Acta Pædiatrica ISSN 0803–5253

REGULAR ARTICLE

The reliability of the Neonatal Oral-Motor Assessment Scale

Saakje P da Costa (s.p.da.costa@pl.hanze.nl)[1], Cees P van der Schans[2]

1.School for Health Care Studies, Hanze University Groningen, University for Applied Sciences, Eyssoniusplein 18, 9714 CE Groningen, the Netherlands
2.Centre for Applied Research and Innovation in Health Care and Nursing, Hanze University Groningen, Groningen, the Netherlands

Keywords
Oral feeding performances, Oral motor problems, Preterm infants, Sucking skills, Swallowing

Correspondence
S. P. da Costa, School for Health Care Studies, Hanze University Groningen, University for Applied Sciences, Eyssoniusplein 18, NL-9714 CE Groningen, the Netherlands.
Tel./Fax: +31 (0)50 526 8776 |
Email: s.p.da.costa@pl.hanze.nl

Received
16 February 2007; revised 26 April 2007; accepted 15 October 2007.

DOI:10.1111/j.1651-2227.2007.00577.x

Abstract

Objectives: Sucking problems in preterm infants can be specified by means of visual observation. The Neonatal Oral-Motor Assessment Scale (NOMAS) is the visual observation method most commonly used to assess the non-nutritive sucking (NNS) and nutritive sucking (NS) skills of infants up to approximately 8 weeks postterm. During the first 2 min of a regular feeding the infant's sucking skill is assessed, either immediately or on video. Although NOMAS has been used since 1993, little is known about the method's reliability. The aim of our study was to determine the test-retest and inter-rater reliability of NOMAS.

Methods: The 75 infants included in this study were born at 26–36 weeks postmenstrual age (PMA). Four observers participated in the study. They were trained and certified to administer NOMAS in the Netherlands by M.M. Palmer between 2000 and 2002.

Results: We found the test-retest agreement of NOMAS to be 'fair' to 'almost perfect' (Cohen's kappa [κ] between 0.33 and 0.94), whereas the inter-rater agreement with respect to the diagnosis was 'moderate' to 'substantial' (Cohen's κ, between 0.40 and 0.65). As a diagnostic tool, however, the current version of NOMAS cannot be used for both full-term and preterm infants. For a measuring instrument such as NOMAS, one should aim at reliability coefficients for inter-rater and test-retest agreement of at least 0.8. A Cohen's κ of 0.6 or less we find unacceptable. Nonetheless, by observing sucking and swallowing according to a protocol much useful information can be gathered about the development of an infant's sucking skills. For instance, whether the infant is able to co-ordinate sucking and swallowing, whether the infant can maintain sucking, swallowing and breathing during the continuous phase and whether the infant is able to suck rhythmically with equally long bursts. In addition, NOMAS offers useful aids for intervention.

Conclusions: NOMAS should be re-adjusted in order to improve inter-rater agreement, and at the same time current insights into the development of sucking and swallowing should be incorporated in the method.

INTRODUCTION

Feeding problems occur frequently in preterm infants during their first year of life (1), particularly in infants of gestational age (GA) of 32 weeks or less (2–4). However, the exact prevalence of feeding problems in preterm infants is unknown. In the case of preterm infants, feeding difficulties usually have a medical cause (gastrointestinal, neurological or pulmonary) due to immaturity and diseases of one or more organ systems and often painful, but medically necessary interventions in the infant's face, mouth and throat region related to these problems. Infants born prior to 34-week GA suffer more gastrointestinal and oral sensory problems, such as abnormal oral reflex activity (1,3,4).

Most feeding difficulties in preterm infants are caused by immature or inadequate coordination of the sucking, swallowing and breathing sequence. In cases of impaired coordination, liquid may be aspirated into the trachea and so into the lungs. Aspiration may occur with no observable signs. In some cases infants may choke, be short of breath or have disorders of the respiratory tract, and a decrease in oxygen saturation, apnoea and bradycardia may occur (5).

In case of low birthweight in addition to prematurity these problems are often more serious and longer lasting, particularly in the case of gastrointestinal disorders and if medical interventions such as artificial ventilation had been necessary (3,4). Difficulties during feeding may also lead to insufficient intake. Insufficient intake, especially in the case of a newborn that is ill, may lead to tension on the part of the caregiver. And tense interactions between the infant and his environment could be a breeding ground for behavioural and parent-related feeding problems in the long run. For these reasons it is important to intervene as quickly as possible and to find out whether feeding problems persist over time, or recover.

Sucking and swallowing movements of newborns can be assessed in different ways. In the case of direct assessment, sucking and swallowing can be described by means of various measures such as measuring saturation, heart rate, pharyngeal pressure, breathing pattern, and the duration of inhaling and exhaling (2,6–9). On the basis of these assessments conclusions may be drawn regarding the coordination of breathing and swallowing, sucking pressure, efficiency, frequency and duration, and the respiratory phase in which

swallowing occurs. A drawback of these invasive measuring techniques is the impact they have on the ill newborn, such as tubes down the infant's throat to measure pressure, and the complex measuring and analyzing instruments necessary to generate the data.

Problems with sucking and swallowing can also be specified by means of indirect observation. We can distinguish between clinical feeding assessment and swallowing assessment (9). The standardized assessment methods available to assess nutritive sucking (NS) or oral feeding skills are presented in Table 1 (11–19). Most of these methods can be used either for observing bottle-fed infants (14) or for breastfeeding (11–13,15–17). Five methods, including the Neonatal Oral-Motor Assessment Scale (NOMAS) and the analysis of feeding behaviour with direct linear transformation (DLT) can be used for observing both breastfeeding and bottle-feeding (11,16–19) infants. The fact that the markers on the infant's face have to be placed very carefully and the fact that a DLT procedure is used, are probably the main reasons why the latter method is still little used.

NOMAS (11,20), a visual observation method, is a much used, noninvasive instrument to assess the NS and NNS skills of infants up to the age of about 8 weeks postterm (Table S1). NOMAS allows infant sucking to be divided into three categories on the basis of the 28 items on the scale.

- A normal sucking pattern is displayed by infants who can coordinate sucking, swallowing and breathing properly during both NNS and NS.
- A disorganized sucking pattern can be observed in infants who are unable to coordinate sucking, swallowing and breathing. This pattern is displayed by newborns who suffer from breathing problems, infants with a heart condition or infants with gastrointestinal problems. Before reaching term, preterm infants usually display immature sucking patterns that match their age. If this sucking pattern is seen after term it is considered abnormal. Therefore, the infant's age is an important element to take into account before diagnosing a sucking pattern as disorganized.
- A dysfunctional sucking pattern is displayed by infants whose motor reactions and jaw and tongue movements are abnormal and therefore inadequate, as is the case in infants with neurological (or anatomical) disorders.

The infant's sucking skill is assessed during NNS and during the first 2 min of a regular feeding, either immediately or recorded on video for assessment later on.

Many authors (2,7,8,11,21) indicate that full-term infants have a *continuous* sucking phase during the first 2–3 min. In this phase the oral reflex activity is present most strongly and the sucking bursts are most stable (the sucking-swallowing-breathing rhythm). After 2 min, due to gastrointestinal influences–the stomach filling up so the infant feels less hungry and a reduction of the oral reflex activity–the continuous sucking phase is replaced by the intermittent phase. This phase is characterized by bursts of sucking and a few swallows followed by a 3–5 sec pause. Therefore, sucking becomes less stable and more difficult to assess. In the case of preterm infants (approximately until full-term age), the *continuous phase* only lasts about 30 sec, influenced by neurologic function and cardiorespiratory control (2).

During observation by using NOMAS the researcher does not touch the infant nor is the infant attached to any measuring apparatus. If the infant is too sleepy or does not want to drink for another reason (such as stomach cramps or distractions in its surroundings), the attempt is postponed to a next feeding time. The number of sucking movements during one sucking burst is counted and the duration of the pauses between bouts of sucking is noted. Jaw and tongue movements, such as the degree and rhythm of jaw lowering and tongue cupping, are analyzed on the basis of 28 items and entered on the NOMAS form (Table S1). Even though NOMAS may be used during breastfeeding as well as bottle-feeding, it may be more difficult to administer during breastfeeding because of the flow: infants adjust their way of swallowing to the flow of their mother's milk (11,20). This results in jaw movements of varying speed and magnitude. As a consequence, our clinical observation was that the infants' jaw movements could erroneously be scored as disorganized.

METHOD

In 2004 we started a study on the development of swallowing in preterm infants. Seventy-five infants were included in the study: 15 were at risk for bronchopulmonary dysplasia, 17 were extremely low birthweight preterms and 20 were healthy preterms. The control group comprised 23 healthy full-term infants. The preterm infants were born at 26–36 week GA. We excluded infants from the study who suffered severe multiple congenital disorders, severe predispositional cerebral disorders and periventricular echo densities with cysts. In addition, infants of drug-addicted mothers were also excluded. We examined each infant 10–12 times: once a week between the ages of 34 and 40 weeks postmenstrual age (PMA) and once a fortnight between 40 and 50 weeks PMA. The reliability study was part of the first phase of a research project on the development of sucking patterns in preterm infants and its relationship with neurodevelopmental outcome at 2 and 5 years of age.

Four NOMAS observers participated in our study. They had been trained and certified by M.M. Palmer in the Netherlands between 2000 (observers A and B) and 2002 (observers C and D). In order to qualify for a certificate the assessor is required to correctly assess all three diagnoses on five NOMAS video recordings (i.e. a 100% correct classification into the categories normal, disorganized or dysfunctional), and to obtain 80% agreement on all 28 items per recording (22). Due to practical reasons (illness or pressure of work), the four observers were unable to perform the same number of assessments. Although A observed 54 recordings and B 126, they observed 50 of the same recordings together. Observer C observed 71 recordings and D 42, and they observed 20 recordings together. The four observers together assessed a total of 293 recordings.

Table 1 Assessments of infant oral-sensorimotor function for feeding

Assessment	Description
1. Neonatal Oral-Motor Assessment Scale (NOMAS); Palmer, Crawley and Blanco, 1993 (10)	Checklists of behaviours in categories of normal, disorganized, and dysfunctional tongue and jaw movements. From birth up to 8 weeks' corrected age.
2. Systematic assessment of the infant at the breast (SAIB); Shrago and Bocar, 1990 (11)	Observations related to alignment, areolar grasp, areolar compression and audible swallow.
3. Preterm Infant Breastfeeding Behaviour Scale (PIBBS); Nyqvist et al., 1996 (12)	Diary kept by mother: rooting, amount of breast in mouth, latching, sucking, sucking bursts, swallowing state, letdown and time.
4. Breastfeeding evaluation for term infants; Tobin, 1996 (13)	Purpose: to identify when a mother would benefit from lactation support. List of expectations for feedings. Full-term infants in the neonatal intensive care unit.
5. Bottle-feeding flow sheet; Van den Berg, 1990 (14)	Observations of state, respiratory rate, heart rate, nipple, form of nutrition, position, coordination, support quantity and duration changes over time.
6. Infant feeding evaluation; Swigert, 1998 (15)	Nonstandardized evaluation: means of documenting a variety of observations, including infants' responses to attempted interventions. Devised for birth to 4 months, components for preterm or ill infants not specified.
7. Semi-demand feeding method for healthy preterm infants; McCain, 2003 (16)	The method combines the use of non-nutritive sucking to promote waking behaviour for feeding, use of behavioural assessment to identify readiness for feeding, and systematic observation of and response to infant behavioural cues to regulate frequency, length and volume of oral feedings.
8. Early feeding skills assessment for preterm infants (EFS); Thoyre, Shaker and Pridham, 2005 (17)	A checklist for assessing infant readiness for and tolerance of feeding and for profiling the infant's developmental stage regarding specific feeding skills.
9. Analysis of feeding behaviour with direct linear transformation; Mizuno et al., 2005 (18)	By placing markers on the lateral angle of the eye, tip of the jaw and throat during sucking while the face of the infant is recorded in profile, the jaw and throat movements are calculated using the direct linear transformation (DLT) procedure.

Adapted from Rogers and Arvedson, 2005 (10).

Following Palmer's method, a video recording was made of the infants at different ages during the first 2 min of NS. We stored the recordings on a digital videodisc and two NOMAS assessors assessed each recording. Subsequently, we determined the test-retest and inter-observer reliability. In contrast to Palmer, we determined the reliability of the diagnoses and not that of the items. On average, the four assessors assessed 70 recordings twice with an interval of 3 months between assessments. The data of the first assessment were not available to them on the occasion of the second assessment.

Statistical analysis

Assessor agreement is defined by Popping as 'sameness of classification' (24). According to Popping, Cohen's kappa (κ), that is, 'the proportion of agreement after chance agreement is removed from consideration' (24), is the best measure to determine agreement between assessors in case of the a posteriori method of coding nominal data. As shown in Table 2, a reliability coefficient of 0.60 is considered the minimum for acceptable assessor agreement, whereas $\kappa = 0.80$ or higher is considered 'almost perfect' or 'satisfactory' (24–26). Although no absolute definitions are possible, the following guidelines should help: Cohen's κ is determined between two observers and between two viewings of the same recording by each assessor.

Table 2 Interpretation of Cohen's kappa (κ) values between 0 and 1 (26)

Value of κ	Strength of agreement
0.00–0.20	Slight
0.21–0.40	Fair
0.41–0.60	Moderate
0.61–0.80	Substantial
0.81–1.00	Almost perfect

RESULTS

For test-retest agreement (Table 3) there was a considerable difference between assessor A with the highest score ($\kappa = 0.948$) and D with the lowest score ($\kappa = 0.331$). Thus intra-rater agreement ranged from 'fair' to 'almost perfect'. With average reliability coefficients of 0.67, the test-retest reliability of assessors B and C was 'substantial'.

We were curious to know whether there was a difference in reliability between the assessments of recordings of preterm infants as compared to those of full-term infants. The reason being that it is perhaps easier to assess a mature sucking pattern than it is to assess an immature sucking pattern (see Table 3). Although the number of the observations was incomplete, making it impossible to do a comparison based on figures, we found no indication that there was a difference between the intra-rater agreement of the preterm infants and that of the full-term

Table 3 A comparison of the intrarater agreement between recordings of preterm and full-term infants (number of observations)

Assessors	Total		Preterm infants		Full-term infants	
	Kappa	Number of observations	Kappa	Number of observations	Kappa	Number of observations
A	0.948	54	1.00	31	0.841	23
B	0.694	126	0.685	77	0.718	49
C	0.659	71	0.752	37	0.630	34
D	0.331	42	na	13	0.410	29

na = not available.

Table 4 A comparison of the inter-rater agreement between recordings of preterm and full-term infants (number of observations)

	Total		Preterm infants		Full-term infants	
	Kappa	Number of observations	Kappa	Number of observations	Kappa	Number of observations
A vs. B	0.406	50	0.484	26	0.385	24
C vs. D	0.652	20	0.714	16	na	4

na = not available.

infants. In the case of inter-rater agreement (Table 4), assessors C and D had assessed less than half of the recordings together due to the practical reasons mentioned above. Our results in Table 3 show that assessors A and B agreed with each other less often than did C and D. The interpretation of the reliability coefficients ranged from 'moderate' to 'substantial'.

DISCUSSION

We found the test-retest agreement of NOMAS with respect to the diagnosis to be 'fair' to 'almost perfect' (Table 4), whereas the inter-rater agreement with respect to the diagnosis was 'moderate' to 'substantial' (Table 4). The reason for the 'moderate' inter-rater reliability possibly lay in the lack of agreement in scoring the separate items and/or in the interpretation of some items belonging to the diagnosis 'disorganization'. It is remarkable that the items that score lowest in Palmer's study are the same items that caused confusion and disagreement in our study. What struck us was that one assessor would attach a different diagnosis to the same score than would the other assessor. In particular, this was the case for the items 'inconsistent jaw degree' and 'arrhythmic jaw/tongue movements':

(1) 'Inconsistent jaw degree': The degree of jaw opening that occurs during the suction component can be noted to vary each time, causing jaw excursions to be of unequal size (20, p. 74).

During different courses Palmer issued different statements on this point. During the course she offered in the Netherlands in May 2006, she stated that the diagnosis 'disorganization' might not be given in the presence of this item alone (pers. comm.).

(2) 'Arrhythmic jaw movements': During a 2-min timed segment of sucking, the jaw movements that occur are jerky, inconsistent, irregular and do not flow in a coordinated way. Sucking bursts are of unequal length, and the number of sucks per burst continues to vary throughout the duration of sucking. There may also be intraburst variability as the sucking-swallowing-breathing ratio changes (20, p. 74).

In case of a segment of sucking counting less than 10 sucking-swallowing-breathing movements, it is classified as 'arrhythmic jaw movement' also if it occurs towards the end of the 2-min observation segment. In the meantime it has become clear, however, that in the case of preterm infants it is not realistic to take a 2-min observation segment as point of departure before they have reached term age because a continuous phase in these infants only lasts 30 sec. Some assessors diagnose such situations as normal because the overall impression of sucking is normal.

One of our concerns about using NOMAS as a diagnostic tool is that since NOMAS was developed in 1993 many studies have been published that describe the nutritive and non-nutritive aspects of sucking. We compared Palmer's findings as set out in NOMAS with recent studies on sucking and the development of sucking, swallowing and sucking patterns. Four questions arose regarding several aspects of NOMAS.

(1) Palmer indicates that NOMAS ought to be administered for *at least* 2 min (11). More recently she suggested that NOMAS be administered for *at most* 2 min because the continuous phase of sucking lasts 2 min (23). Mizuno et al. found a continuous phase of 30 sec in preterm infants (2). Does this imply that for the assessment of sucking pattern in preterm infants NOMAS should only be administered for 30 sec?

(2) Palmer mentions '10–30 suck/swallows per burst' as being part of a mature sucking pattern (11, p. 28). She states that:

- The interburst variation should be stable'.
- 'Ten or more sucks per burst means a mature sucking pattern, less than 10 sucks per burst is abnormal and is not part of a mature sucking pattern'.

Palmer does not mention a development in the number of sucking movements per sequence, nor does she specify whether there is a quantitative difference between the number of movements an infant shows in its sucking pattern. Recently, Qureshi et al. spoke of an average of 10 sucking movements per sequence at term and of 20 sucking movements per sequence at 1 month postterm (7). It seems advisable to consider the results of the study by Qureshi et al. when using NOMAS.

(3) Palmer only speaks of a 1:1:1 rhythm when considering bottle-feeding and indicates a nonrhythmic intraburst as abnormal and one that should be scored as disorganized. In breastfeeding, rhythm depends on the flow and a nonrhythmic intraburst (e.g. suck-swallow-breath suck-suck-swallow-breath) is not abnormal and should not be diagnosed as 'disorganization' (11,20).

Qureshi et al. concluded that during the first month of life, infants develop from a 1:1:1 suck-swallow-breath rhythm to a 2:1:1 or 3:1:1 rhythm, thus displaying their increased skill to collect a larger amount of food in the valleculae that is swallowed at once (7).

Palmer does not mention the infant's ability to collect food from a number of sucking movements as part of the maturation process. It signifies the first step towards developing a new way of feeding. We advise noting the number of sucking movements per burst when using NOMAS (11,20). And, in accordance with Qureshi, we advise not to regard a rhythm different from 1:1:1 as abnormal.

(4) In her publications Palmer points out that NOMAS informs us about the jaw and tongue movements during sucking, about the coordination of sucking-swallowing-breathing and about the difference between nutritive and non-nutritive sucking. She also suggests noting the bolus volume the infant ingests during the 2 min of NOMAS administration (23). According to Qureshi, during the first month of life, the amount of cm^3 per swallow doubles and the number of swallowing movements increases to 46–50 per minute (7). We recommend counting the number of swallowing movements per minute as a measure of swallowing efficiency.

Palmer states that NOMAS has predictive value (22). She bases this statement on the finding that 9 out of 34 infants who had a dysfunctional sucking pattern in infancy had developed abnormally when they were re-examined at 2 years of age. The follow-up study included only 18 of the original 34 children, and the result does not specify the degree of abnormal functioning at the age of 2. In our opinion, to say that NOMAS has predictive value on the basis of this evidence, is insufficient. Nevertheless, it appears that practitioners set great store by the value that the diagnosis 'dysfunction' may have regarding expectations of neurodevelopmental outcome at a later age.

NOMAS is used mainly for full-term infants with sucking and swallowing difficulties. Even though it has been in use since 1993, little is known about the instrument's intrarater and test-retest agreement. Palmer (11) studied interrater agreement of each NOMAS item in 35 infants aged 35–49 weeks and weighing more than 1900 g at the time of assessment (23–42 week GA). Palmer did not study the reliability of the method with regard to the diagnosis, as was our aim. The inter-rater agreement of all 26 items, that is, 13 items dealing with the functioning of the tongue and 13 items dealing with the functioning of the jaw, is expressed in percentage agreement and ranges between 63% and 100%. The score on 17 of the 26 items is 80% or higher. Subsequently, Palmer revised NOMAS. She added one item to category 'dysfunction', she subdivided two items into three subitems each, she transferred one item from category 'disorganized' to 'dysfunctional' and she redefined one item (Tables S1 and S2). The reliability of the revised version was not investigated. The large range in agreement between the assessors made it impossible to say anything about the reliability of the classifications by the instrument as a whole. Moreover, Palmer's study did not take into account agreement based on chance as determined by, for instance, Cohen's κ.

In conclusion, the following issues need to be addressed:

NOMAS requires adjustment as far as the instructions about the interpretation of the items is concerned. At present the interpretation and/or classification of the items (especially with regard to the diagnosis 'disorganization') is not consistent. In addition, a clear distinction should be made between the interpretation in the case of bottle-feeding and breastfeeding.

As far as the diagnosis 'disorganization' is concerned, the emphasis should lie on the fact that breathing is not coordinated with sucking and swallowing. Taking into account the extent to which sucking behaviour is diagnosed as disorganized seems meaningful when assessing preterms. In so doing it is possible during follow-up to better assess the development of sucking behaviour and the necessity of intervention.

The length of the time segment to be measured, either preterm or postterm, should be determined on the basis of Mizuno's recent data on the continuous phase prior to term age (2).

According to Qureshi, NOMAS should be extended with the fact that at term an infant should be able to do 10 sucking-swallowing-breathing movements per burst and at 4 weeks of age this should have increased to approximately 20 (7). If an infant is unable to do this, this fact should be incorporated in the diagnosis. The number of swallowing movements per minute should count as a measure for increased efficiency of sucking and swallowing.

Moreover, Qureshi recommends that the diagnosis 'disorganization' should not be based on intraburst arrhythmicity. In the case of this diagnosis, care should be taken with interburst arrhythmicity (7). Until such adjustments come into effect, NOMAS can be used for detailed observation of an infant's sucking pattern for purposes of intervention but not for diagnoses because especially in the case of preterm infants, the differentiation into three diagnoses is not sufficiently reliable if the assessment is performed by different observers. We recommend testing the intraobserver reliability of NOMAS observers. In addition, we advise against involving more than one assessor in the longitudinal follow-up of one and the same infant.

In case NOMAS is used as a means to measure neurodevelopmental outcome for research purposes, we recommend

- that each measurement be assessed by two reliable assessors, and
- to reach a consensus in case of absence of agreement.

Because the test-retest agreement is not sufficient for everyone, the individual observer should be tested regularly and receive extra training if need be. We expect the inter-rater agreement to improve when the test-retest agreement increases, and when the instrument is adjusted. Our point of departure is that the test-retest and inter-rater agreement of measures such as NOMAS should have a Cohen's κ of at least 0.8. As far as we are concerned a Cohen's κ of 0.6 or lower is unacceptable.

References

1. Hawdon JM, Beauregard N, Slattery J, Kennedy G. Identification of neonates at risk of developing feeding problems in infancy. *Dev Med Child Neurol* 2000; 42: 235–9.
2. Mizuno K, Ueda A. The maturation and coordination of sucking, swallowing and respiration in preterm infants. *J Paediatr* 2003; 1: 36–40.
3. Rommel N. Diagnosis of oropharyngeal disorders in young children. Thesis, University of Leuven, 2002.
4. Engel-Hoed Van Den J. Eet-en drinkproblemen bij jonge kinderen. *Acco* 2006: 24–26.
5. Garg BP. Dysphagia in children: an overview. *Semin Pediatr Neurol* 2003; 10: 252–4.
6. Mathew OP. Science of bottle feeding. *J Pediatr* 1991; 119: 511–19.
7. Qureshi MA, Vice FL, Taciak VL, Bosma JF, Gewolb IH. Changes in rhythmic suckle feeding patterns in term infants in the first month of life. *Dev Med Child Neurol* 2002; 44.1: 34–9.
8. Lau C, Kusnierczyk I. Quantitative evaluation of infant's non-nutritive and nutritive sucking. *Dysphagia* 2001; 16.1: 58–67.
9. Gewolb IH, Vice FL. Maturational changes in the rhythms, patterning, and coordination of respiration and swallow during feeding in preterm and term infants. *Dev Med Child Neurol* 2006; 48: 589–94.
10. Rogers B, Arvedson J. Assessment of infant oral sensorimotor and swallowing function. *Ment Retard Dev Disabil Res* 2005; 11.1: 74–82.
11. Palmer MM, Crawley K, Blanco IA. Neonatal Oral-Motor Assessment Scale: a reliability study. *J Perinatol* 1993; XIIL: 28–34.
12. Shrago L, Bocar D. The infant's contribution to breastfeeding. *J Obstet Gynecol Neonatal Nurs* 1990; 19: 209–15.
13. Nyqvist KH, Rubertsson C, Ewald U, Sjoden PO. Development of the Preterm Infant Breast-feeding Behavior Scale (PIBBS): a study of nurse-mother agreement. *J Hum Lact* 1996; 12: 221–8.
14. Tobin DL. A breast-feeding evaluation and education tool. *J Hum Lact* 1996; 12: 47–9.
15. Vandenberg KA. Behaviorally supportive care for the extremely premature infant. In:Gunderson L, Kenner C, editors. *Care of the 24–25 week gestational age infant (small baby protocol)*. San Francisco, CA: Neonatal Network, 1990; 129–57.
16. Swigert N. *The Source® for Pediatric Dysphagia*. 1998; San Diego, CA: Singular.
17. McGain GC, Gartside PS. Behavioral responses of preterm infants to a standard-care and semi-demand feeding protocol. *Newborn Infant Nurs Rev* 2002; 2: 187–93.
18. Thoyre SM, Shaker CS, Pridham KF. The early feeding skills assessment for preterm infants. *Neonat Netw* 2005; 24.3: 7–16.
19. Mizuno K, Aizawa M, Saito S, Kani K, Tanaka S, Kawamura H, et al. Analysis of feeding behavior with direct linear transformation. *Early Hum Dev* 2006; 82: 199–204.
20. Palmer MM. Identification and management of the transitional suck pattern in premature infants. *J Perinat Neonatal Nurs* 1993; 7: 66–75.
21. Lau C, Alagugurusamy R, Schanler RJ, Smith EO, Shulman RJ. Characterization of the developmental stages of sucking in preterm infants during bottle-feeding. *Acta Paediatr* 2000; 89: 846–52.
22. Palmer MM. Developmental Outcome for neonates with dysfunctional and disorganized sucking patterns: preliminary findings. *Transdiscip J* 1999; 3: 299–308.
23. Palmer MM. Personal communication. First Dutch Certification Course. *WKZ/UMCU Utrecht* 2000.
24. Popping R. Overeenstemmingsmaten voor nominale data. Thesis, Rijksuniversiteit Groningen, 1983.
25. Cohen J. A coefficient of agreement for nominal scales. *Educ Psychol Meas* 1960; 20: 37–46.
26. Landis JR, Koch GG. The Measurement of observer agreement for categorical data. *Biometrics* 1977; 33: 159–75.

Supplementary material

The following supplementary material is available for this article:

Table S1 Neonatal Oral-Motor Assessment Scale (NOMAS), 1993 revision (Copyright © 1990 Marjorie Meyer Palmer)
Table S2 Neonatal Oral-Motor Assessment Scale (NOMAS) original 1990 version (Copyright © 1990 Majorie Meyer Palmer)

This material is available as part of the online article from: http://www.blackwell-synergy.com/doi/abs/10.1111/j.1651-2227.2007.00577.x
(This link will take you to the article abstract).

Please note: Blackwell Publishing is not responsible for the content or functionality of any supplementary materials supplied by the authors. Any queries (other than missing material) should be directed to the corresponding author for the article.