Non-nutritive sucking for promoting physiologic stability and nutrition in preterm infants (Review)

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Non-nutritive sucking for promoting physiologic stability and nutrition in preterm infants

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ABSTRACT

Background
Non-nutritive sucking is used during gavage feeding and in the transition from gavage to breast/bottle feeding in preterm infants. The rationale for this intervention is that non-nutritive sucking facilitates the development of sucking behaviour and improves digestion of enteral feedings. Non-nutritive sucking has been considered to be a benign intervention, although it has the potential to have a negative effect on breastfeeding or on the incidence of later oral aversion.

Objectives
To determine whether non-nutritive sucking (NNS) in preterm infants influences: a) weight gain, b) energy intake, c) heart rate, d) oxygen saturation, e) length of hospital stay, f) intestinal transit time, g) age at full oral feeds, or h) any other clinically relevant outcomes.

Search strategy
MEDLINE and CINAHL databases back to 1976 and The Cochrane Central Register of Controlled Trials (CENTRAL, The Cochrane Library, Issue 1, 2005) were searched. The EMBASE database was added to the search strategy for 2005. Reference lists/bibliographies of relevant articles and reviews were also searched. A comprehensive list of relevant articles was sent to two major authors in this area. They were asked if they knew of any other published or unpublished studies relevant to the area that had not been included in the original list.

Selection criteria
All trials utilizing experimental or quasi-experimental designs in which non-nutritive sucking in preterm infants was compared to no provision of non-nutritive sucking. Measured clinically relevant outcomes. Reports were in English or a language for which a translator was available.

Computerized searches were conducted by both reviewers. All potentially relevant titles and abstracts identified by either reviewer were extracted. All retrieved articles were assessed for relevance independently by each reviewer, based on a pre-determined set of criteria. The reference lists/bibliographies of each article were reviewed independently for additional relevant titles and were also retrieved and assessed for relevance. Articles that met all relevance criteria were then assessed for methodologic quality based on a predetermined set of criteria. Those articles judged to have the appropriate quality by both reviewers were included in the analysis.
Data collection and analysis

Data were extracted independently by the two authors. No subgroup analyses were performed because of the small number of studies related to the relevant outcomes.

Main results

This review consisted of 21 studies, 15 of which were randomized controlled trials. NNS was found to decrease significantly the length of hospital stay in preterm infants. The review did not reveal a consistent benefit of NNS with respect to other major clinical variables (weight gain, energy intake, heart rate, oxygen saturation, intestinal transit time, age at full oral feeds and behavioral state). The review identified other positive clinical outcomes of NNS: transition from tube to bottle feeds and better bottle feeding performance. No negative outcomes were reported in any of the studies.

Authors’ conclusions

This review found a significant decrease in length of stay in preterm infants receiving a NNS intervention. The review did not reveal a consistent benefit of NNS with respect to other major clinical variables (weight gain, energy intake, heart rate, oxygen saturation, intestinal transit time, age at full oral feeds and behavioral state). The review identified other positive clinical outcomes of NNS: transition from tube to bottle feeds and better bottle feeding performance. No negative outcomes were reported in any of the studies.

In view of the fact that there are no long-term data, further investigations are recommended. In order to facilitate meta-analysis of these data, future research in this area should involve outcome measures consistent with those used in previous studies. In addition, published reports should include all relevant data.

Plain Language Summary

Non-nutritive sucking for promoting physiologic stability and nutrition in preterm infants

An infant born prematurely may be fed through a tube into the stomach, so is often given a pacifier to suck on to improve nutrition. An infant needs coordinated sucking, swallowing and breathing to feed. The ability to suck and to swallow is present by 28 weeks gestation, but infants are not fully coordinated until 32 to 34 weeks. This means that preterm infants less than 32 weeks gestation are usually not able to feed effectively from the breast or a bottle. They are fed by a small tube that is placed up the nose into the stomach (gavage feeding). Sucking on a pacifier (non-nutritive sucking) during gavage feeding may encourage the development of sucking behaviour and improve digestion of the feeding. Non-nutritive sucking may also have a calming effect on infants, although it does have the potential to interfere with breastfeeding. The authors searched the medical literature and found 21 studies, 15 were randomized controlled trials and six were non-randomized. The total number of infants in each study ranged from 10 to 59. Weight gain was similar with and without use of a pacifier. Preterm infants with pacifiers did not stay in hospital as long as those without and hospital costs were less (two studies). These infants showed less defensive behaviors during tube feedings, spent less time in fussy and active states during and after tube feedings, and settled more quickly into sleep. Their transition to full enteral (by tube or mouth) or bottle feeds (three studies) and bottle feeding performance, in general, (one study) were easier. No negative outcomes were reported.

Background

The early components of sucking have been demonstrated to occur in fetal life from about seven to eight weeks post-conceptual age. Oral and gag reflexes appear at about 12-16 weeks and sucking at 24 weeks. Sucking and swallowing are present by 28 weeks, although not fully coordinated until about 32-34 weeks (Goldson 1987).

The development of sucking behaviours in preterm infants is thought to reflect neurobehavioural maturation and organization. From a clinical perspective, the ability to feed depends upon a coordinated sucking, swallowing and breathing pattern. In preterm infants, the ability to feed is facilitated by using techniques to stimulate sucking.

The authors searched the medical literature and found 21 studies, 15 were randomized controlled trials and six were non-randomized. The total number of infants in each study ranged from 10 to 59. Weight gain was similar with and without use of a pacifier. Preterm infants with pacifiers did not stay in hospital as long as those without and hospital costs were less (two studies). These infants showed less defensive behaviors during tube feedings, spent less time in fussy and active states during and after tube feedings, and settled more quickly into sleep. Their transition to full enteral (by tube or mouth) or bottle feeds (three studies) and bottle feeding performance, in general, (one study) were easier. No negative outcomes were reported.
infants less than 32 weeks gestation, this ability is not usually effective enough to sustain full oral feeds. In the interim, infants are fed by gavage tube until they are mature enough to take milk directly from the breast or bottle. Non-nutritive sucking has been used during gavage feeding and in the transition from gavage to breast/bottle feeding. The rationale for this intervention is that non-nutritive sucking facilitates the development of sucking behaviour and improves digestion of enteral feeds. A number of enzymes/hormones have been implicated in the facilitation of digestion through non-nutritive sucking; lingual lipase, gastrin, insulin and motilin. Non-nutritive sucking is thought to stimulate the secretion of these enzymes/hormones through vagal innervation in the oral mucosa (Hamosh 1979; Chey 1980; Wiener 1987). In addition, non-nutritive sucking is believed to have a calming effect on infants and is commonly used as an intervention in nurseries and neonatal intensive care units (Kimble, 1992). Non-nutritive sucking has been considered to be a benign intervention, although it has the potential to have a negative effect on breastfeeding or on the incidence of later oral aversion.

Non-nutritive sucking is organized in a stable temporal pattern whose features can be analyzed by quantitative techniques (Wolff 1972). Non-nutritive sucking has been studied using quasi-experimental and experimental designs for its effect on neonates with respect to a number of clinical outcomes.

Schwartz 1987 synthesized five studies of non-nutritive sucking in preterm infants in a meta-analysis. The authors concluded that non-nutritive sucking reduced the time to first bottle feeding and reduced the days of hospitalization. Outcome data related to weight gain were inconclusive.

A meta-analysis of the non-nutritive sucking research in preterm infants by Steer, Lucas and Sinclair (Steer 1992) included eight randomized trials. The major outcome variables studied in these trials included weight gain, gastrointestinal transit, readiness for nipple feedings and length of hospitalization. A lack of blinding to the intervention and/or outcome measurement in all studies affected the methodologic quality of the findings. The authors concluded that in view of the limitations in the available research, there was insufficient beneficial evidence to support the use of non-nutritive sucking in the management of tube-fed preterm infants.

The review of literature demonstrates the need for the continued synthesis of available evidence to support the on-going use of non-nutritive sucking interventions in neonatal care.


The objectives of this review are to examine the evidence for the beneficial or adverse effects of non-nutritive sucking in preterm infants by:

i) identifying all experimental and quasi-experimental trials of non-nutritive sucking in preterm infants

ii) assessing the methodologic quality of each study

iii) estimating overall effects of non-nutritive sucking on clinically relevant outcomes such as:

- weight gain
- length of hospital stay
- transition to oral/nipple feedings
- heart rate and oxygen saturation/oxygenation
- activity/behaviour
- any other clinically relevant outcomes

**METHODS**

**Criteria for considering studies for this review**

**Types of studies**

All experimental and quasi-experimental studies in which non-nutritive sucking in preterm infants was compared to no provision of non-nutritive sucking were identified.

**Types of participants**

All infants born at < 37 weeks post-conceptual age. Studies involving both preterm and term (greater than or equal to 37 weeks) were excluded.

**Types of interventions**

Non-nutritive sucking involving the use of a pacifier. The intervention occurred before, during or after feeding by a naso/orogastric tube; before or after bottle feeding; or outside of feeding times.
Types of outcome measures
a) weight gain
b) length of hospital stay
c) transition to oral/nipple feedings
d) heart rate and oxygen saturation/oxygenation
e) activity/behaviour
f) any other clinically relevant outcomes

Search methods for identification of studies
Computerized searches were conducted by both reviewers. MEDLINE and CINAHL databases back to 1976 and the Cochrane Central Register of Controlled Trials (CENTRAL, The Cochrane Library, Issue 1, 2005) were searched using the following MeSH headings: infant, premature; intensive care units, neonatal; enteral nutrition; sucking behaviour; infant nutrition; gastric emptying; growth; parenteral nutrition; bottle feeding; infant care; infant, low birth weight; somatostatin; crying; oxygen; child development; physical stimulation; taste; infant, newborn; feeding behaviour. These headings were chosen from the articles in the meta-analysis by Steer et al (Steer 1992). The following text words were also searched: non(tw) and nutritive(tw) and suck(tw). Trials evaluating the effect of NNS on pain in the preterm infant were excluded.

All potentially relevant titles and abstracts identified by either reviewer were retrieved. The reference lists/bibliographies of each article were reviewed independently for additional relevant titles and these were also retrieved. The list of all relevant articles was sent to two major authors in this area. They were asked if they knew of any other published or unpublished studies relevant to the area that have not been included in the original list.

Data collection and analysis
The systematic review followed the method described in the Cochrane Collaboration Handbook. All of the articles that were retrieved from the complete search were assessed for relevance independently by the two reviewers. Criteria for relevance included trials that utilized: experimental or quasi-experimental designs, intervention of non-nutritive sucking in preterm infants, and clinically relevant outcomes. The articles that met all relevance criteria were assessed for methodological quality based on the criteria stated in the section below. A kappa statistic was calculated on the agreement between both reviewers at two stages in the review process: in the assessment of relevance of the articles and in the assessment of the methodological quality of the relevant articles. For relevance of the articles, the kappa was 0.62, with 87% agreement. For methodologic quality the kappa was 0.61, with 82% agreement. Differences were resolved through discussion and were mainly related to oversights on the part of one of the readers.

Those articles judged to have the appropriate quality by both reviewers were included in the analysis. Data were extracted independently by the two reviewers. Missing data were obtained from the original authors where possible. No subgroup analyses were performed because of the small number of studies related to the relevant outcomes. The study by Yu 1999 was assessed by only one reviewer because of the language limitation.

Results

Description of studies
See Characteristics of included studies; Characteristics of excluded studies.
All of the 21 studies that met the relevance criteria were included in the review. It should be noted that none of the 21 studies met all of the methodologic quality criteria. Of the 21 studies, 15 were randomized controlled trials and six utilized non-randomized designs. The total sample sizes in the studies ranged from 10 to 59 infants. The intervention of non-nutritive sucking was delivered through the use of a pacifier and occurred during gavage feeding, before and/or after bottle feeding, or not related to feeding. A large number of outcomes were utilized in the 21 studies but only a few were common among them. The overall review includes both randomized and non-randomized studies, although only randomized studies are included in the data analysis. Details of each included study are in the table, Characteristics of Included Studies.

Thirteen studies were excluded from the review. The reason for exclusion in all cases was because they did not meet one or more of the relevance criteria (see Characteristics of Excluded Studies). The relevance of the studies in these cases could not be determined by the title or abstract and required a review of the entire article.

Risk of bias in included studies
The included (and excluded) studies were assessed using the following key criteria: blindness of randomization, blindness of intervention, complete follow-up and blinding of outcome measurement. Additional criteria of study quality included: evidence of cointervention, objective criteria of measuring outcomes and defined exclusion/inclusion criteria. The non-nutritive sucking intervention cannot be blind to those providing care, but should be blind to the assessors of the outcomes. Of the 15 RCTs, eight utilized a cross-over design where the infants served as their own controls. These studies were not included in the meta-analysis, but were included in the results. Blindness of randomization was evident in only six of the studies. In only one study was it clear that the outcome assessors were blinded. Complete follow-up occurred in all of the studies.

Non-nutritive sucking for promoting physiologic stability and nutrition in preterm infants (Review)
Effects of interventions

This review consisted of 21 studies, 15 of which were randomized controlled trials. The data analysis involved seven clinical outcomes, although only four included more than one study in the outcome category. The results of the tests of heterogeneity of the analyses utilizing more than one study were significant for only one outcome, heart rate. The analyses of the studies for the remaining three outcomes were all non-significant for heterogeneity.

The first of those four outcomes is weight gain in grams per day. Three randomized trials were included in the meta-analysis. Two of the trials showed no difference between groups during a two-week study period (Ernst 1989; Mattes 1996). The third trial demonstrated a trend favouring the control group, although the time of data collection is not specified (Field 1982). The overall effect was non-significant (WMD 1.57 g/day, 95% CI -0.37, 3.50). A fourth randomized trial, Bernbaum (1983), demonstrated a significant difference in weight gain favouring the treatment group by the second week and the difference remained significant throughout the study period (six weeks). This study was not included in the meta-analysis because the standard deviations were unavailable from the authors. In addition, two non-randomized studies utilized weight gain as an outcome. Both studies showed no difference in weight gain between the treatment and control groups (Measel 1979; Sehgal 1990). Based on the results of the randomized and non-randomized studies, there is no clear benefit of NNS with respect to weight gain in grams per day.

Heart rate was measured in four randomized trials. Neither study by Pickler (Pickler 1993; Pickler 1996) showed a difference between groups. One study by McCain (1995) also demonstrated no difference but her earlier study showed a difference in favour of the treatment group (McCain 1992). Although statistically significant, the difference in heart rate was not clinically significant. The overall effect of the analysis, however, showed no statistically significant difference between groups (WMD -1.4 beats/min, 95% CI -5.9, 3.1). It should be noted that this analysis was significant for heterogeneity so the results must be viewed with caution.

Three randomized trials measured oxygen saturation as an effect of NNS. None of the individual trials showed a significant difference between groups, but the overall effect approached significance in favour of the control group (WMD 1.0 %, 95% CI -0.04, 2.1). As with heart rate, the differences were not clinically significant. Two randomized trials examined the effect of NNS on length of hospital stay (in days). Field (1982) found no difference between groups, while Bernbaum (1983) demonstrated a significant reduction in length of stay. The overall analysis did reveal a significant difference in length of hospital stay (WMD -7.1 days, CI -12.6, -1.7). Although Field (1982) did not demonstrate a significant difference in length of hospital stay, she did report a positive economic impact of NNS on hospital costs.

There are a number of outcomes associated with NNS that have been reported in single studies. Three of these studies have been included in the table of comparisons because of their clinical relevance and because they are randomized trials. DeCurtis 1986 found no significant difference between experimental and control groups with respect to intestinal transit time (in hours) or energy intake (kcal/kg/day). In contrast, another randomized study by Bernbaum 1983 showed a significantly increased transit time in infants receiving NNS by the end of the first week and persisted throughout the remaining four weeks. This study was not included in the meta-analysis because the standard deviations were unavailable from the authors. Mattes 1996 showed no difference in post-conceptual age at full oral feeds (in days).

Ernst 1989 studied the effect of NNS on energy balance and DeCurtis 1986 studied nutrient retention. Both studies were done in tube fed babies. Ernst (1989) found NNS to have no effect on energy expenditure, stool excretion or stool fat. DeCurtis (1986) reported that NNS had no effect on stool energy and stool fat. Three randomized trials reported no effect of NNS on gastric emptying (Ernst 1989; Szabo 1985; Widstrom 1988). No data were available for these trials so that a meta-analysis was not possible. Widstrom 1988 and Kanarek 1992 studied the effect of NNS on specific hormones in tube fed infants. Kanarak 1992 found that NNS has no apparent effect on the blood concentrations of motilin, gastrin, insulin or insulin-like growth factor 1, three days after commencing feeds. Widstrom 1988 reported a significant decrease in somatostatin levels with NNS. DiPietro 1994 reported the effect of NNS on physiological parameters in tube fed infants. She found NNS to have no effect on vagal tone, oxygen saturation and heart rate. However, Burroughs 1978 did report a significant improvement in TcPO2 readings in the infants receiving NNS that was not associated with feeding. The effect of NNS on the transition from tube feeds to bottle feeds has been reported by Field 1982 and Sehgal 1990. Field 1982 found that infants offered NNS had significantly fewer days of tube feeding (three-day difference). Sehgal 1990 reported that the time for transition from tube feeds to bottle feeds was significantly reduced by 1.6 days in infants receiving NNS. Widstrom 1988 also reported a significant decrease in tube feeding time in infants receiving NNS. Yu 1999 found that feeding performance was improved in the NNS group. With NNS there was significantly more intake within the first five minutes, more total amount of feeding, less feeding time and a faster feeding rate. Pickler 2004 found no statistically significant effect of NNS on the amount of formula consumed per minute of feeding.

DiPietro 1994 and Field 1982 both analyzed the effect of NNS on behavioral state during tube feedings. The data, however, cannot be combined as the authors used different measurement scales. DiPietro 1994 used Anderson's 12-level Behavioral State Scale (ABSS) and found that infants receiving NNS spent significantly less time in fussy and active awake states during and after a tube feed, and settle more quickly into a sleep state. Field 1982 used the Brazelton Neonatal Behavioral Assessment Scale (NBAS) and found that NNS had no effect on behavioral state. DiPietro 1994 found that infants receiving NNS exhibited less defensive behav-
iors during tube feeding. Yu 1999 found that preterm infants receiving NNS before bottle feeding spent significantly more time in a quiet awake state and less time in active sleep, drowsiness, active awake and crying states. Three and five minutes of NNS showed the same effect on behavioral states and feeding. Pickler 2004 analyzed the effect of NNS on behavioral state before, during and after bottle feeding and demonstrated no effect on behavioral state.

In summary, the results of this review demonstrated a significant effect on the length of hospital stay favouring the experimental group. Several studies also demonstrated a positive effect from NNS on: decreased somatostatin levels; increased TcPO2 readings; decreased time to establish nipple feeds; better bottle feeding performance; decreased time in fussy and awake states; settled more quickly following feeds; and exhibited less defensive behaviors during tube feeding. The results of this review revealed no significant effect of NNS on: weight gain; energy intake; heart rate; oxygen saturation; intestinal transit time; time to full oral feeds; energy expenditure; stool excretion or stool fat; stool energy; gastric aspirates; blood concentrations of motilin, gastrin, insulin or insulin-like growth factor-1; vagal tone; or behavioral state.

DISCUSSION

The results of this review demonstrated a significant benefit of NNS on length of hospital stay (in days). The review did not reveal a benefit of NNS with respect to the other major clinical variables (weight gain, energy intake, heart rate, oxygen saturation, intestinal transit time, and post-conceptual age at full oral feeds).

The review identified other positive clinical outcomes of NNS: transition from tube to bottle feeds, better bottle feeding performance. No negative outcomes were reported in any of the studies. There were a number of limitations of the presently available evidence:

1. Design Limitations

Although 15 of the 21 studies reviewed were randomized trials, eight were cross-over designs. Cross-over designs present at least two limitations in assessing the effects of non-nutritive sucking. The appropriate length of time to wash out the effects of the NNS intervention prior to crossover is not known; and late effects, e.g. time to full feeding, cannot be assessed. In only six trials was the randomization clearly blinded. Because of the nature of the intervention, blinding was not possible. However, blinding of outcome assessors, although possible was evident in only one of the studies reviewed.

2. Outcome Variability

Meta-analysis was limited in this review due to the large variation in outcomes and limited number of randomized trials that were included in each outcome. Although many of the studies measured similar outcomes, the outcomes were too dissimilar to be included in a meta-analysis. Alternatively, the authors reported the significance level but no specific data were provided. In addition, the context of the measurement of the outcomes varied greatly among studies. For example, outcomes were measured before, during or after gavage feeding; before or after bottle feeding; or not associated with feeding. Because of the small number of studies in each category that measured comparable outcomes, all studies were combined regardless of context. These contextual differences should be noted when considering the results of the review.

3. Lack of long-term data

The studies reviewed included no short- or long-term negative outcomes. The outcomes chosen were either found to have a positive short-term effect or no effect as a result of NNS. Examples of potential negative effects would be the effect of NNS on breastfeeding or on incidence of later oral aversion. The negative impact of NNS was not measured in any of the studies. None of the infants in the studies reviewed were followed past hospital discharge. NNS demonstrated a benefit in only one of the major outcomes measured. There were also a number of short-term positive results for several of the secondary outcomes. No negative effects of NNS were studied, however.

AUTHORS’ CONCLUSIONS

Implications for practice
The main results of the meta-analysis, and from the single and non-randomized studies indicate that NNS decreases length of hospital stay in preterm infants, and appears to facilitate the transition to full oral/bottle feeds and bottle feeding performance in general. Infants receiving NNS exhibited less defensive behaviors during tube feedings, spent significantly less time in fussy and active states during and after tube feedings, and settled more quickly into sleep states. Positive effects of NNS on behavioral state were not consistently demonstrated.

Although a number of outcomes demonstrated no difference with or without NNS, there do not appear to be any short-term negative effects as a result of this intervention. Based on the available evidence, NNS in preterm infants would appear to have some clinical benefit. Although not specifically studied, NNS does not appear to have any negative effect, short-term. No long-term data on the effects of NNS are presently available.

Implications for research
In view of the fact that there are no long-term data, further investigations are recommended. In order to facilitate meta-analysis of these data, future research in this area should involve outcome...
measures consistent with those used in previous studies. In addition, published reports should include all relevant data.

**ACKNOWLEDGEMENTS**

We would like to thank Patricia Austin for her assistance in retrieval of the references for this review.

**REFERENCES**

References to studies included in this review

Bernbaum 1983 [published data only]

Burroughs 1978 [published data only]

DeCurtis 1986 [published data only]

DiPietro 1994 [published data only]

Ernst 1989 [published data only]

Field 1982 [published data only]

Gill 1988 [published data only]

Gill 1992 [published data only]

Kanarek 1992 [published data only]

Mattes 1996 [published data only]

McCain 1992 [published data only]

McCain 1995 [published data only]

Measel 1979 [published data only]

Pickler 1993 [published data only]

Pickler 1996 [published data only]

Pickler 2004 [published data only]

Sehgal 1990 [published data only]

Szabo 1985 [published data only]

Widstrom 1988 [published data only]

**A C K N O W L E D G E M E N T S**

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DeCurtis 1986 [published data only]

DiPietro 1994 [published data only]

Ernst 1989 [published data only]

Field 1982 [published data only]

Gill 1988 [published data only]

Gill 1992 [published data only]

Kanarek 1992 [published data only]

Mattes 1996 [published data only]

McCain 1992 [published data only]

McCain 1995 [published data only]

Measel 1979 [published data only]

Pickler 1993 [published data only]

Pickler 1996 [published data only]

Pickler 2004 [published data only]

Sehgal 1990 [published data only]

Szabo 1985 [published data only]

Widstrom 1988 [published data only]

**Woodson 1988a (published data only)**


**Woodson 1988b (published data only)**


**Yu 1999 (published data only)**


**References to studies excluded from this review**

**Bingham 2003 (published data only)**


**Burroughs 1981 (published data only)**


**Daniels 1988 (published data only)**


**Kimble 1992 (published data only)**


**Marchini 1987 (published data only)**


**Miller 1993 (published data only)**


**Narayanan 1991 (published data only)**


**Neeley 1979 (published data only)**


**Orenstein 1988 (published data only)**


**Paludetto 1984 (published data only)**


**Paludetto 1986 (published data only)**


**Standley 2003 (published data only)**


**Woodson 1985 (published data only)**


**Additional references**

**Barrett 1973**


**Chey 1980**


**Dreier 1979**


**Dubignon 1969**


**Goldson 1987**


**Hamosh 1979**


**Kessen 1963**


**Kessen 1967**


**Kimble, 1992**

Mathew 1985

Medoff-Cooper 1995

Miller 1975

Pickler 1994

Sameroff 1967

Schwartz 1987

Semb 1968

Steer 1992

Wiener 1987

Wolff 1972

Wolff 1967

References to other published versions of this review

Pinelli 1998

Pinelli 2001

Pinelli 2003

* Indicates the major publication for the study
### Characteristics of included studies [ordered by study ID]

**Bernbaum 1983**

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<tr>
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<td>Blinding of intervention - No</td>
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<td>Blinding of outcome assessors - Can't tell</td>
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<td></td>
<td>Complete follow-up - Yes</td>
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<tr>
<td>Participants</td>
<td>Appropriate for gestational age</td>
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<tr>
<td></td>
<td>Birth weight &lt; 1.5kg</td>
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<tr>
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<td>Sucking behaviour</td>
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<td></td>
<td>Days for transition to oral feeds</td>
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#### Risk of bias

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**Burroughs 1978**

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<td>Blinding of outcome assessors - Can't tell</td>
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<td>Complete follow-up - Yes</td>
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<td>Participants</td>
<td>Gestational age &lt; 37 weeks</td>
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<td></td>
<td>Birth weight &gt; 1.0kg</td>
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<td>TcPO2 measured pre-intervention, during the intervention, post-intervention.</td>
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## Burroughs 1978  (Continued)

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### Risk of bias

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<td>Allocation concealment?</td>
<td>Unclear</td>
<td>D - Not used</td>
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</tbody>
</table>

### DeCurtis 1986

<table>
<thead>
<tr>
<th>Methods</th>
<th>Participants</th>
<th>Interventions</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Randomized, crossover</td>
<td>Mean gestational age - 28.8 weeks, Mean birthweight - 1.111kg, Sample size = 10</td>
<td>Experimental group: Pacifier during tube feeds. Control group: No pacifier.</td>
<td>Energy and nitrogen balance, Net nitrogen utilization, Fat absorption, Gastrointestinal transit time</td>
</tr>
</tbody>
</table>

### Notes

<table>
<thead>
<tr>
<th>Risk of bias</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Authors' judgement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allocation concealment?</td>
<td>Unclear</td>
<td>B - Unclear</td>
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</table>

### DiPietro 1994

<table>
<thead>
<tr>
<th>Methods</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Randomized, crossover, Blinding of randomization - No, Blinding of intervention - No, Blinding of outcome assessors - No, Complete follow-up - Yes</td>
<td>Gestational age - 1.0 - 2.0kg, Birth weight &lt; 34 weeks, Sample size = 36</td>
</tr>
</tbody>
</table>
### Interventions

**Experimental group:** Pacifier during tube feed and after feed x 15 minutes or until in sleep state x 5 minutes.  
**Control group:** No pacifier

### Outcomes

- Behaviour
- Heart rate
- Vagal tone
- Oxygen saturation

### Notes

#### Risk of bias

<table>
<thead>
<tr>
<th>Item</th>
<th>Authors' judgement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allocation concealment?</td>
<td>No</td>
<td>C - Inadequate</td>
</tr>
</tbody>
</table>

### Ernst 1989

Methods

- Randomized
- Blinding of randomization - Can’t tell
- Blinding of intervention - No
- Blinding of outcome assessors - Can’t tell
- Complete follow-up - Yes

Participants

- Gestational age < 30 weeks
- Birth weight < 1.4kg
- Sample size = 18
- Number randomized to each group=9

Interventions

**Experimental group:** Pacifier during feed and after feed for 30 minutes.  
**Control Group:** No pacifier.  
Both groups: No pacifier between feedings. Intake was held constant in both groups.

Outcomes

- Anthropometric measures
- Serum proteins
- Gastrointestinal transit time
- Energy and fat excretions (8 subjects)
- Energy expenditure (8 subjects)

Notes

#### Risk of bias

<table>
<thead>
<tr>
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<th>Description</th>
</tr>
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<tbody>
<tr>
<td>Allocation concealment?</td>
<td>Unclear</td>
<td>B - Unclear</td>
</tr>
</tbody>
</table>
### Field 1982

| Methods | Randomized, stratified  
|         | Blinding of randomization - Can't tell  
|         | Blinding of intervention - No  
|         | Blinding of outcome assessors - can't tell  
|         | Complete follow-up - Yes  

| Participants | Gestational age < 35 weeks  
|             | Birth weight < 1.8kg  
|             | Sample size = 57  
|             | Number randomized to each group=27(Control), 30(Exp)  

| Interventions | Experimental group: Pacifier during all tube feeds  
|              | Control group: No pacifier during tube feeds  
|              | Both groups: Pacifier offered between feeds  

| Outcomes | Behaviour (assessed when in open crib)  
|          | Feeding behaviour  
|          | Days of tube feeding  
|          | Number of tube feeds  
|          | Daily weight gain  
|          | Length of hospital stay  
|          | Hospital cost  

### Gill 1988

| Methods | Randomized  
|         | Blinding of randomization - Yes  
|         | Blinding of intervention - No  
|         | Blinding of outcome assessors - No  
|         | Complete follow-up - Yes  

| Participants | Gestational age < 34 weeks  
|             | Birth weight < 2.0kg  
|             | Sample size = 24  
|             | Number randomized to each group=12  

| Interventions | Experimental group: Pacifier before bottle feed x 5 minutes  
|              | Control group: No pacifier  

| Outcomes | Behaviour  

### Risk of bias

<table>
<thead>
<tr>
<th>Item</th>
<th>Authors' judgement</th>
<th>Description</th>
</tr>
</thead>
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Non-nutritive sucking for promoting physiologic stability and nutrition in preterm infants (Review)
### Gill 1988

#### Notes

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<th>Description</th>
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<tbody>
<tr>
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<td>Yes</td>
<td>A - Adequate</td>
</tr>
</tbody>
</table>

#### Gill 1992

#### Methods
- Randomized
- Blinding of randomization - Yes
- Blinding of intervention - Yes
- Blinding of outcome assessors - No
- Complete follow-up - Yes

#### Participants
- Gestational age < 34 weeks
- Birth weight < 2.0kg
- Sample size = 42
- Number randomized to each group=21

#### Interventions
- Experimental group: Pacifier before bottle feed x 5 minutes
- Control group: No pacifier

#### Outcomes
- Behaviour

#### Notes

<table>
<thead>
<tr>
<th>Item</th>
<th>Authors' judgement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allocation concealment?</td>
<td>Yes</td>
<td>A - Adequate</td>
</tr>
</tbody>
</table>

#### Kanarek 1992

#### Methods
- Randomized
- Blinding of randomization - Yes
- Blinding of intervention - No
- Blinding of outcome assessors - Can’t tell
- Complete follow-up - Yes

#### Participants
- 30-35 weeks gestational age
- Receiving bolus or continuous feeds
- Sample size = 21
- Number randomized to each group=11(Control), 10(Exp)
### Kanarek 1992

<table>
<thead>
<tr>
<th>Interventions</th>
<th>Experimental group: Pacifier during and after feeds and when awake. Control group: No pacifier. Stroked when restless.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outcomes</td>
<td>Gastrin, Motilin, Insulin, Insulin-like growth factor</td>
</tr>
<tr>
<td>Notes</td>
<td></td>
</tr>
</tbody>
</table>

**Risk of bias**

<table>
<thead>
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<tbody>
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### Mattes 1996

<table>
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<tr>
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</tr>
<tr>
<td></td>
<td>Blinding of intervention - No</td>
</tr>
<tr>
<td></td>
<td>Blinding of outcome assessors - Can't tell</td>
</tr>
<tr>
<td></td>
<td>Complete follow-up - Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Participants</th>
<th>Gestational age &lt; 34 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Birth weight &gt; 1.25kg</td>
</tr>
<tr>
<td></td>
<td>Sample size = 42</td>
</tr>
<tr>
<td></td>
<td>Number randomized to each group=14</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Interventions</th>
<th>Experimental group 1: Sweet edible pacifier during tube feeds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Experimental group 2: Latex pacifier during tube feeds</td>
</tr>
<tr>
<td></td>
<td>Control group: No pacifier. Maternal heart beat played during tube feeds</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Anthropometric measurements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sucking measures</td>
</tr>
<tr>
<td></td>
<td>Age at full oral feeds</td>
</tr>
</tbody>
</table>

| Notes                               | Latex pacifier group used as experimental group for analysis |

**Risk of bias**

<table>
<thead>
<tr>
<th>Item</th>
<th>Authors' judgement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allocation concealment?</td>
<td>Yes</td>
<td>A - Adequate</td>
</tr>
</tbody>
</table>
### McCain 1992

| Methods                  | Randomized, multiple crossover  
|                         | Blinding of randomization - No  
|                         | Blinding of intervention - No  
|                         | Blinding of outcome assessors - No  
|                         | Complete follow-up - Yes  
| Participants            | Mean gestational age - 31.6 weeks  
|                         | Mean birth weight - 1.649kg  
|                         | Sample size = 20  
| Interventions           | Experimental group 1: Pacifier before bottle feeds x 10 minutes  
|                         |Experimental group 2: Pacifier before bottle feeds with stroking/rocking x 10 minutes  
|                         | Control group: No pacifier  
| Outcomes                | Behaviour  
|                         | Heart rate  
| Notes                   |  

**Risk of bias**

<table>
<thead>
<tr>
<th>Item</th>
<th>Authors' judgement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allocation concealment</td>
<td>No</td>
<td>C - Inadequate</td>
</tr>
</tbody>
</table>

### McCain 1995

| Methods                  | Randomized, crossover  
|                         | Blinding of randomization - No  
|                         | Blinding of intervention - No  
|                         | Blinding of outcome assessors - No  
|                         | Complete follow-up - Yes  
| Participants            | Mean gestational age - 31.6 weeks  
|                         | Mean birth weight - 1.649kg  
|                         | Sample size = 20  
| Interventions           | Experimental group: Pacifier before bottle feeds x 10 minutes  
|                         | Control group: No pacifier  
| Outcomes                | Behaviour  
|                         | Heart rate  
|                         | Length of feeding time/oral intake  
| Notes                   | The samples in McCain 1992 and 1995 are the same. McCain 1992 was the first phase of a study analyzing outcomes prior to feeds. This study analyzed the outcomes during feeds.  

**Risk of bias**

<table>
<thead>
<tr>
<th>Item</th>
<th>Authors' judgement</th>
<th>Description</th>
</tr>
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Non-nutritive sucking for promoting physiologic stability and nutrition in preterm infants (Review)  
Copyright © 2009 The Cochrane Collaboration. Published by John Wiley & Sons, Ltd.
McCain 1995  (Continued)

<table>
<thead>
<tr>
<th>Item</th>
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<th>Description</th>
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<tbody>
<tr>
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Measel 1979

<table>
<thead>
<tr>
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<th>Alternate sequential series and matching</th>
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<tr>
<td></td>
<td>Blinding of intervention - No</td>
</tr>
<tr>
<td></td>
<td>Blinding of outcome assessors - Yes</td>
</tr>
<tr>
<td></td>
<td>Complete follow-up - Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Participants</th>
<th>Gestational age 28 - 34 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Birth weight &gt; 1.0kg</td>
</tr>
<tr>
<td></td>
<td>Sample size = 59 (30 in Control and 29 in Exp groups)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Interventions</th>
<th>Experimental group: Pacifier during tube feed and 5 minutes after feed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control group: No pacifier during feed or 5 minutes after feed</td>
</tr>
<tr>
<td></td>
<td>Both groups: Pacifier between feeds PRN</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Weight gain</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Readiness for bottle feeds</td>
</tr>
<tr>
<td></td>
<td>Feeding performance during first bottle feed</td>
</tr>
</tbody>
</table>

Notes

Risk of bias

<table>
<thead>
<tr>
<th>Item</th>
<th>Authors' judgement</th>
<th>Description</th>
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<tbody>
<tr>
<td>Allocation concealment?</td>
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Pickler 1993

<table>
<thead>
<tr>
<th>Methods</th>
<th>Method of allocation - uncertain (author clarification being sought)</th>
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<tbody>
<tr>
<td></td>
<td>Blinding of intervention - No</td>
</tr>
<tr>
<td></td>
<td>Blinding of outcome assessors - No</td>
</tr>
<tr>
<td></td>
<td>Complete follow-up - Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Participants</th>
<th>Gestational age - 26 - 34 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Birth weight - 0.81 - 1.99kg</td>
</tr>
<tr>
<td></td>
<td>Sample size = 20 (10 in each group)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Interventions</th>
<th>Experimental group: Pacifier before bottle feed x 5 minutes and after bottle feed x 5 minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control group: No pacifier</td>
</tr>
</tbody>
</table>
### Pickler 1993  (Continued)

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Behaviour</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Feeding performance</td>
</tr>
<tr>
<td></td>
<td>Oxygen saturation</td>
</tr>
<tr>
<td></td>
<td>Heart rate</td>
</tr>
</tbody>
</table>

#### Notes

### Risk of bias

<table>
<thead>
<tr>
<th>Item</th>
<th>Authors' judgement</th>
<th>Description</th>
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<tbody>
<tr>
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### Pickler 1996

#### Methods

<table>
<thead>
<tr>
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</tr>
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<tr>
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</tr>
<tr>
<td></td>
<td>Blinding of intervention - No</td>
</tr>
<tr>
<td></td>
<td>Blinding of outcome assessors - No</td>
</tr>
<tr>
<td></td>
<td>Complete follow-up - Yes</td>
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</table>

#### Participants

<table>
<thead>
<tr>
<th></th>
<th>Mean gestational age - 29.5 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean birth weight - 1.3577kg</td>
</tr>
<tr>
<td></td>
<td>Sample size = 13</td>
</tr>
</tbody>
</table>

#### Interventions

<table>
<thead>
<tr>
<th></th>
<th>Experimental group: Pacifier pre-bottle feed x 2 minutes prior to 2 feeds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control group: No pacifier</td>
</tr>
</tbody>
</table>

#### Outcomes

<table>
<thead>
<tr>
<th></th>
<th>Behaviour</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Feeding performance</td>
</tr>
<tr>
<td></td>
<td>Heart rate</td>
</tr>
<tr>
<td></td>
<td>Oxygen saturation</td>
</tr>
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#### Notes

### Risk of bias

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<tbody>
<tr>
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<td>A - Adequate</td>
</tr>
</tbody>
</table>
## Pickler 2004

<table>
<thead>
<tr>
<th>Methods</th>
<th>Randomized, crossover Blinding of randomization - No Blinding of intervention - No Blinding of outcome assessors - No Complete follow-up - Yes</th>
</tr>
</thead>
</table>
| Participants | Gestational age <32 weeks  
No known cognitive, neurologic, cardiovascular, gastrointestinal or craniofacial disorder  
Sample size = 13  
(data collection completed on 10) |
| Interventions | Experimental group: Pacifier pre-bottle feed x 2 minutes prior to 1 feed  
Control group: No pacifier for 1 feed |
| Outcomes | Behavioral state |
| Notes | |

### Risk of bias

<table>
<thead>
<tr>
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<th>Description</th>
</tr>
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<tbody>
<tr>
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<td>No</td>
<td>C - Inadequate</td>
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</table>

## Sehgal 1990

| Methods | Method of allocation - uncertain  
(author clarification being sought)  
Blinding of intervention - No  
Blinding of outcome assessors - Can't tell  
Complete follow-up - Yes |
|----------|----------------------------------------------------------------------------------------------------------------------------------|
| Participants | Gestational age < 35 weeks  
Birth weight < 1.8kg  
Sample size = 40 (20 in each group) |
| Interventions | Experimental group: Pacifier during tube feed x 3 minutes  
Control group: No pacifier |
| Outcomes | Anthropometric measures  
Length of nursery stay  
Transition time to bottle feeds  
Stool frequency  
Time to ingest first 8 bottle feeds |
| Notes | |

### Risk of bias

<table>
<thead>
<tr>
<th>Item</th>
<th>Authors’ judgement</th>
<th>Description</th>
</tr>
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</table>
### Szabo 1985

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<thead>
<tr>
<th>Allocation concealment?</th>
<th>Unclear</th>
<th>B - Unclear</th>
</tr>
</thead>
</table>

#### Methods
- Randomized, multiple cross-over
- Blinding of randomization - Yes
- Blinding of intervention - No
- Blinding of outcome assessors - No
- Complete follow-up - Yes

#### Participants
- Gestational age - 33-36 weeks
- Birthweight: < 1500 g
- Sample size = 10

#### Interventions
- Experimental group: Pacifier during tube feed for 5 minutes
- Control group: No pacifier
- Group III: Nutritive suck for 1/2 feed

#### Outcomes
- Gastric emptying

#### Notes
- Group III not used in analysis

### Risk of bias

<table>
<thead>
<tr>
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<th>Authors' judgement</th>
<th>Description</th>
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<tbody>
<tr>
<td>Allocation concealment?</td>
<td>Yes</td>
<td>A - Adequate</td>
</tr>
</tbody>
</table>

### Widstrom 1988

| Methods                  | Randomized, crossover
|--------------------------|------------------------|
|                          | Blinding of randomization - No
|                          | Blinding of intervention - No
|                          | Blinding of outcome assessors - Can't tell
|                          | Complete follow-up - Yes |

| Participants             | Mean gestational age - 32.3 weeks
|--------------------------| Mean birth weight - 1.826kg
|                          | Taking 2-4 bottle feeds/day
|                          | Sample size = 8

| Interventions            | Experimental group: Pacifier 15 minutes before tube feed and during feed. Pacifier offered between feeds.
|--------------------------| Control group: No pacifier

| Outcomes                 | Somatostatin level
|--------------------------| Gastrin level
|                          | pH

---

*Non-nutritive sucking for promoting physiologic stability and nutrition in preterm infants (Review)*

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### Woodson 1988a

| Methods                  | Non-randomized cross-over  
|                         | Blinding of intervention - No  
|                         | Blinding of outcome assessors - No  
|                         | Complete follow-up - Yes  
| Participants            | AGA preterm infants receiving intermediate care  
|                         | Sample size = 24  
| Interventions           | NNS Period: Pacifier given 30 minutes after bottle feeding followed by no pacifier  
|                         | No NNS Period: No pacifier after bottle feed x 30 minutes followed by pacifier  
| Outcomes                | Heart rate  
| Notes                   | Outcomes assessed between feeds  

### Risk of bias

<table>
<thead>
<tr>
<th>Item</th>
<th>Authors' judgement</th>
<th>Description</th>
</tr>
</thead>
</table>
| Allocation concealment?     | No                 | C - Inadequate  

### Woodson 1988b

| Methods                  | Non-randomized cross-over  
|                         | Blinding of intervention - No  
|                         | Blinding of outcome assessors - No  
|                         | Complete follow-up - Yes  
| Participants            | AGA preterm infants receiving intermediate level care  
|                         | Sample size = 13  
| Interventions           | Pacifier given between every other bottle feed x 12 hours  
| Outcomes                | Heart rate  
| Notes                   | Outcomes assessed between feeds  

### Risk of bias

<table>
<thead>
<tr>
<th>Item</th>
<th>Authors' judgement</th>
<th>Description</th>
</tr>
</thead>
</table>
| Allocation concealment?     | Unclear            | D - Not used  

---

**Non-nutritive sucking for promoting physiologic stability and nutrition in preterm infants (Review)**

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Risk of bias

<table>
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<tr>
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<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Allocation concealment?</td>
<td>Unclear</td>
<td>D - Not used</td>
</tr>
</tbody>
</table>

Yu 1999

Methods
Randomized cross-over
Blinding of intervention - No
Blinding of outcome assessors - No
Complete follow-up - Yes

Participants
Gestational age < 37 weeks. Birth weight < 2.0 kg. Sample size = 11. 176 events analyzed (4 feeds/day x 4 days).

Interventions
Experimental groups: Group 1 received 3 minutes of NNS prior to bottle feeding; Group 2 received 5 minutes of NNS prior to bottle feeding. Control Group: No NNS

Outcomes
Amount of feeding in first 5 minutes
Amount of total feeding
Feeding time
Feeding rate
Behavioral state

Notes
English translation from Chinese required.

Risk of bias

<table>
<thead>
<tr>
<th>Item</th>
<th>Authors' judgement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allocation concealment?</td>
<td>No</td>
<td>C - Inadequate</td>
</tr>
</tbody>
</table>

Characteristics of excluded studies  [ordered by study ID]

<table>
<thead>
<tr>
<th>Study</th>
<th>Reason for Exclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bingham 2003</td>
<td>Non-nutritive sucking is not the intervention</td>
</tr>
<tr>
<td>Burroughs 1981</td>
<td>Not experimental or quasi-experimental</td>
</tr>
<tr>
<td>Daniels 1988</td>
<td>Not experimental or quasi-experimental</td>
</tr>
</tbody>
</table>
| Kimble 1992   | Term infants
No clinical outcomes
Not experimental or quasi-experimental |
<table>
<thead>
<tr>
<th>Study</th>
<th>Sample Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marchini 1987</td>
<td>Term infants</td>
</tr>
<tr>
<td>Miller 1993</td>
<td>Term infants</td>
</tr>
<tr>
<td>Narayanan 1991</td>
<td>No intervention</td>
</tr>
<tr>
<td>Neeley 1979</td>
<td>Term infants</td>
</tr>
<tr>
<td>Orenstein 1988</td>
<td>Term infants</td>
</tr>
<tr>
<td>Paludetto 1984</td>
<td>Not experimental or quasi-experimental</td>
</tr>
<tr>
<td>Paludetto 1986</td>
<td>Not experimental or quasi-experimental</td>
</tr>
<tr>
<td>Standley 2003</td>
<td>Non-nutritive sucking not the primary intervention</td>
</tr>
<tr>
<td>Woodson 1985</td>
<td>Term infants</td>
</tr>
<tr>
<td></td>
<td>Not experimental or quasi-experimental</td>
</tr>
</tbody>
</table>
### DATA AND ANALYSES

#### Comparison 1. Nonnutritive sucking vs control in premature infants

<table>
<thead>
<tr>
<th>Outcome or subgroup title</th>
<th>No. of studies</th>
<th>No. of participants</th>
<th>Statistical method</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Weight gain (g/day)</td>
<td>3</td>
<td>103</td>
<td>Mean Difference (IV, Fixed, 95% CI)</td>
<td>1.57 [-0.37, 3.50]</td>
</tr>
<tr>
<td>2 Heart rate (beats/min)</td>
<td>4</td>
<td>126</td>
<td>Mean Difference (IV, Fixed, 95% CI)</td>
<td>-1.42 [-5.90, 3.07]</td>
</tr>
<tr>
<td>3 Oxygen saturation (%)</td>
<td>3</td>
<td>72</td>
<td>Mean Difference (IV, Fixed, 95% CI)</td>
<td>1.04 [-0.04, 2.13]</td>
</tr>
<tr>
<td>4 Length of hospital stay (days)</td>
<td>2</td>
<td>87</td>
<td>Mean Difference (IV, Fixed, 95% CI)</td>
<td>-7.15 [-12.60, -1.70]</td>
</tr>
<tr>
<td>5 Intestinal transit time (hours)</td>
<td>1</td>
<td>20</td>
<td>Mean Difference (IV, Fixed, 95% CI)</td>
<td>-1.0 [-7.14, 5.14]</td>
</tr>
<tr>
<td>6 Energy intake (kcal/kg/day)</td>
<td>1</td>
<td>20</td>
<td>Mean Difference (IV, Fixed, 95% CI)</td>
<td>-2.0 [-21.36, 17.36]</td>
</tr>
<tr>
<td>7 Post-conceptional age at full oral feeds (days)</td>
<td>1</td>
<td>28</td>
<td>Mean Difference (IV, Fixed, 95% CI)</td>
<td>-1.70 [-46.06, 42.66]</td>
</tr>
</tbody>
</table>

#### Analysis 1.1. Comparison 1 Nonnutritive sucking vs control in premature infants, Outcome 1 Weight gain (g/day).

**Review:** Non-nutritive sucking for promoting physiologic stability and nutrition in preterm infants

**Comparison:** 1 Nonnutritive sucking vs control in premature infants

**Outcome:** 1 Weight gain (g/day)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Favors control</th>
<th>Favors treatment</th>
<th>Mean Difference (IV, Fixed, 95% CI)</th>
<th>Weight</th>
<th>Mean Difference (IV, Fixed, 95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ernst 1989</td>
<td>9</td>
<td>9</td>
<td>38.7 %</td>
<td>0.50</td>
<td>[ -2.61, 3.61 ]</td>
</tr>
<tr>
<td>Field 1982</td>
<td>30</td>
<td>27</td>
<td>50.9 %</td>
<td>2.80</td>
<td>[ 0.08, 5.52 ]</td>
</tr>
<tr>
<td>Mattes 1996</td>
<td>14</td>
<td>14</td>
<td>10.4 %</td>
<td>0.50</td>
<td>[ -6.50, 5.50 ]</td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td><strong>53</strong></td>
<td><strong>50</strong></td>
<td><strong>100.0 %</strong></td>
<td><strong>1.57</strong></td>
<td><strong>[-0.37, 3.50]</strong></td>
</tr>
</tbody>
</table>

Heterogeneity: Chi² = 1.70, df = 2 (P = 0.43); I² =0.0%

Test for overall effect: Z = 1.58 (P = 0.11)
### Analysis 1.2. Comparison 1 Nonnutritive sucking vs control in premature infants, Outcome 2 Heart rate (beats/min).

**Review:** Non-nutritive sucking for promoting physiologic stability and nutrition in preterm infants

**Comparison:** 1 Nonnutritive sucking vs control in premature infants

**Outcome:** 2 Heart rate (beats/min)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>Mean(SD)</td>
<td>N</td>
<td>Mean(SD)</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>McCain 1992</td>
<td>20</td>
<td>152.1 (12.2)</td>
<td>20</td>
</tr>
<tr>
<td>McCain 1995</td>
<td>20</td>
<td>162.1 (13.3)</td>
<td>20</td>
</tr>
<tr>
<td>Pickler 1993</td>
<td>10</td>
<td>160.3 (12.9)</td>
<td>10</td>
</tr>
<tr>
<td>Pickler 1996</td>
<td>13</td>
<td>161.6 (14.4)</td>
<td>13</td>
</tr>
</tbody>
</table>

**Total (95% CI):** 63 63 100.0 % \[-1.42, 3.07\]

Heterogeneity: $\chi^2 = 9.05$, df = 3 ($P = 0.03$); $I^2 = 67$

Test for overall effect: $Z = 0.62$ ($P = 0.54$)

### Analysis 1.3. Comparison 1 Nonnutritive sucking vs control in premature infants, Outcome 3 Oxygen saturation (%).

**Review:** Non-nutritive sucking for promoting physiologic stability and nutrition in preterm infants

**Comparison:** 1 Nonnutritive sucking vs control in premature infants

**Outcome:** 3 Oxygen saturation (%)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Favors control</th>
<th>Favors treatment</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>Mean(SD)</td>
<td>N</td>
<td>Mean(SD)</td>
<td>IV,Fixed</td>
<td>95% CI</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>DiPietro 1994</td>
<td>13</td>
<td>96.4 (2)</td>
<td>13</td>
<td>95.7 (2.6)</td>
<td>37.1 %</td>
</tr>
<tr>
<td>Pickler 1993</td>
<td>10</td>
<td>95.9 (1.6)</td>
<td>10</td>
<td>95 (3)</td>
<td>26.5 %</td>
</tr>
<tr>
<td>Pickler 1996</td>
<td>13</td>
<td>97.5 (1.6)</td>
<td>13</td>
<td>96 (2.9)</td>
<td>36.4 %</td>
</tr>
</tbody>
</table>

**Total (95% CI):** 36 36 100.0 % \[1.04, 2.13\]

Heterogeneity: $\chi^2 = 0.41$, df = 2 ($P = 0.82$); $I^2 = 0$

Test for overall effect: $Z = 1.88$ ($P = 0.059$)
Analysis 1.4. Comparison 1 Nonnutritive sucking vs control in premature infants, Outcome 4 Length of hospital stay (days).

Review: Non-nutritive sucking for promoting physiologic stability and nutrition in preterm infants

Comparison: 1 Nonnutritive sucking vs control in premature infants

Outcome: 4 Length of hospital stay (days)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Favors treatment</th>
<th>Favors control</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>N Mean(SD)</td>
<td>N Mean(SD)</td>
<td>IV,Fixed,95% CI</td>
<td>IV,Fixed,95% CI</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Bernbaum 1983
  - 15 51.9 (8.2)
  - 15 58.7 (9.8)
  - 71.0% -6.80 [-13.27, -0.33]

- Field 1982
  - 30 48 (21)
  - 27 56 (18)
  - 29.0% -8.00 [-18.13, 2.13]

Total (95% CI) 45 42
- 100.0% -7.15 [-12.60, -1.70]

Heterogeneity: Chi² = 0.04, df = 1 (P = 0.84); I² = 0.0%
Test for overall effect: Z = 2.57 (P = 0.010)

Analysis 1.5. Comparison 1 Nonnutritive sucking vs control in premature infants, Outcome 5 Intestinal transit time (hours).

Review: Non-nutritive sucking for promoting physiologic stability and nutrition in preterm infants

Comparison: 1 Nonnutritive sucking vs control in premature infants

Outcome: 5 Intestinal transit time (hours)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Favors treatment</th>
<th>Favors control</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>N Mean(SD)</td>
<td>N Mean(SD)</td>
<td>IV,Fixed,95% CI</td>
<td>IV,Fixed,95% CI</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- DeCurtis 1986
  - 10 19 (7)
  - 10 20 (7)
  - 100.0% -1.00 [-7.14, 5.14]

Total (95% CI) 10 10
- 100.0% -1.00 [-7.14, 5.14]

Heterogeneity: not applicable
Test for overall effect: Z = 0.32 (P = 0.75)
Analysis 1.6. Comparison 1 Nonnutritive sucking vs control in premature infants, Outcome 6 Energy intake (kcal/kg/day).

Review: Non-nutritive sucking for promoting physiologic stability and nutrition in preterm infants

Comparison: 1 Nonnutritive sucking vs control in premature infants

Outcome: 6 Energy intake (kcal/kg/day)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Favors treatment</th>
<th>Favors control</th>
<th>Mean Difference</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>DeCurtis 1986</td>
<td>10</td>
<td>10</td>
<td>-2.00</td>
<td>100.0%</td>
</tr>
<tr>
<td></td>
<td>129 (20)</td>
<td>131 (24)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>10</td>
<td>10</td>
<td>-2.00 [ -21.36, 17.36 ]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>100.0%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: not applicable

Test for overall effect: Z = 0.20 (P = 0.84)

Analysis 1.7. Comparison 1 Nonnutritive sucking vs control in premature infants, Outcome 7 Post-conceptional age at full oral feeds (days).

Review: Non-nutritive sucking for promoting physiologic stability and nutrition in preterm infants

Comparison: 1 Nonnutritive sucking vs control in premature infants

Outcome: 7 Post-conceptional age at full oral feeds (days)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Favors treatment</th>
<th>Favors control</th>
<th>Mean Difference</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mattes 1996</td>
<td>14</td>
<td>14</td>
<td>-1.70</td>
<td>100.0%</td>
</tr>
<tr>
<td></td>
<td>249.7 (62.08)</td>
<td>251.4 (57.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>14</td>
<td>14</td>
<td>-1.70 [ -46.06, 42.66 ]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>100.0%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: not applicable

Test for overall effect: Z = 0.08 (P = 0.94)

WHAT'S NEW

Last assessed as up-to-date: 13 July 2005.
**HISTORY**


<table>
<thead>
<tr>
<th>Date</th>
<th>Description</th>
<th>Notes</th>
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</thead>
<tbody>
<tr>
<td>14 July 2005</td>
<td>New search has been performed</td>
<td>This review updates the existing review of “Non-nutritive sucking for promoting physiologic stability and nutrition in preterm infants” which was published in The Cochrane Library, Issue 3, 2003 (Pinelli 2003). One new trial (Pickler 2004) was identified and included as a result of the most recent search.</td>
</tr>
<tr>
<td>14 July 2005</td>
<td>New citation required but conclusions have not changed</td>
<td>Substantive amendment</td>
</tr>
</tbody>
</table>

**DECLARATIONS OF INTEREST**

None

**INDEX TERMS**

**Medical Subject Headings (MeSH)**

*Infant Care; Sucking Behavior; Infant, Newborn; Infant, Premature [*physiology]; Infant Nutritional Physiological Phenomena; Weight Gain*

**MeSH check words**

Humans