/motor system. These are key aspects of neonatal self-regulation and interactions between the newborn and the environment\(^11\). Keller et al. also found evidence of synaesthetic theory and associated it with findings of greater neuromuscular maturity in premature infants when placed in a hammock, demonstrating the importance of position in the development of the central nervous system in this population\(^1\).

The development of the central nervous system is divided into six steps: neurulation, prosencephalic development, neural proliferation, neuronal migration, organization, and myelination. This organization has a peak period around the fifth month of gestation. When a premature infant grows in the NICU\(^1\), this environment induces impactful changes in the brain development pattern. Thus, neuroprotective care strategies are important and lead to positive results with regards to neurological development. Newborn individualized development care (NIDC) is based on seven principal measures (represented by lotus petals): healing environment in partnership with the family, positioning and handling, safeguarding sleep, minimizing stress and pain, protecting skin, and optimizing nutrition\(^20\).

One of the aims of the present systematic review was to determine the effect of the hammock method on the vital signs of premature infants. Seven studies included in the review\(^2, 3, 6, 9, 10, 12\) evaluated this outcome. In five of these studies\(^3, 9, 10, 12\), the infants were in the supine position in the hammock. Keller et al.\(^1\) found reductions in HR and respiratory rate associated with a more relaxed condition when in the hammock. Jesus et al. also found a significant reduction in HR and respiratory rate, with the maintenance of \(\text{SpO}_2\) at normal levels\(^12\). Zanardo et al. only investigated \(\text{SpO}_2\) in 15 premature infants, all of whom had a diagnosis of bronchopulmonary dysplasia and exhibited a worsening of \(\text{SpO}_2\), with no significant difference in the pre-hammock/post-hammock comparison\(^10\). Costa et al. (2019) also found no significant difference in vital signs. In contrast,Ribas et al.\(^6\) found a reduction in HR and respiratory rate as well as an increase in \(\text{SpO}_2\) in premature infants in lateral decubitus, which maintained the newborns in a position of flexion and the head in a favorable position for the pulmonary mechanism, exerting a direct influence on \(\text{SpO}_2\)\(^21\).

Two other studies investigated weight gain as the outcome. Comparing the hammock and nest methods, Keller et al.\(^1\) found no significant difference in weight gain but explained this lack of difference by the short intervention time, as the hammock method promotes relaxation and less energy expenditure. The other study compared the hammock and kangaroo methods and also found no statistically significant difference in weight gain or stay in the NICU\(^11\).

One of the limitations of the present systematic review was the small number of studies on the hammock method for preterm newborns. Greater information is needed on measures and results regarding motor improvements in these patients. Future studies should perform more detailed motor assessments to make the practice of this type of intervention viable for healthcare providers who seek to improve the quality of life of premature infants and enhance neuroprotective care in the NICU.

### Quality of evidence

The quality of the evidence was appraised using the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) approach, which is used to classify the body of evidence on the outcome level rather than the study level. To determine the strength of the recommendation, GRADE considers key factors, such as the risk of bias, inconsistency, indirectness, publication bias, and other distortions. The classification of

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**Table 4. Results of GRADE analysis**

<table>
<thead>
<tr>
<th>N(^\circ) of studies</th>
<th>Study design</th>
<th>Risk of bias</th>
<th>Inconsistency</th>
<th>Indirectness</th>
<th>Impact of Other considerations</th>
<th>Absolute (95% CI)</th>
<th>Relative (95% CI)</th>
<th>Risk of bias</th>
<th>Inconsistency</th>
<th>Indirectness</th>
<th>Impact of Other considerations</th>
<th>Quality of evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Randomised trials</td>
<td>Very serious</td>
<td>Not serious</td>
<td>Not serious</td>
<td>-</td>
<td>Mean 1.44 (0.13 more to 2.75 more)</td>
<td>Mean 1.48 (0.16 more to 0.8 more)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>CRITICAL</td>
</tr>
<tr>
<td>2</td>
<td>Randomised trials</td>
<td>Very serious</td>
<td>Not serious</td>
<td>Not serious</td>
<td>-</td>
<td>Mean 1.44 (0.13 more to 2.75 more)</td>
<td>Mean 1.48 (0.16 more to 0.8 more)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>CRITICAL</td>
</tr>
</tbody>
</table>
quality has four levels of certainty in evidence: very low, low, moderate, and high. Interventions with a high level of certainty are strongly recommended. In the present systematic review and meta-analysis, a moderate level of certainty in the evidence was found for two outcomes: behavioral state (NBAS) and pain (NFCS) (Table 4).

Conclusions
The hammock method proved to be viable and promising for the reduction in pain/stress as well as the improvement in the behavioral state of preterm newborns. In contrast, no significant differences in heart rate or oxygen saturation were found in comparison to other intervention methods. Longitudinal studies are needed to confirm the neuroprotective importance of the hammock method as well as its effects on motor development in preterm newborns.

Conflicts of interests. Authors declare the absence of any conflicts of interests and their own financial interest that might be construed to influence the results or interpretation of their manuscript.

References

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Використання гамака в недоношенних немовлях: систематичний огляд і метааналіз

Резюме. Низка різноманітних чинників служать причиною недоношеності, що, у свою чергу, призводить до розвитку респіраторних, серцевих, метаболічних порушень, а також до рухової дисфункції у зв'язку з незрілістю органів. Належне позиціонування недоношеної дитини є високоекстективним нефармакологічним компонентом у догляді за таким дітям. Заостреної позиціонування гамака грунтується на синактивній теорії і вважається, сприяє поліпшенню фізіологічних показників, поведінкової організації та координації рухів. Мета цього систематичного огляду й метааналізу — оцінити вплив застосування гамака на життєві показники, біль/стрес, поведінку в недоношених немовлях. Були вивчені клінічні дослідження, в яких порівнювали ефективність гамака й інших методів у недоношених дітей. Цей огляд був проведений згідно з настановами PRISMA й включав статті лише про клінічні та квазі-експериментальні дослідження, проведені в умовах відділень реанімації для новонароджених з участю недоношених немовлят, у догляді за якими застосовували гамак як основний метод. За даними 8 статей був проведений якісний аналіз і за чотирма з них — метааналіз. Було доведено, що застосування гамака є доцільним і багатообіцяючим методом для зменшення білу/стресу, а також для поліпшення поведінкового статусу в недоношених немовлят.

Ключові слова: недоношені немовлята; відділення реанімації для новонароджених; терапевтичне позиціонування; огляд