**Title:** A Systematic Review of Positioning of Preterm Infants for Optimal Physiological Development.

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**Background:**

Premature infants are at risk for developmental delays. Due to immaturity, they often lack adequate muscle tone and are at risk for developing abnormal movement patterns as well as skeleton deformation. Some delays are related to improper body mechanics rather than neurological impairment. Hypotonia or decreased muscle tone normally observed in the infant born 28 to 30 weeks’ gestational. Proper position of premature infants may promote normal motor development while minimizing development of abnormal movement patterns.

Positioning of preterm infants is a basic neonatal nursing care. It includes supine, prone, side-lying, and head up tilted position. Several studies demonstrated a variety outcome affected by different body positioning of preterm infants. In addition, several studies indicated a strong association between prone sleep position and Sudden Infant Death Syndrome (SIDS). Therefore, The Task Force of the American Academy of Pediatrics (AAP) recommends the non-prone sleeping position for asymptomatic preterm infants to prevent SIDS. As a result of these findings, there is increasing pressure to avoid the prone sleep position in all infants, including preterm infants who do not have respiratory distress and are being readied for hospital discharge. This
presents a dilemma for nurses and paediatricians caring for healthy preterm infants because other studies indicate that preterm infants in the prone position spend less time awake and more quiet sleep, \(^4\)-\(^5\) less cry and less move. \(^6\)-\(^7\) What constitutes the most advantageous sleep position for preterm infants remains undetermined.

Furthermore, previous studies found that preterm infants with lie in a prone position compared to those in a supine position have early motor milestone, \(^8\) decreased energy expenditure, more rapid gastric emptying and less gastric reflux, \(^9\)-\(^10\) greater chest wall synchrony and improved respiration, \(^11\)-\(^12\) decrease respiratory rate, \(^6\),\(^11\) greater tidal volume, minute volume, elastic work, inspiratory and tidal viscous work, total work of breathing, and work of ventilating, \(^13\) improved oxygenation in both spontaneous breathing preterm infants \(^12\),\(^14\)-\(^16\) and intubated preterm infants. \(^6\),\(^17\)-\(^19\) Despite the physiologic benefits of the prone position, the very low birth weight infant is at risk for postural abnormalities such as flattened posture that is known to affect developmental milestones up to age six. \(^20\) Three studies indicated that the supine positioning in healthy preterm infants was associated with higher respiratory rate than prone position, \(^11\),\(^20\)-\(^21\) but the other study demonstrated that there were no significant differences in the incidence of clinically significant apnea, bradycardia, or desaturation between supine and prone positions. \(^22\) In addition, some studies found that head elevated tilt position reduces hypoxemic and bradycardia events in preterm infants, \(^23\)-\(^24\) and increases transcutaneous \(\text{PO}_2\). \(^25\) However, a comprehensive literature review during 1966-2000 by Monterosso et al \(^26\) found that the prone position is preferred for very low birth weight infants because it promotes development of pulmonary, cardiovascular, sleep state organizational, and gastrointestinal functions and facilitates the preterm infants recovering from the respiratory complications associated with immaturity. In addition, the results of a systematic review suggested that prone position slightly improved the oxygenation in neonates undergoing mechanical ventilation. \(^17\) However, there was no evidence concerning whether particular body positions during mechanical ventilation of the neonate were effective in producing clinical relevant improvements.

Although research shows advantages and disadvantages for both supine and prone position among preterm infants to their physiological outcomes, there is a trend remains toward keeping preterm infants in a supine position; mainly for ease of observation and handling. This review evaluates the clinical evidence that investigates the effects of positioning of preterm infants including prone position, supine position, side-lying position, and head elevated tilt position on physiological outcomes including respiratory function, hemodynamic, neuromotor development, gastric function and sleep states.
Objectives:

Objective of this review is to determine the best available evidence related to the positioning of preterm infants. The following questions will be addressed in this review:

1. What are the physiological outcomes affected by different positioning of preterm infants?
2. What is the best position for promoting sleep among preterm infants?

Criteria for considering studies for this review:

Types of participants
This review considered all studies that included healthy infants born before 37 weeks of gestational age in any hospital setting, including those admitted to newborn nurseries, neonatal intensive care units, and medical clinics.

Types of Intervention
Interventions of interest are those related to positioning of preterm infants including prone, supine, side-lying, and head elevated tilt position.

Types of outcome measures
Outcomes of interest are as follow:

- physiologic effects including respiratory function (oxygen saturation, tidal volume, functional residual capacity, respiratory rate), hemodynamic (heart rate, blood pressure), neuromotor development (motor activity), and gastric function (gastro-esophageal reflux, gastric residual)
- sleep state classified as awake, active sleep, quiet sleep or indeterminate sleep.

Types of studies
This review will consider randomized clinical trails (RCTs) that explore different positions in preterm infant. In the absence of RCTs, Quasi-experimental design will be reviewed for possible conclusion in a narrative summary to enable the identification of current best evidence regarding position in preterm infants.

Exclusion criteria:
This review will excluded articles that are expert opinion, literature reviews, or included no detailed results of the study. In addition, studies included infants who had medical problems or were on medication at the time of study will be excluded from this review.
Search strategy:
Both published and unpublished studies will be used. Three stages of search strategy include:

1. Limited search from journal indexes from MEDLINE, DARE and CINAHL. An analysis of the text words contained in the title, abstracts, and subject descriptors / MeSH terms of relevant articles will be considered to identify additional key words. In addition to this, a number of electronic databases will be searched to locate relevant studies in this subject area. Databases to be searched include:
   - CINAHL
   - EMBASE
   - Cochrane Library
   - MEDLINE/PubMed
   - DARE
   - ProQuest 5000
   - Science Direct
   - Currents @ OVID
   - Centre for Reviews and Dissemination databases
   - Other applicable databases

2. Individual search strategies will be developed for each database, adopting the different terminology of index thesauri if available.

3. In order to avoid publication bias, hand searching of the most recent issues of following journals will be searched for additional references:
   Journal of Pediatric Nursing, Pediatrics, Archives of Disease in Childhood, Pediatric Physical Therapy, and Neonatal Network.
   The search will also be conducted to locate relevant unpublished materials, such as conference papers, research reports, and dissertations. The sources searched to locate unpublished studies will include:
   - Dissertation Abstracts
   - Index to Theses
   - Conference proceedings
   - WWW sites of relevant associations
   - Direct communication with neonatal organizations, and neonatal nurse researchers.

4. Searches will include English and foreign language publications. Assessment for inclusion of foreign language publication will be based on the English language abstracted, when available.

5. Content experts will also be contacted in order to provide other alternatives for securing relevant literature.

6. All included literature will have their reference lists searched for additional relevant source journals.
Keywords include:
All studies retrieved of a combination keywords will be reviewed regarding their title, abstract, and descriptive terms for meeting the inclusion criteria. Keywords include: position, positioning, sleep, prone, supine, side-lying, head elevated tilt, premie, preterm, premature and infants.

Methods of the review:

Critical appraisal
All studies that meet the inclusion criteria will be assessed for methodological quality using an evaluation tool which will be developed on an existing tool used by the Joanna Briggs institution (JBI) for Evidence Based Nursing (Appendices 2 and 3). Two reviewers will independently assess all articles, and disagreements between reviewers will be resolved by discussion with a third reviewer. Data that can be used as evidence will be extracted, and the level of evidence will be evaluated.

Data extraction
Two reviewers will extract data independently, using a tool designed for this purpose (Appendix 4). A third reviewer will be asked to resolve any differences if the initial reviewers cannot reach agreement. When necessary, the principal primary researcher will be contacted to obtain missing information.

Data analysis:
If two or more comparable studies are identified, data will be pooled in statistical meta-analysis using Review Manager software. Studies will be considered comparable if they have drawn subjects from comparable populations, using similar interventions and had comparable outcomes measures. Double data entry will be used to minimize the risk of data entry errors.

Heterogeneity between combined studies will be tested using standard chi-square test and visual inspective of the graphic presentation of the results. Where possible, odds ratio (for categorical outcome data) or weighted mean differences (for continuous) and their 95% confidence intervals will be calculated for each study. If statistical pooling of results is not appropriate, the findings will be summarized in a narrative form.

References


Appendix 1
Inclusion criteria

A Systematic Review of Positioning of Preterm Infants for Optimal Physiological Development.

Author........................................Year................Record No......

Types of participants
Infants less than 37 weeks gestational age admitted to newborn nurseries. □
Infants less than 37 weeks gestational age admitted to neonatal intensive care units. □
Infants less than 37 weeks gestational age admitted to medical clinics. □

Types of interventions
Prone position, □
Supine position □
Side-lying position □
Head elevated tilt position □
Other (specify)................................. □

Types of outcome measures
Physiologic effects including respiratory function (oxygen saturation, tidal volume, functional residual capacity, respiratory rate), hemodynamic (heart rate, blood pressure), neuromotor development (motor activity), gastric function (gastroesophageal reflux, gastric residual) □
Sleep states classified as awake, active sleep, quiet sleep or indeterminate sleep. □

Types of studies
RCTs □
Quasi-experimental design □
Appendix 2
Critical Appraisal Form
for Quasi-Experimental Design

Title of article……………………………………………….Record No……………………
Author…………………………………………. ..Year…………………….

1. Was the criteria for inclusion in the sample clearly defined?
   Yes □   No □   N/A □

2. Other than research intervention, were participants in each group treated the same?
   Yes □   No □   N/A □

3. Were the outcomes measure clearly defined for all participants?
   Yes □   No □   N/A □

4. Was an appropriate statistical analysis used?
   Yes □   No □   N/A □

5. Was there adequate follow up of participants? (if less than 80% will be No)
   Yes □   No □   N/A □

6. Was the study based on random sample?
   Yes □   No □   N/A □

Question 1 to 5 must be answered “yes” for study to be included in the systematic review

Summary   Total Yes…………….. No………   N/A…………………
Included………………………… .Rejected………………………………

Comments……………………………………………………………………………………
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Reviewer's name…………………………………………………………….
Title of article…………………………………… Record No………………………
Author………………………………………...Year……………………………

1. Were the assignment to treatment groups random?
   Yes ☐  No ☐  N/A ☐

2. Were participants blinded to treatment allocation?
   Yes ☐  No ☐  N/A ☐

3. Was allocation to treatment groups concealed from the allocator?
   Yes ☐  No ☐  N/A ☐

4. Were the outcomes of people who withdrew described and included in the analysis?
   Yes ☐  No ☐  N/A ☐

5. Were those assessing outcomes blind to the treatment allocation?
   Yes ☐  No ☐  N/A ☐

6. Were the control and treatment groups comparable at entry?
   Yes ☐  No ☐  N/A ☐

7. Were groups treated identically other than for named intervention?
   Yes ☐  No ☐  N/A ☐

8. Were outcomes measured in the same way for all groups?
   Yes ☐  No ☐  N/A ☐

9. Were outcomes measured in a reliable way?
   Yes ☐  No ☐  N/A ☐

10. Was appropriate statistical analysis used?
    Yes ☐  No ☐  N/A ☐

Summary Total yes…………….. No………… N/A……………………………
    Included………………Rejected………………………………………

Comments……………………………………………………………………
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Reviewer's name…………………………………………………………………
Appendix 4
Data Extraction Form

Title of article…………………………………………Record number………………
Author……………………………………………………………………………………
Journal…………………………………………Year…………Volume……
Method of study……………………………………………………………………
Setting………………………………………………………………………………
Participants…………………………………………………………………………
Number of participants
Group A………………………………………………………………………………
Group B………………………………………………………………………………
Description of interventions
Intervention A……………………………………………………………………
Intervention B……………………………………………………………………

Outcome measures

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Results

Dichotomous data

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<th>Outcome</th>
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<th>Control group Number/Total number</th>
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Continuous Data

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Author conclusions
……………………………………………………………………………………

Comments……………………………………………………………………………..

Reviewer's name……………………………………………………………………