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

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[Intervention Review]

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 They were asked if they knew of any other published or unpublished studies relevant to the area that had not been included in the original list.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. There were also a number of limitations of the presently available evidence related to the design of the studies, outcome variability, and lack of long-term data. Based on the available evidence, NNS in preterm infants would appear to have some clinical benefit. It does not appear to have any short-term negative effects.

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 co-ordinated sucking, swallowing and breathing pattern. In preterm

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.

This review updates the existing review of non-nutritive sucking in premature infants which was published in The Cochrane Library, Issue 3, 2003. Oxford:Update software.

OBJECTIVES

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 methodologic 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.

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.

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* *Indicates the major publication for the study*

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Bernbaum 1983

Methods	Randomized Blinding of randomization - Yes Blinding of intervention - No Blinding of outcome assessors - Can't tell Complete follow-up - Yes
Participants	Appropriate for gestational age Birth weight < 1.5kg Sample size = 30 (15 in each group)
Interventions	Experimental group: Pacifier during tube feed only Control group: No pacifier
Outcomes	Weight, length, head circumference Gastrointestinal transit time Sucking behaviour Time taken for first 5 bottle feeds Days for transition to oral feeds Length of hospital stay
Notes	Random envelope assignment (information supplied by author)

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Yes	A - Adequate

Burroughs 1978

Methods	Pretest-posttest design Blinding of intervention - No Blinding of outcome assessors - Can't tell Complete follow-up - Yes
Participants	Gestational age < 37 weeks Birth weight > 1.0kg Sample size = 11
Interventions	No sucking (pretreatment), pacifier (treatment), no sucking (post-treatment)
Outcomes	TcPO2 measured pre-intervention, during the intervention, post-intervention.

Burroughs 1978 (*Continued*)

Notes		
Risk of bias		
Item	**Authors' judgement**	**Description**
Allocation concealment?	Unclear	D - Not used

DeCurtis 1986

Methods	Randomized, crossover Blinding of randomization - can't tell Blinding of intervention - No Blinding of outcome assessors - Can't tell Complete follow-up - Yes
Participants	Mean gestational age - 28.8 weeks Mean birthweight - 1.111kg Sample size = 10
Interventions	Experimental group: Pacifier during tube feeds. Control group: No pacifier.
Outcomes	Energy and nitrogen balance Net nitrogen utilization Fat absorption Gastrointestinal transit time
Notes	

Risk of bias		
Item	**Authors' judgement**	**Description**
Allocation concealment?	Unclear	B - Unclear

DiPietro 1994

Methods	Randomized, crossover Blinding of randomization - No Blinding of intervention - No Blinding of outcome assessors - No Complete follow-up - Yes
Participants	Gestational age - 1.0 - 2.0kg Birth weight < 34 weeks Sample size = 36

DiPietro 1994 (*Continued*)

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

Item	Authors' judgement	Description
Allocation concealment?	No	C - Inadequate

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

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

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
Notes	

Risk of bias

Item	**Authors' judgement**	**Description**
Allocation concealment?	Unclear	B - Unclear

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

Gill 1988 (*Continued*)

Notes		
Risk of bias		
Item	**Authors' judgement**	**Description**
Allocation concealment?	Yes	A - Adequate

Gill 1992

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 = 42 Number randomized to each group=21
Interventions	Experimental group: Pacifier before bottle feed x 5 minutes Control group: No pacifier
Outcomes	Behaviour
Notes	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Yes	A - Adequate

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 (*Continued*)

Interventions	Experimental group: Pacifier during and after feeds and when awake. Control group: No pacifier. Stroked when restless.
Outcomes	Gastrin Motilin Insulin Insulin-like growth factor
Notes	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Yes	A - Adequate

Mattes 1996

Methods	Randomized Blinding of randomization - Yes Blinding of intervention - No Blinding of outcome assessors - Can't tell Complete follow-up - Yes
Participants	Gestational age < 34weeks Birth weight > 1.25kg Sample size = 42 Number randomized to each group=14
Interventions	Experimental group 1: Sweet edible pacifier during tube feeds Experimental group 2: Latex pacifier during tube feeds Control group: No pacifier. Maternal heart beat played during tube feeds
Outcomes	Anthropometric measurements Sucking measures Age at full oral feeds
Notes	Latex pacifier group used as experimental group for analysis

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Yes	A - Adequate

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

Item	Authors' judgement	Description
Allocation concealment?	No	C - Inadequate

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

McCain 1995 (*Continued*)

Item	Authors' judgement	Description
Allocation concealment?	No	C - Inadequate

Measel 1979

Methods	Alternate sequential series and matching Blinding of intervention - No Blinding of outcome assessors - Yes Complete follow-up - Yes
Participants	Gestational age 28 - 34 weeks Birth weight > 1.0kg Sample size = 59 (30 in Control and 29 in Exp groups)
Interventions	Experimental group: Pacifier during tube feed and 5 minutes after feed Control group: No pacifier during feed or 5 minutes after feed Both groups: Pacifier between feeds PRN
Outcomes	Weight gain Readiness for bottle feeds Feeding performance during first bottle feed
Notes	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	D - Not used

Pickler 1993

Methods	Method of allocation - uncertain (author clarification being sought) Blinding of intervention - No Blinding of outcome assessors - No Complete follow-up - Yes
Participants	Gestational age - 26 - 34 weeks Birth weight - 0.81- 1.99kg Sample size = 20 (10 in each group)
Interventions	Expermental group: Pacifier before bottle feed x 5 minutes and after bottle feed x 5 minutes Control group: No pacifier

Pickler 1993 (*Continued*)

Outcomes	Behaviour Feeding performance Oxygen saturation Heart rate
Notes	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Pickler 1996

Methods	Randomized, crossover Blinding of randomization - Yes Blinding of intervention - No Blinding of outcome assessors - No Complete follow-up - Yes
Participants	Mean gestational age - 29.5 weeks Mean birth weight - 1.3577kg Sample size = 13
Interventions	Experimental group: Pacifier pre-bottle feed x 2 minutes prior to 2 feeds Control group: No pacifier
Outcomes	Behaviour Feeding performance Heart rate Oxygen saturation
Notes	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Yes	A - Adequate

Pickler 2004

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

Item	Authors' judgement	Description
Allocation concealment?	No	C - Inadequate

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

Item	Authors' judgement	Description

Sehgal 1990 (*Continued*)

Allocation concealment?	Unclear	B - Unclear

Szabo 1985

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

Item	**Authors' judgement**	**Description**
Allocation concealment?	Yes	A - Adequate

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

Widstrom 1988 (*Continued*)

Notes	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	No	C - Inadequate

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	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	D - Not used

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

Woodson 1988b (*Continued*)

Risk of bias		
Item	**Authors' judgement**	**Description**
Allocation concealment?	Unclear	D - Not used

Yu 1999

Methods	Randomized cross-over Blinding of intervention - No Blinding of outcome assessors - No Complete follow-up - Yes
Participants	Gestational age < 37weeks. Birth weight < 2.0kg. Sample size = 11. 176 events analyzed (4 feeds/day x 4 days).
Interventions	Experimental groups: Group 1 recieved 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		
Item	**Authors' judgement**	**Description**
Allocation concealment?	No	C - Inadequate

Characteristics of excluded studies *[ordered by study ID]*

Bingham 2003	Non-nutritive sucking is not the intervention
Burroughs 1981	Not experimental or quasi-experimental
Daniels 1988	Not experimental or quasi-experimental
Kimble 1992	Term infants No clinical outcomes Not experimental or quasi-experimental

(*Continued*)

Marchini 1987	Term infants
Miller 1993	Term infants
Narayanan 1991	No intervention
Neeley 1979	Term infants
Orenstein 1988	Term infants
Paludetto 1984	Not experimental or quasi-experimental
Paludetto 1986	Not experimental or quasi-experimental
Standley 2003	Non-nutritive sucking not the primary intervention
Woodson 1985	Term infants Not experimental or quasi-experimental

DATA AND ANALYSES

Comparison 1. Nonnutritive sucking vs control in premature infants

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

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)

Study or subgroup	Favors control N	Mean(SD)	Favors treatment N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Ernst 1989	9	30.3 (3)	9	29.8 (3.7)		38.7 %	0.50 [-2.61, 3.61]
Field 1982	30	19.3 (4.9)	27	16.5 (5.5)		50.9 %	2.80 [0.08, 5.52]
Mattes 1996	14	24.3 (7.1)	14	24.8 (9)		10.4 %	-0.50 [-6.50, 5.50]
Total (95% CI)	**53**		**50**			**100.0 %**	**1.57 [-0.37, 3.50]**

Heterogeneity: Chi^2 = 1.70, df = 2 (P = 0.43); I^2 =0.0%

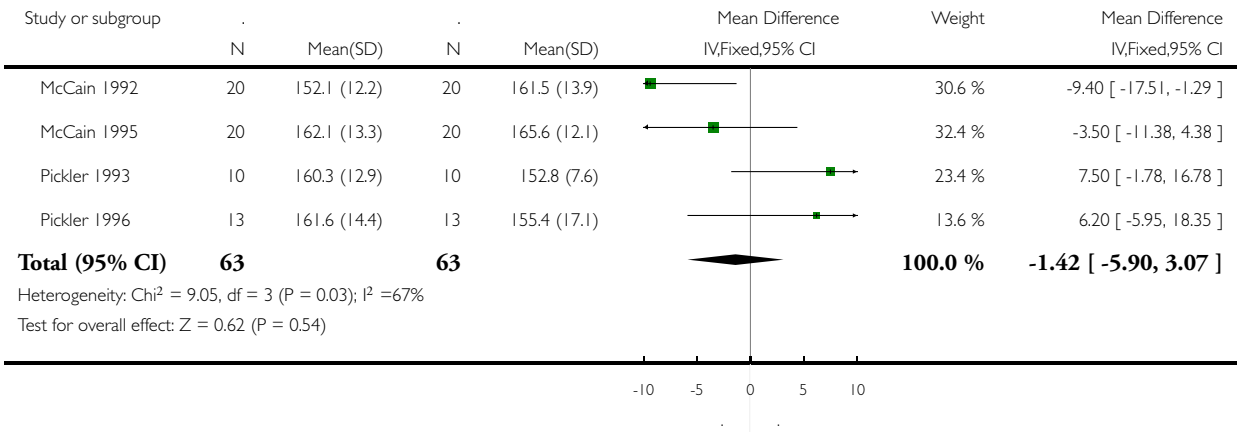
Test for overall effect: Z = 1.58 (P = 0.11)

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)

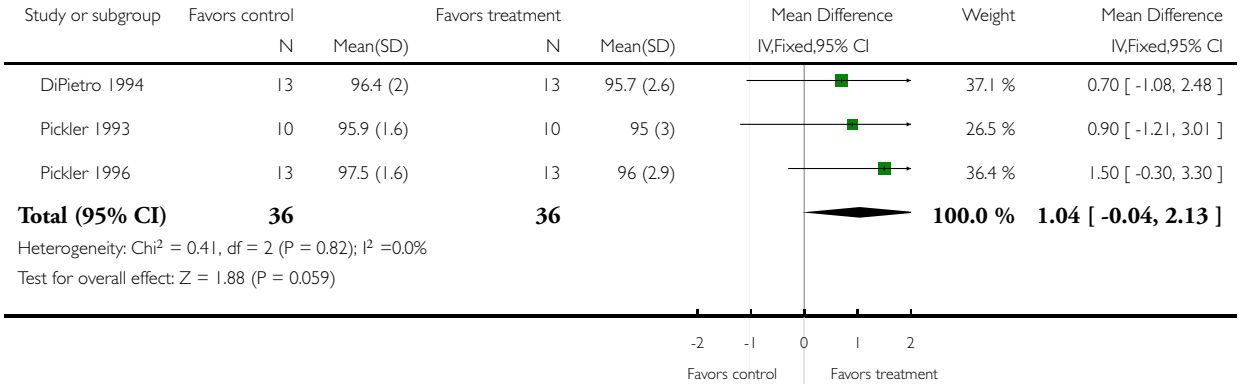


Analysis 1.3. Comparison 1 Nonnutritive sucking vs control in premature infants, Outcome 3 Oxygen saturation (%).

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 (%)



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)

Study or subgroup	Favors treatment N	Mean(SD)	Favors control N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
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

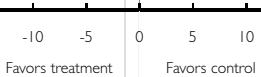
Comparison: 1 Nonnutritive sucking vs control in premature infants

Outcome: 5 Intestinal transit time (hours)

Study or subgroup	Favors treatment N	Mean(SD)	Favors control N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
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)

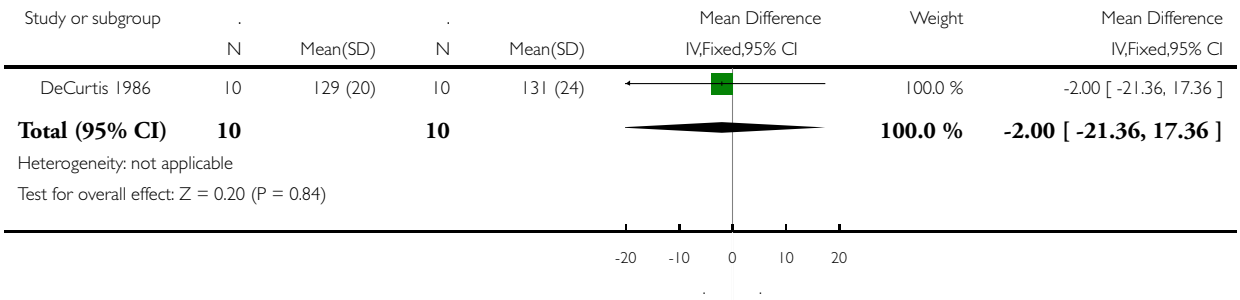


Analysis 1.6. Comparison 1 Nonnutritive sucking vs control in premature infants, Outcome 6 Energy intake (kcal/kg/day).

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)

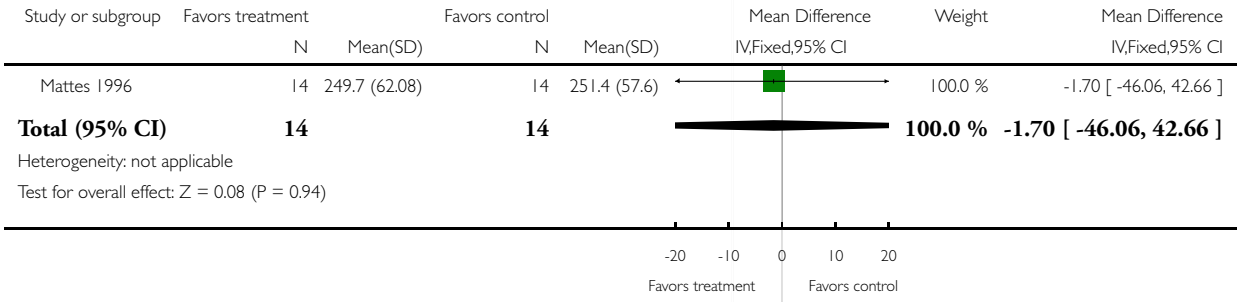


Analysis 1.7. Comparison 1 Nonnutritive sucking vs control in premature infants, Outcome 7 Post-conceptional age at full oral feeds (days).

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)



WHAT'S NEW

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

28 October 2008	Amended	Converted to new review format.

HISTORY

Protocol first published: Issue 2, 1998

Review first published: Issue 3, 1998

14 July 2005	New search has been performed	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.
14 July 2005	New citation required but conclusions have not changed	Substantive amendment

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