Using Non-nutritive sucking to support feeding development for premature infants: A commentary on approaches, current practice and recent systematic reviews.

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Abstract

Non-nutritive sucking is often used with premature infants by either using a pacifier or an expressed breast nipple to support the introduction and development of early oral feeding. The pattern of non – nutritive sucking is distinct in that it involves two sucks per second in contrast to nutritive sucking which is one suck per second. Although some literature has identified that non – nutritive sucking has some benefit for the premature infant's feeding development, it is not entirely clear why such an approach is helpful as neurologically, activation of non – nutritive and nutritive skills are different. A summary is presented of the main approaches that use non – nutritive sucking with reference to the literature. This paper also considers other factors and beneficial approaches to managing the introduction of infant feeding. These are: the infant's toleration of enteral feeds pre oral trials, overall development and gestational age when introducing oral experiences, developing swallow skills before sucking, physiological stability, health status and the development and interpretation of infant oral readiness signs and early communication.

Key words:

Infant; premature; non-nutritive sucking; feeding; nutrition; communication

Introduction

Premature infants are highly likely to have difficulties starting, developing and maintaining feeding skills (1). Estimates of the rates of feeding difficulties in premature infants vary with 26.8% of low birthweight infants demonstrating airway protection problems (2), and up to 40 % of premature infants aged between 25 – 37 weeks gestational birth age showing signs of aspiration (3). More recently, a survey in Holland identified prevalence rates for feeding difficulties in neonatal units as being 20.4% (4). Nurses and therapists on neonatal units use a range of approaches to

support the introduction and development of oral feeding, including non – nutritive sucking and cue based infant driven feeding, but there are wide variations in methods used, with little consistency in practice (5). A Cochrane Review which investigated valid tools to assess infant oral readiness found that no studies met the inclusion criteria for the review, and the authors concluded that at present, there was no clear evidence available to inform clinical practice in this area (6). Non – nutritive sucking (NNS) has dominated the literature in relation to developing premature infant oral feeding competence. Foster et al (7) in their Cochrane Review found that although NNS enabled quicker transition to full oral feeding, and reduced number of days in hospital, it did not have any consistent benefit on infant physiological behaviour or weight gain (See Table 1 for Search Terms). Similarly, Greene et al (8) identified that NNS shortened the time to full oral feeding, reduced the time on tube feeds and reduced hospital stay, although longer term benefits were not clear (See Table 2 for Search Terms). Non – nutritive sucking is a more tangible strategy used with premature infants, compared with the identification of oral readiness signs. This may explain why many studies have focused more in researching this area. The focus of this Commentary is to consider the complexities involved when introducing oral feeding to premature infants.

Table 1: Search Strategy and Terms used by Forster et al, (2016) in their Cochrane review of non-nutritive sucking and its benefits for physiologic stability and nutrition

Cochrane Central Register of Controlled Trials (CENTRAL 2016, Issue 1) Clinical trial registries for ongoing or recently completed trials (clinicaltrials.gov; the World Health Organization's International Trials Registry and Platform www.whoint/ictrp/search/en/, and the ISRCTN Registry). MEDLINE via PubMed (1996 to 25 February 2016) Embase (1980 to 25 February 2016) CINAHL (1982 to 25 February 2016) Search terms used: (non-nutritive AND suck*) OR (nonnutritive AND suck*) OR (pacifier OR dummy) No language restrictions were applied. No date limits were applied. 12 studies reviewed.

Table 2: Search Strategy and Terms used by Greene et al, (2016) in their Cochrane review of oral – stimulation to promote oral feeding

Cochrane Central Register of Controlled Trials (CENTRAL 2016, Issue 1) and The Cochrane Collaboration and Cochrane Neonatal Review Group Clinical trial registries for ongoing or recently completed trials (clinicaltrials.gov; the World Health Organization's International Trials Registry and Platform www.whoint/ictrp/search/en/, and the ISRCTN Registry). MEDLINE via PubMed (1996 to current) Embase (1980 to current) The Cumulative Index to Nursing and Allied Health Literature (CINAHL; 1982 to current) Search terms used: (non-nutritive suck*) OR pacifier OR dummy OR (myofunctional therapy) OR oromotor OR (oral motor) OR sensorimotor OR ((suckOR oralOR orocutaneous OR physical OR mechanical OR sensory OR somatosensory OR pre-feeding) AND (stimulation OR training OR support) AND(feed*OR growth) No language restrictions were applied. 19 studies reviewed.

Problems feeding for premature infants

Sucking in typically developing infants is a vigorous activity supported by circulatory and digestive functions which require autonomic system involvement (9). Premature infants find the

initial development of sucking skills difficult due to immature respiratory and neurological systems. Consequently, when feeding is being introduced, the development of the suck – swallow – breathe cycle required for full oral feeding and maintaining stamina to maintain feeding are challenging (10;11). Co-ordination of the suck – swallow – breathe cycle is rarely established before 34 weeks gestation (12). In the development of early infant feeding, stable swallowing appears before a rhythmical suck pattern (13). Premature infants, therefore, may have developed a competent swallow but can have persistent difficulties learning to coordinate the sucking with the swallow-breathe sequence necessary for successful feeding. (12).

Ineffective suck - swallow - breathe cycles during early feeding can lead to variable oxygenation and irregular patterns of breathing, hypoxia, apnoea and / or bradycardia (1;10;12). Effective respiration patterns during oral feeding trials can be further complicated by the presence of a feeding tube. Weak pharyngeal pressure due to immature upper oesophageal sphincter function can inhibit the initiation of successful oral feeding, and subsequently this can interrupt sequential sucking development (11). Immature motor skills and hypotonia can contribute to weak sucking pressure, decreased sucking bursts, variable suck pressures throughout the feed and compromised oral intake (14). Premature infants may have a range of health needs, in particular respiratory problems, which may interrupt establishment of a consistent suck-swallow-breathe cycle which in turn impact on motor and sensory development during a period of critical brain development (12; 15). Specifically, infants born prematurely with significant respiratory problems often have increased respiratory rates, with a less rhythmic coordination of swallowing and respiration during feeding, leading to risk of aspiration (14). As the infant matures, they are developing a wider range of infant states, including oral readiness signs although these may be variable when beginning the process of oral feeding (16).

Current practice when introducing oral feeding for premature infants

There are a wide range of approaches which neonatal staff use when introducing oral feeding to premature infants (5). Infant states and developing oral readiness signs are considered to be important indicators of infant readiness to feed, but which specific strategies to use and when are unclear in the literature (17). Introducing oral feeding with premature infants is likely to be varied because of differing rates of infant development (18; 19). There are some published checklists and assessment tools available which evaluate premature infant feeding and swallowing, but these are rarely in standard use in neonatal units (20). These tools cover a wide range of early feeding skills relevant for premature infants and may only focus on some of the skills required to achieve successful full oral feeding. Currently, no randomized controlled trials have evaluated these tools for determining successful feeding (6). Typically, although there may be variation in the methods neonatal practitioners use, many may focus on an infant's ability to manage a pacifier, (non – nutritive sucking), toleration of enteral feeding, weight gain, observing and monitoring the development of infant states and allowing an infant to go at a manageable pace when beginning oral feeding (5;21). There are many factors which influence oral feeding success, but it is interesting to note using a pacifier to provide oral and sensory motor stimulation through NNS has generated a high level of investigation (8).

What is Non – Nutritive Sucking?

With typically developing infants, nutritive and non – nutritive sucking differ in a number of ways. Both NS and NNS have different intra-oral pressures (22). Nutritive sucking is the process of obtaining nutrition initially at a rate of one suck per second, whereas NNS occurs at two sucks per second in the absence of milk (23). Nutritive sucking maintains a consistent sequential pattern during feeding with an alternation between expression and suction when sucking (9). The process involves the co-ordination of sucking , swallowing and breathing involving the lips, cheeks, jaw, tongue, palate, pharynx and larynx working together (9). During nutritive sucking, the suck – swallow

ratio of 1:1 changes in the first month of life, with patterns of 2:1 and 3:1 emerging as the infant matures (24). Premature infants also develop sequential nutritive sucking skills in the same way as term infants as they mature, though this process may take longer to establish depending upon their initial feeding experiences and health status (9; 10). *The therapeutic use of non-nutritive sucking*

Non – nutritive sucking (NNS) is frequently used to prepare an infant for oral readiness and feeding in a variety of ways and is described as either oral sensory or motor stimulation (8). Non-nutritive sucking (NNS) and nutritive sucking (NS) are sometimes used as indicators of an infant's oral-motor status and behavioural state (25). However, an infant's potential to suck non-nutritively is only one aspect of oral feeding development, and understanding the rationale and possible outcomes for this approach vary. The ability to suck non – nutritively does not confirm or deny the ability to feed orally, nor can it provide information about the suck – swallow – breathe cycle, as respiratory patterns do not change during NNS in the way that they would during NS; however, they do enable a practitioner to make judgements about sensory, physiological and neurological status at the time of assessment (26). Assessment of potential feeding ability does not just involve oral reflexes, but tolerance of tube feeds, and changes in times between feeds alongside the development of an increased range of infant states pre-feeds (5; 25).

Much of the literature which investigates NNS describes it as a form of oral –sensory and motor stimulation to facilitate the development of NS skills using a prescribed 12 -15 minute programme (27). These programmes typically focus on intensive oral motor work and peri – oral stimulation completed by a practitioner, not a parent (27). They tend to be implemented when the infant is around 34 - 36 weeks gestational age. The notion that NNS will facilitate development of NS through strengthening of muscles and neurological pathways has influenced the rationale for many of these studies (28; 29; 30; 31; 32; 33; 34; 35). This is an interesting idea given that neurological research highlights that activation sites for both nutritive and non-nutritive oral motor skills are distinct (36), and that one case study has demonstrated that using NNS did not lead to NS for a

substantial time (37). It is also interesting to consider that although some studies have completed the same programme of NNS (27) with infants of similar gestational birth age it is difficult to compare outcomes because of age ranges and the size of the samples within the studies (8). For example, Rocha (33) achieved a mean 38.5 days to full oral feeding with the experimental group (a significant difference compared to the control group = mean 47.2 days), in contrast to Fucile et al (30) whose intervention groups achieved a mean of 10.8 days (a significant difference compared to the control group) to achieve full oral feeding (control group = 20.7 days). Lessen (35) also completed the same programme and the experimental group had a mean of 18.1 days transitioning to full oral feeding (control group = 23.4 days), with no significant differences between the groups. Variations in outcomes could be due to differences in samples and sample sizes, with Rocha et al (33) investigating 98 very low birthweight infants compared with Fucile (30) who had a sample of 75, and Lessen who evaluated 19 infants. Rocha and Fucile refer to gestational age, with sample participants ranging in gestational birth age from 28. 4 – 32.2 weeks, and Fucile, 26 – 32 weeks (30; 33). Lessen (35) included infants aged 27.5 – 28.9 but referred to post menstrual age. These differences make it difficult to draw conclusions about the efficacy of the approach.

Another method uses NNS either before tube feeding or on onset of tube feeding in a non – specific way to develop carer interpretation of both oral readiness skills and awareness of other infant states (38; 39). In this context, NNS is used to stimulate sequential sucking to enable parents to learn to identify and respond to varying infant states, and once the infant is ready to begin oral trials, NNS is used to support the infant to achieve a [quiet alert] state required for oral feeding. As mothers of premature infants are at greater risk of developing mental health problems, studies which investigate approaches that enable parent – infant interaction to develop as part of infant feeding programmes would be beneficial (40).

Non - nutritive sucking appears to help some infants to develop NS by supporting physiological stability and developing infant oral readiness states pre-feeding. The infants who

benefit most from NNS as an approach where it seems to help the development of oral feeding are those who seem to have no significant additional medical problems. However, it seems likely that this success may not be entirely for the reasons hypothesized by the majority of the studies which discuss NNS (28; 29; 30; 31; 32; 33; 34; 35). As a premature infant matures and as gestational age increases, NS patterns increase in frequency with a decrease in time required for each sucking burst, but in comparison NNS patterns tend to show less variety with maturation (24). This is important as studies investigating NNS show maturational changes with both NS and NNS, therefore it would be difficult to confirm that changes in NS are attributable to NNS practice and not simply the results of maturation.

Other methods that support the introduction of oral feeding for premature infants

Other strategies that support the development of infant feeding have comparable outcomes to NNS, such as targeting the swallow before sucking (41), and cue based infant -led feeding (21; 42). As competent swallowing develops a stable pattern before sucking (13), Lau and Smith (41) compared stimulation of the swallow with milk in comparison with other approaches, including NNS. **.** Seventy infants born 24 – 33 weeks gestation were randomly allocated to a control group, a NNS group or a swallow group at 34 weeks gestation. In the swallow group, infants received 0.05 – 0.2 mls presented between the medial and posterior part of the tongue 30 minutes before receiving a feed. The NNS group received stimulation using a pacifier, and the control group received the usual care of the neonatal unit. There were no significant differences between the control group infants and the NNS group infants, with the control infants taking 20.8 ± 1.9 days, and the NNS infants taking 18.9 ± 0.5 days to move onto full oral feeding. In contrast, the swallow group infants moved onto full oral feeding significantly more rapidly than their peers, taking 14.6 ± 1.6 days. These results are comparable with outcomes relating to full oral feeding in the NNS studies.

In comparison, stimulation of the swallow and cue - based infant driven feeding have demonstrated similar outcomes to the studies using NNS. Being able to interpret infant signs and

states is becoming more recognised as an important aspect of infant maturation, and is also important in supporting parent – infant bonding (38). Using this approach, Kirk et al., (21) investigated 28 infants aged 36 ± 1 post menstrual age, and found that they achieved full oral feeding 6 days sooner than controls. Using a cue –based infant driven approach has been shown to decrease length of hospital stay by 6.63 days (21). When data are stratified according to gestational birth age, infants less than 28 weeks gestational birth age are discharged 9 days earlier, and take full oral feeds 17 days sooner; infants aged 28 – 31 gestational birth age are discharged 9 days earlier, and take full oral feeds 11 days earlier, and infants aged 32 -33 weeks gestational birth age are discharged 3 days sooner and take full oral feeds 3 days sooner compared to control infants (43). The findings from this study compare favourably with the outcomes presented for the NNS studies mentioned in the Greene et al Cochrane review (8).

Conclusions

Non - nutritive sucking has dominated the literature on developing oral feeding for premature infants. Both Cochrane Reviews (7; 8) which explore NNS from a nursing (7) and a therapy (8) perspective, highlight the fact that the quality of evidence for NNS as an approach is low, with small numbers of participants included in the studies considered. Both authors suggest that further controlled trials be undertaken to investigate the efficacy of NNS. There are a variety of studies which utilise NNS for different purposes, and the literature tends to focus on using NNS to promote physiological stability or as a method of promoting nutritive sucking abilities (7; 8). As an approach, NNS is undoubtedly beneficial for premature infants who do not have additional medical problems. The evidence for NNS does show significant benefits, but the reasons for progress for the infants studied are not clear (7; 8; 28; 29; 30; 31; 32; 33; 34; 35). In light of this, future research needs to investigate the infant's overall development, swallow skills before sucking, well designed studies which evaluate NNS using rater-reliable assessment tools, toleration of enteral feeds pre-oral trials, physiological stability, health status and the development and interpretation of infant oral readiness

signs. Consideration of these factors would enable neonatal units to develop oral feeding protocols which can support a positive early feeding experience for infants. Thinking about early communication and parent – infant interaction is an additional important part of the early feeding experience (21).With the increased risks mothers of premature infants are of developing mental health problems, training parents to identify and respond to infant states to stimulate early communication whilst in the neonatal unit caring for their infant and integrating these communication goals into everyday tasks such as feeding can potentially enhance parent mental health outcomes, and also enrich an infant's communication environment.

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Cite as: Harding, C., Cockerill, H., Cane, C., & Law, J. (2018). Using non-nutritive sucking to support feeding development for premature infants: A commentary on approaches and current practice. *Journal of pediatric rehabilitation medicine*, *11*(3), 147-152.

Acknowledgements: Thanks, as always to L. Frank, Adv. Nurse Practitioner; Karina Wyles, Matron; Adele Mynard, Senior Nurse; A. Hollings; Dr. V. Van Someren; Dr. T. Wickham, Emily Hills, OT.

Statement of conflict of interest: Dr. C. Harding was a co – author of a grant in 2014 as follows: *Craig G; Harding C; Flood C, et al. NIHR 14-04-04, How do different neurodisability services meet the psychosocial support needs of children / young people with feeding disabilities & their families?, £376,000.*
There are no other conflicts of interest for any of the other authors.