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Assessment and management of infant feeding

Some infants have difficulty establishing the consistent suck-swallow-breathe cycle that is important for the development of competent feeding. This article summarises the progress of nine infants with neurodevelopmental disorders to consider the core components necessary for a comprehensive feeding assessment for vulnerable infants. It also highlights the main approaches used to support the development of infant feeding.

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Key points

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1. Not all infants will have achieved full oral feeding when they go home from neonatal care.
2. Supporting parents to identify infant states is an important part of oral feeding and oral care development.
3. It is important that practitioners who work with infants understand the rationale underpinning approaches that support infant feeding.

Feeding requires coordination of sucking, swallowing and breathing. Infants demonstrate two types of sucking: nutritive sucking (NS) and non-nutritive sucking (NNS).[1] NS is the intake of fluid that occurs when there is an alternation between expression and suction at one suck per second, whereas NNS does not involve any nutrient flow and is at two sucks per second.[1] NS is coordinated with swallowing and breathing.[2] Oral readiness, usually demonstrated by waking for feeds, is an essential part of feeding development.[3]

The feeding problems seen in vulnerable infants are likely to be multifactorial in origin. Difficulties include an ineffective cycle of sucking, swallowing and breathing which can lead to variable oxygenation, irregular breathing sequence and consequently poor digestion.[4] The lack of ability to develop a suck-swallow-breathe cycle could be due to other factors such as poor motor skills and posture, an immature autonomic nervous system, gastro-oesophageal reflux or fatigue effects from heart difficulties. Underdeveloped or abnormal neurology, eg central nervous system damage or neuromuscular disorders, can also impact on feeding development.[4]

As an infant matures sucking amplitude, rate, pressure, timing of sucking cycles, sucking efficiency and proficiency begin to change and become more consistent over time. These sucking attributes are important in the development of competent feeding. Undeveloped motor skills and abnormal muscle tone can contribute to weak sucking pressure, a decreased sucking cycle, variable pressure throughout the feed, and reduced oral intake.[5] Poor general health, particularly respiratory difficulties, may delay the development of competent feeding skills and impact on the establishment of a consistent suck-swallow-breathe cycle.[6]

Few studies discuss the management of infants who struggle to develop competent feeding skills; the vast majority of articles that look at feeding in premature infants focus on NNS and its link to development of oral feeding.[7] For infants with more complex needs, NNS does not have similar benefits. This is because NS and NNS have different and distinct sites of neurological activation.[8,9] However, NNS is important in helping parents and carers to learn to focus on the differing states of their infants as well as helping the preparation of an appropriate state to attempt some feeding or oral care. This article summarises the progress of nine infants with neurodevelopmental disorders who used NNS to help focus their parents' attention on the developing infant states. It also summarises the main types of approaches that focus on maximising feeding and oral motor competence.

Assessment of early oral motor and feeding skills

Observation

Observation focuses on the infant's interaction with the environment, in particular parent-infant responsiveness, and can provide important information about developing behavioural states.[10] Infant states are well classified with descriptors that include: deep sleep, quiet alert, active sleep, active alert, drowsiness, crying and indeterminate states.[10] For

premature infants, observation and helping the infant to develop oral readiness signs are important when preparing for the introduction of oral feeding.[11,12] The same approaches to observing infants with neurodevelopmental problems should also be followed.[13] Oral readiness is one of the key markers that practitioners use when deciding if progression to oral feeding is an option. A coordinated swallow is present at 34 weeks' gestation and can be the most effective time to consider the introduction of some oral feeding.[4]

Heart rate and bradycardia are often important indicators of autonomic control and stability during observation.[14,15] In premature infants, autonomic control is not fully developed until 37-38 weeks' gestation but infants with neurodevelopmental problems may also show difficulties beyond this age.[16] An increase in respiratory effort can interrupt the sequential nature of the swallow process and lead to aspiration risk.[14,15]

Oral motor examination

An oral motor examination must include evaluation of muscle tone, the palate (both the anterior and posterior palate, with checks made for any clefts), tongue, jaw and general appearance of the oral cavity, ie presence of any oral residue. Examination of the tongue should include an evaluation of NNS to ascertain the type of sucking pattern the infant uses.[12] Some available assessments require a practitioner to have training, such as the neonatal oral motor assessment scale (NOMAS).[17] An infant may display normal, disorganised or dysfunctional sucking. Disorganised sucking is characterised by bursts of 3-5 sucks with varying pauses between each burst. This pattern is immature in its presentation. Dysfunctional sucking refers to unusual or inconsistent movements. This does not mean that the infant will not develop the ability to feed orally, but indicates that there may be difficulties that indicate slower progress to achieve oral feeding.[4,13] Infant sucking rates change in the first month of life: from 55 sucks per minute to 70 sucks per minute.[18] The suck-swallow ratio of 1:1 also changes in the first month, with patterns of 2:1 and 3:1 emerging.[18]

Reflexes provide an important marker of sensory status[19] and reflexes for assessment include the biting reflex, rooting reflex, stimulation of the cough reflex and the gag reflex. Activation of the gag is different from initiation of a cough; the gag utilises glossopharyngeal sensory input (cranial nerve XI) and vagal motor output (cranial nerve X) whereas the cough reflex involves superior laryngeal (vagal) sensory input with recurrent laryngeal motor and glottic closure output.[8] Although the gag does not provide specific information about the swallow, it can provide important sensory information and give an indication of any changes that are occurring in neurological status.[19]

Oral readiness

Alertness, hunger signs and NNS competence are often assessed in combination with a review of successful weight gain, respiratory stability and general physiological stability before a tube feed or when suckling on an empty expressed breast nipple.[20]

Oral trials

An oral trial can involve a small amount (5-20mL) of milk or water (via syringe, bottle or breast).[21] This amount will allow evaluation of bolus organisation and some sequential movements, and assessment of the suck-swallow-breathe cycle, which is important for successful feeding.[1]

Management strategies to support infant feeding

Using NNS during the initial part of a tube feed (gastrostomy, nasogastric or nasojejunal) may, though not always, facilitate transition to oral feeding. It can help to:[11,15]

- calm the infant
- support state regulation and establish an association between sucking and satiation
- support oral care
- enhance parent/carer and child interaction.

Regular use of NNS during tube feeding can be important as a method of using verbal coaching to support parent interpretation of infant communication states and can lead to quicker discharge home for those infants without difficulties.[11,13] Parents can be taught to identify their infant's states and to 'read' their early communication as part of overall feeding management.[11]

Strategies involving close skin-to-skin contact with a parent[22] can be used to support development of autonomic stability as well as parent-infant bonding. This is important as an immature autonomic system can impact on the suck-swallow-breathe cycle leading to variable oxygenation, irregular breathing sequence and inadequate digestion.[4,23]

More unstable infants may benefit from work on the swallow first as stable swallow function emerges before sequential sucking.[4] Small amounts of milk (50-200μL) delivered initially by a syringe are recommended for this approach.[21] Once the swallow is established, pacing can be used with small amounts of milk so that the infant learns to develop a suck-swallow-breathe pattern during feeds.[18]

Managing any amount of oral intake is dependent on safety of the swallow and tolerance of feeds. Dodrill et al[24] suggest that management needs to include a combination of factors such as physiological states, respiration, gastrointestinal aspects, NNS and NS patterns, readiness cues and the needs of parents and carers. Moving towards full oral feeding is often indicated by the infant taking 75-80% of the oral feed, at least 4-6 feeds per day or being on the breast for 5-20 minutes with 'good sucking'.[24] For more compromised infants, small amounts of oral intake or an oral care programme must be considered to support carer-infant bonding and interaction[12,13] Other factors, such as speed of milk flow from a bottle teat or whether nipple shields are needed to help support the development of breastfeeding, are important considerations.[25]

Positioning may be used to help promote the best head and neck support in the process of feeding. For bottle fed infants, side lying can ensure a patent airway and also reduces the effort of maintaining a more upright and sustained position.[26] It also helps the infant to develop a sustained experience of consistent sequential sucking with the suck-swallow-breathe cycle.[2,15,27]

There may be problems with managing the flow of milk when learning to bottle feed, particularly with premature infants or term infants with neurodisability.[4] When bottle feeding, a vulnerable infant's respiratory rate may decrease, which compromises ventilation and tidal volume. The reduction of ventilation results in less oxygenation of the blood and a build up of carbon dioxide leading to apnoeic episodes and bradycardia.[14]

Sometimes more viscous milk or thickeners are recommended, although the use of thickeners for premature infants is often criticised due to perceived:[9]

Case	Sex	Gestational age (weeks)	Birth weight (g)	Medical information	Days in hospital	Method of feeding on discharge	Days to FOF
1	M	35	2106	IUGR	39	NGT/b	-
2	M	37	2844	Down's syndrome; hypotonia	16	b	14
3	F	41	3980	Beckwith-Wiedemann syndrome; apnoea when feeding	7	Thickened milk in bt	7
4	M	37	2834	Down's syndrome; hypotonia; VSD	9	NGT/bt	-
5	M	37	2705	Down's syndrome	25	NGT/b	-
6	F	37	2260	Sepsis; severe perinatal hypoxia	33	NGT/bt	-
7	F	34	1890	IUGR; GOR	92	GT/bt	-
8	F	40	3120	Floppy at birth; poor suck	7	NGT/bt	112
9	F	31	2650	Hypotonic; poor reflexes; GOR	56	NGT/bt	-

TABLE 1 Characteristics of the infant participants. Key: M = male, F = female, FOF = full oral feeds, GT = gastrostomy tube, NGT = nasogastric tube, b = breastfeeding, bt = bottle feeding, IUGR = intrauterine growth retardation, VSD = ventricular septal defect, GOR = gastro-oesophageal reflux disease.

- reduction in the absorption of nutrients from milk
- difficulties with absorption in the immature gut
- greater risk of necrotising enterocolitis.

Some thickening agents are used with term infants to increase the viscosity of milk but for premature infants, practitioners usually alter the flow of a bottle teat. Often rate of milk flow is evaluated and a different teat may be trialled, so for example, a slow flow teat may enable an infant to learn to develop a successful suck-swallow-breathe sequence.[25]

Clinical examples

Nine infants born between 30 and 42 weeks' gestation were recruited to participate in this study (**TABLE 1**). Three infants were diagnosed with Down's syndrome (Cases 2, 4 and 5) and one with Beckwith-Wiedemann syndrome (Case 3). The remaining five infants did not have identifiable diagnoses, but did present with a range of difficulties including dysfunctional sucking on initial assessment (**TABLES 1 AND 2**), variable states of muscle tone, variable displays of oral reflexes and limited ability to feed effectively or safely to complete feeds. The parents were trained to use NNS to identify infant states and to prepare the infant pre-oral trials and pre-tube feeds. All infants remained in hospital until a feeding regime was established (either oral, tube or mixed approach). The infants' days in hospital ranged from 7-92 days (median 9.37; mean 31.5; mode 7; standard deviation 28.08). These outcomes compare favourably with other studies that include premature infants who do not have additional difficulties.[7] Infants were monitored on discharge from the hospital for the first six months of life. Ethical approval was gained from the NHS Integrated Research Application System committee at a London hospital. Parents were informed of the study with relevant information, and informed signed consent was obtained.

Assessment

Upon initial assessment, the following skills were identified:

- Two infants (Cases 3 and 7) had some normal sucking patterns
- Eight infants (Cases 1, 2, 3, 4, 5, 7, 8, 9) had some disorganised sucking patterns
- Seven infants (Cases 1, 2, 4, 5, 6, 8, 9) had some dysfunctional sucking patterns

None of the infants with Down's syndrome (Cases 2, 4 and 5) showed any features of a normal sucking pattern on assessment; all shared similar disorganised and dysfunctional sucking patterns. Only one of the three (Case 2) went home fully orally fed.

On assessment, features that prevented the implementation of full oral feeding included:

- a high level of oral residue
- aspiration signs, including significant apnoea episodes during oral trials
- an inability to sustain a short suck-swallow-breathe sequence during an oral trial
- an MRI that indicated a neurological presentation likely to impact on feeding, eg cerebellar and basal ganglia damage or immature development
- inconsistent demonstration of oral reflexes
- information provided by videofluoroscopy that demonstrated aspiration.

Skills on discharge

On discharge, the following skills were identified:

- Five infants (Cases 2, 3, 4, 7, 8) had some features of normal sucking patterns
- Eight infants (Cases 1, 3, 4, 5, 6, 7, 8, 9) had some features of disorganised sucking patterns
- Four infants (Cases 1, 5, 6, 9) had some features of dysfunctional sucking patterns
- Three infants (Cases 2, 3, 8) went home fully orally fed. Case 2 took 14 days to achieve full oral feeding, Case 3 took seven days and Case 8 took 112 days.

Only one infant (Case 6) developed no normal sucking patterns. He had significant reflux and had a range of difficulties related to his severe perinatal hypoxia. He had a gastrostomy inserted and an oral care programme implemented to stimulate oral sensitivity and to reduce the presence of oral pathogens.

Features that supported transition to partial or full oral feeding included:

- stable oral reflexes
- reduced oral residue

Case	Disorganised suck pattern at initial assessment	Disorganised suck pattern on discharge	Dysfunctional suck pattern at initial assessment	Dysfunctional suck pattern on discharge	Normal suck pattern at initial assessment	Normal suck pattern on discharge
1	2	6	2	1	0	0
2	4	0	3	0	0	10
3	5	5	0	0	8	8
4	4	1	3	0	0	7
5	5	5	5	5	0	0
6	0	4	10	6	0	0
7	5	7	0	0	2	2
8	4	6	6	0	0	4
9	3	5	2	5	0	0

TABLE 2 Neonatal oral motor assessment scale (NOMAS) sucking patterns[17] of infant participants.

- no aspiration signs during oral trials
- evidence of fewer dysfunctional suck patterns
- no clear evidence of neurological problems identified by an MRI
- an increase in weight and an increase in oral feeding beyond 50% of required intake.

The Wilcoxon signed rank test was used to evaluate the NOMAS scores[17] of normal, disorganised and dysfunctional sucking patterns for all infants pre-feeding assessment and on discharge from hospital. Normal sucking patterns increased from zero to two within the sample, but a high number of tied scores did not permit a Wilcoxon calculation. For disorganised sucking, there was a median increase from two to four (not significant) and for dysfunctional sucking, there was a median decrease from three to zero (not significant).

Premature infants with no significant additional differences demonstrate that their sucking patterns become less disorganised and more mature as they develop feeding skills.[3,4] In this small sample, the infants with neurodisability demonstrated a variety of sucking patterns (**TABLE 2**). Although there were some changes in sucking these were not predictable, as with infants who do not have any difficulties. These signs of erratic sucking patterns should be regarded as important indicators, alongside other factors (such as general health, respiratory difficulties and variable muscle tone), to suggest that establishing oral feeding may be a lengthy procedure and that equal attention must be given to non-oral feeding methods that consider both infant and carer well-being.

Although a sucking pattern can provide important information in terms of predicting outcomes, it needs to be considered alongside other information such as NS trials, maturity, general stability and any other relevant medical information (eg neurological examination).

Summary

Supporting infants and their parents to make the transition from tube feeding and oral care, through to partial oral feeding alongside non-oral feeding, requires the use of a range of strategies. Use of NNS needs to be clearly explained to parents, especially for those infants where oral feeding will not be an option. If full oral feeding is not going to develop, reaching a compromise with parents that enables some oral stimulation or small amounts of nutrition with good interaction should be achieved.

This article suggests that training parents about an infant's state through verbal coaching, using NNS and establishing an important communication agenda during non-oral feeding, can contribute towards improving quality of life for both infants and parents. Some oral intake, when judged to be safe, can have important physiological and health benefits, which should not be underestimated.

This article also outlines the most important pre-feeding skills for those infants who are taking time to learn to feed orally, but who can move beyond the need for alternative feeding and progress to full oral feeding at their own pace, with the support of professionals with expertise in management of infant feeding.

Ethics approval

Ethical approval was gained from the London Central National Research Ethics Service Committee.

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