Development of sucking patterns in preterm infants

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6 The development of sucking patterns in preterm infants with bronchopulmonary dysplasia

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Abstract

Background Preterms with bronchopulmonary dysplasia (BPD) are at risk of acquiring brain abnormalities. In combination with ongoing breathing difficulties this may influence the development of the sucking patterns of these infants.

Objective To investigate the longitudinal development of sucking patterns from birth until the age of ten weeks post-term in preterm infants with and without BPD.

Methods A longitudinal, comparative study of the sucking patterns of 16 preterm infants with BPD and 15 preterms without BPD from the start of oral feeding at around 34 weeks' postmenstrual age (PMA) until 50 weeks' PMA. The infants were matched for gestational age (less than 30 weeks). We recorded approximately twelve feeding episodes per infant and assessed these with the Neonatal Oral-Motor Assessment Scale (NOMAS). We diagnosed the infants' sucking patterns as normal, dysfunctional, or disorganised. We examined the development of the sucking patterns in relation to relevant clinical characteristics.

Results Thirty (21%) out of 142 feeding episodes of the preterms with BPD and 36 (23%) out of 156 feeding episodes of the preterms without BPD were diagnosed as normal (not significant). Of the infants with abnormal patterns only three were diagnosed as dysfunctional and 229 as disorganised. Especially before term-equivalent age, definitely abnormal sucking patterns, i.e. all the abnormal patterns except 'arrhythmical only', were more prevalent in the preterms with BPD than in the preterms without BPD: 69 (49%) and

47 (30%) episodes, respectively (chi-squared = 10.7, $p<.01$). In particular, the abnormal patterns including the item 'incoordination' were more prevalent in the preterms with BPD: 25 (36%) out of 69 definitely abnormal patterns were found in this group and 7 (15%) out of the 47 episodes in the preterms without BPD (chi-squared = 6.37, $p<.05$). There was no difference between the two groups regarding the age at which they acquired normal sucking patterns, and relevant clinical characteristics did not influence the development of the sucking patterns.

Conclusions Characteristic of the development of sucking patterns in infants with BPD was that these infants were unable to coordinate swallowing with breathing. This was the case especially prior to term-equivalent age; after term-equivalent age the development of sucking closely resembled that of preterms without BPD.

Introduction

Preterms with bronchopulmonary dysplasia (BPD) have less favourable neurodevelopmental 1-3 outcomes than preterms without BPD 4;5. They are more at risk of acquiring brain abnormalities 6-8. In addition, they have continuous respiratory problems. Both these aspects influence the development of sucking. From the onset of oral feeding until they reach term-equivalent age, it is more difficult for preterms with BPD to learn to suck in a coordinated fashion than it is for preterms without BPD 9;10. Moreover, their feeding endurance and feeding performance is poor 10. In the first place, successful feeding for these infants is hindered by decreases in oxygen saturation during feeding, so-called deglutition apnoea 9;11 and their higher respiratory effort with increasing BPD 10. In the second place, successful feeding is hindered by their abnormal neurological development. We know that in preterm infants with BPD, maturational patterns of individual rhythms of sucking, swallowing, and respiration are disrupted 9;11. Preterm infants with BPD do not follow the predicted maturational patterns of suck-swallow rhythmic integration until 40 weeks' PMA 9. To date, the developmental course of the sucking patterns of preterms with BPD after they have reached term-equivalent age, is unknown.

A useful method to investigate sucking patterns in young infants up to the age of several months post-term is the Neonatal Oral-Motor Assessment Scale (NOMAS) 12. It is a standardized, non-invasive tool for both breastfeeding and bottle-feeding situations. Inter-rater and intra-rater reliabilities are fair 13. Of all available non-invasive tools, it turned out to be the most suitable method for assessing sucking patterns in young infants 14. The NOMAS has not been used previously in a longitudinal study of preterm infants with BPD.

Our aim was to investigate the longitudinal development of sucking patterns from birth until ten weeks' post-term in preterm infants with and without BPD. We hypothesised that preterm infants with BPD acquire a normal sucking pattern later, experience feeding difficulties due to an abnormal sucking pattern longer, and as a consequence, depend on tube-feeding longer than do preterm infants without BPD.

Methods

Subjects

We enrolled 16 preterms with BPD, who had been admitted to the Neonatal Intensive Care Unit of the University Medical Center in Groningen, in a prospective, longitudinal study. The inclusion criteria were a gestational age of less than 30 weeks and oxygen dependency at 36 weeks' postmenstrual age (PMA). The control group comprised 15 preterm infants without BPD, who were matched for gestational age. For one preterm infant with BPD, we were unable to find an appropriate matched control. Infants with major congenital defects were excluded from both groups.

The BPD group comprised preterm infants who either received supplemental oxygen or assisted ventilation or both, at a postmenstrual age of 36 weeks 15. The severity of the BPD was determined by the duration of the supplemental oxygen.

We collected perinatal and neonatal clinical data including gender, birth weight, Apgar scores at 1 and 5 minutes, need for ventilatory support, the presence of brain lesions and the Nursery Neurobiologic Risk Score at discharge at around term-equivalent age 16. Possible brain lesions for both groups were determined from serial, weekly ultrasound scans. Germinal matrix haemorrhages (GMH) were classified according to Volpe 17 and periventricular leukomalacia classified according to De Vries et al. 18. Table 1 provides the infants' demographics and clinical characteristics.
The study commenced after permission was granted by the medical and ethical review committee of the University Medical Center Groningen, the Netherlands and after obtaining informed parental consent

Recording of sucking patterns

The NOMAS was assessed from video-taped recordings. The infants were recorded immediately after oral feeding started, i.e. from 34 weeks' PMA, at the earliest. We recorded the first ten minutes of breastfeeding or bottle-feeding while the infant was in a quiet, alert state 19. The infants were recorded in profile. At the time of the recording they did not have any concurrent illness. The infants were either fed by one of the parents or, in some cases, by a nurse. We registered the following details for each

recording: breastfeeding or bottle-feeding, whether a regular teat was used or a Special Needs Feeder. Mother's milk or a choice of 12 formulae (or a combination of two formulae), were allowed. If possible, we noted the amount the infants had consumed, any change in their behavioural states during feeding, and whether there had been any choking, breathlessness, discolouring, or stress.

From 34 to 40 weeks' PMA, we recorded the infants at weekly intervals and every two weeks from 40 to 50 weeks' PMA (ten weeks' post-term). At most, we obtained twelve recordings per infant. Altogether we analysed 298 usable feeding episodes in 31 infants: 142 in the preterms with BPD and 156 in the preterms without BPD. Before term-equivalent age we recorded 56 episodes in the preterms with BPD and 72 episodes in the preterms without BPD. After term-equivalent age we recorded 86 measurements in the preterms with BPD and 84 episodes in the preterms without BPD.

Analysis of the sucking patterns

From the ten-minute recordings we selected the first two-minute episode of feeding to assess the infant's sucking pattern with the NOMAS 12. The NOMAS is an often used, non-invasive observation instrument consisting of 28 items: 14 for assessing jaw movements and 14 for assessing tongue movements. The instrument distinguishes three sucking patterns: a normal (mature) sucking pattern, a disorganised sucking pattern, and a dysfunctional sucking pattern 12.

In case of a disorganised sucking pattern, the coordination between sucking, swallowing and breathing is disrupted while the tongue and jaw movements are normal. In case of a dysfunctional sucking pattern, abnormal jaw and tongue movements cause sucking to be impossible or inefficient. A dysfunctional sucking pattern is considered to be more abnormal than a disorganised sucking pattern.

We also assessed the separate items of the NOMAS during each two-minute episode. In addition, we distinguished between a slightly abnormal sucking pattern (only the item 'arrhythmical' was scored) and a definitely abnormal sucking pattern ('arrhythmical' combined with other abnormal items, or a dysfunctional pattern).

Interobserver and intra-observer reliability

Previously, we found that the intra-observer agreement of the NOMAS was 'fair' to 'almost perfect' whereas the interobserver agreement with respect to the diagnosis was 'moderate' to 'substantial' 13. For the purpose of this study two NOMAS assessors judged each episode independently of each other. The assessors were 20 Dutch speech therapists, who were certified NOMAS examiners. If two assessors were unable to reach consensus about a particular episode in a recording, it was discussed with all the assessors. Consensus was reached in all cases.

Longitudinal trajectories

The results of the repeated assessments of each infant's sucking pattern (diagnosed as normal, disorganised or dysfunctional) were displayed graphically on the time-axis, thus depicting individual developmental trajectories. In case of abnormal assessments, we depicted the details of the abnormalities found.

From the longitudinal trajectories we attempted to determine at what age the sucking patterns had normalised. Since we were not aware of any study that had used the NOMAS in a longitudinal design, no benchmark existed to determine at what point in time an infant could be considered to have acquired a normal sucking pattern. Therefore, based on our findings in term infants [20] we decided that an infant had acquired a normal sucking pattern if at least two out of three consecutive episodes were diagnosed as normal. The infant is said to have acquired a normal sucking pattern on the first normal pattern of these three episodes.

Effectiveness of oral feeding

For each episode we determined whether feeding had been effective. In case of bottle-feeding intake was measured from the bottle in cm3. In case of breastfeeding we weighed the infant two minutes before nursing and again thirty minutes after nursing. We noted whether the infants choked or whether they showed any signs of stress while feeding (colour change, nasal flaring, head turning, and extraneous movements). Finally, we noted whether the infant needed additional tube feeding.

Relation between sucking patterns and clinical characteristics

We examined the course of sucking patterns, the infant's age at the time sucking normalised, and specific abnormal patterns in relation to several relevant clinical characteristics. Table 1 shows the infants' clinical characteristics. With regard to the age at which the sucking patterns normalised, we deliberately chose to determine whether the sucking pattern had normalized at term-equivalent age, and again at the age of ten weeks post-term, the end of the period under study. The clinical characteristics we investigated included gestational age, birth weight, gender, Apgar scores at 1 and 5 minutes, the necessity and duration of continuous positive airway pressure (CPAP) and nasal low flow, the presence and degree of periventricular leukomalacia [18] and the presence and degree of germinal matrix haemorrhages [17]. At discharge from the hospital we determined the Nursery Neurobiologic Risk Score (NBRS) [16]. In the preterms with BPD, the severity of BPD, determined on the basis of the duration of supplementary oxygen during the postmenstrual weeks, was also investigated in relation to the normalisation of sucking patterns. Finally, we examined the relationship

between the course and normalisation of sucking patterns and the necessity of additional tube- feeding.

Statistical Analysis

Data were analysed using the statistical software package SPSS for Windows, version 16.0. The chi-squared test was used to compare the two groups for frequencies of normal and abnormal sucking patterns. Where appropriate we used the Fisher's Exact test. The Kruskal-Wallis test and the Mann-Whitney U test were used to evaluate the associations between clinical data and the age at which the infant had developed a normal sucking pattern. Because perinatal and neonatal characteristics are likely to be interdependent, we performed a multivariate logistic regression analysis to investigate which factors contributed independently to developing a normal sucking pattern at term-equivalent age and at ten weeks' post-term age. Only factors detected by the univariate analysis (with $p < .10$) were included in the multivariate model. Throughout the analysis we considered $p < .05$ to be statistically significant.

Results

Analysis of sucking patterns

Figure 1a shows the results of the individual assessments, grouped according to postmenstrual age for preterms with BPD. Figure 1b shows the results for the preterms without BPD. We found that 30 (21%) out of all 142 episodes in the preterms with BPD were diagnosed as normal. In the preterms without BPD this was 36 (23%) out of 156 episodes. The prevalence of normal episodes was not different between groups (Chi^2 = ns). In the preterms with BPD, one (0.7%) of the 142 episodes was diagnosed as dysfunctional and 111 (78%) out of 142 were diagnosed as disorganized. In the preterms without BPD, two (1.3%) out of the 156 episodes were diagnosed as dysfunctional and 118 (76%) out of the 156 assessments were diagnosed as disorganised. We found no differences between the frequencies of the dysfunctional and disorganised patterns between the group of preterms with BPD and the group of preterms without BPD. Of the episodes that were diagnosed as disorganised, 116 were 'arrhythmical only': 43 (30%) in the preterms with BPD, and 73 (47%) in the preterms without BPD (chi-squared = 31.0, $p<.001$). Definitely abnormal sucking patterns (all abnormal patterns except 'arrhythmical only') occurred in 116 episodes. They were more prevalent in the preterms with BPD than in the preterms without BPD: 69 (49%) and 47 (30%) episodes, respectively (chi-squared = 10.7, $p<.01$). In particular, the abnormal pattern including the item 'incoordination' was more prevalent in the preterms with BPD: 25 episodes (36%) out of the 69 definitely abnormal patterns in this group and 7 (15%) out of 47 episodes in the preterms without BPD (chi-squared = 6.37, $p<.05$).

Given the fact that there were eight items, one could possibly find many combinations of items in the diagnosis 'disorganised'. It appeared, however, that only a limited cluster of items were found (Figure 1). Apart from the item 'only arrhythmical', there were three other clusters, i.e. 'arrhythmical + unable to sustain', 'arrhythmical + uncoordinated', and 'arrhythmical + unable to sustain + uncoordinated'. If the infant did not start sucking this was due to 'difficulty initiating movements'. If the infant did eventually start sucking during that same episode, it was possible that the infant would have an arrhythmic sucking pattern afterwards or a combination of one of the clusters.

Figures 1a and 1b might create the impression that the prevalence of normal, slightly abnormal ('arrhythmical only') and definitely abnormal patterns differed between the groups for the postmenstrual ages before and after term-equivalent age. The prevalence of normal and abnormal patterns separately for the postmenstrual ages up to 40 weeks, and for postmenstrual ages between 40 and 50 weeks, is shown in Tables 2a and 2b. Indeed, analysis showed that the differences between the groups were confined to the period before term-equivalent age: the group of infants with BPD had less 'arrhythmical only' sucking patterns (chi-squared = 10.1, $p<.01$) and more 'arrhythmical' + 'incoordination' (chi-squared = 7.3, $p<.01$).

The longitudinal course of sucking patterns

As is depicted in Figures 1a and 1b, the longitudinal course of the development of sucking patterns varied considerably in both groups.

We found no differences between the two groups as far as the age at which they acquired normal sucking was concerned. Eleven (64%) preterms with BPD and eight (53%) preterms without BPD acquired a normal sucking pattern before the age of ten weeks post-term (not significant). It was striking that one preterm infant with BPD had normalised his sucking pattern before reaching term-equivalent age, but he became consistently abnormal again afterwards (infant 24). In the group of infants without BPD, again only one infant had normalised his sucking pattern before term-equivalent age, but in this case it remained consistently normal (infant 55).

Of the ten preterms with BPD who had not yet acquired a normal sucking pattern at term-equivalent age, but who had acquired it by ten weeks' post-term, we noted that up to the age of six weeks' post-term corrected age, five infants still found it difficult to coordinate breathing with sucking and swallowing, they were unable to sustain sucking, and they still had short bursts of sucking.

The sucking patterns of all but one of the preterms with BPD (15 out of 16) were repeatedly diagnosed as definitely abnormal until term-equivalent age. For the group of preterms without BPD this was the case for 12 of the 15 infants. Only in the case of six infants, however, it involved more than two

Figure 1a **The development of sucking patterns in preterm infants with BPD** The results of the repeated assessments of each infant according to the gestational age, were graphically displayed on the time-axis, thus depicting individual developmental trajectories.

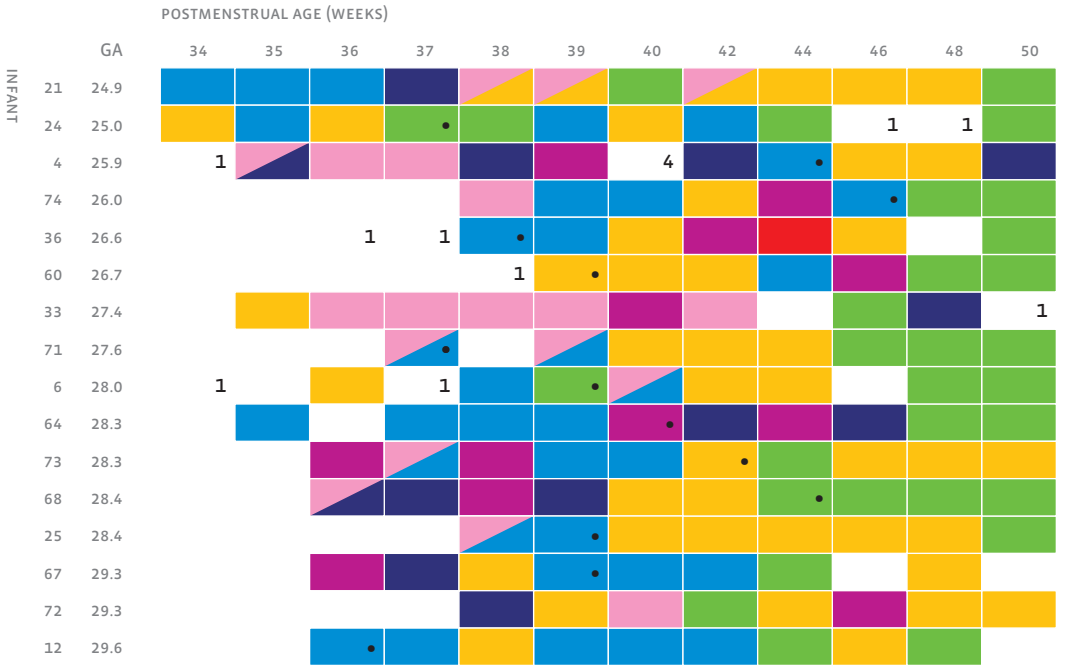

Figure 1b **The development of sucking patterns in preterm infants without BPD** The results of the repeated assessments of each infant according to the gestational age were graphically displayed on the time-axis, thus depicting individual developmental trajectories.

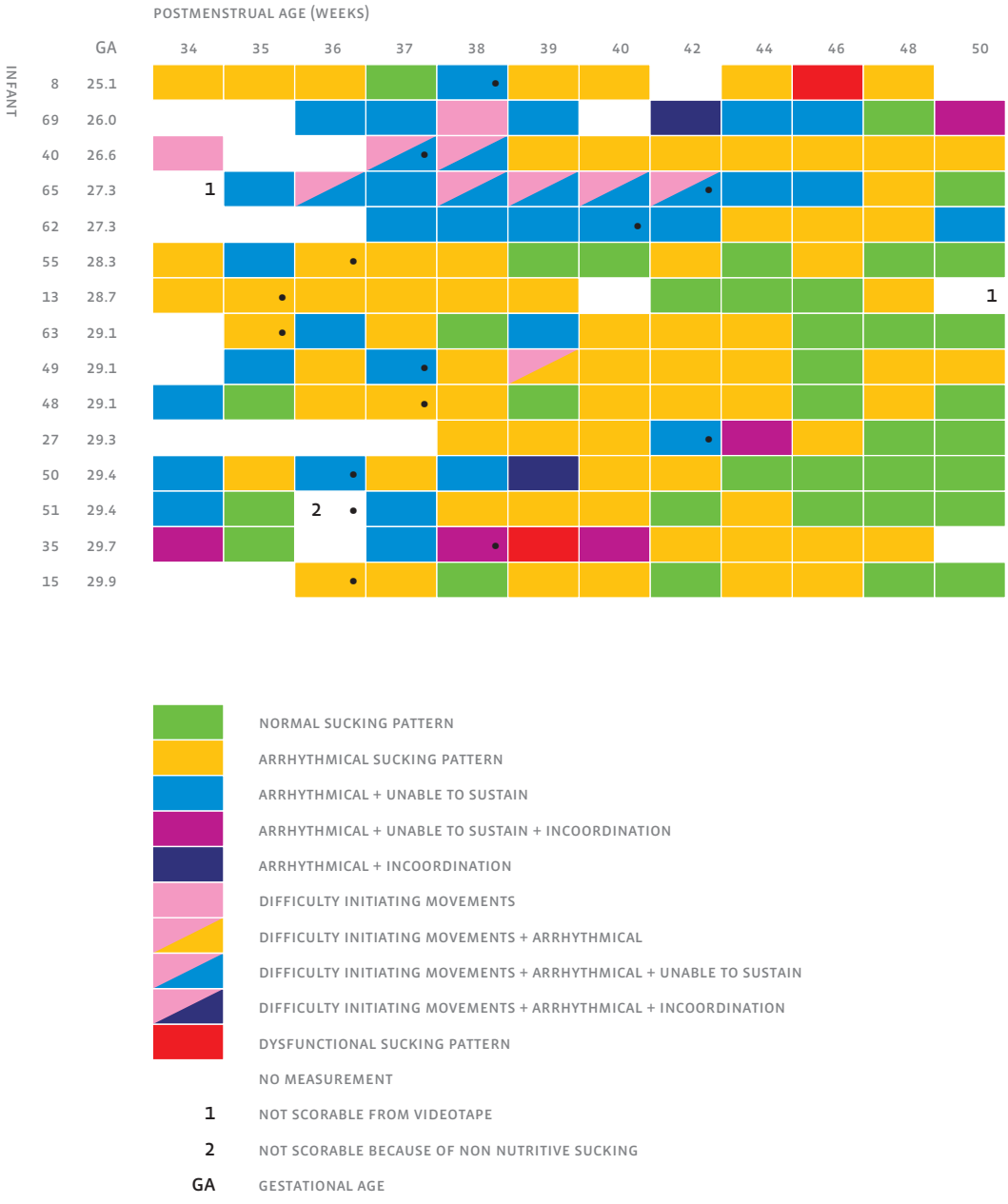

Table 1 **The clinical characteristics of the study group. The data are presented as median (range) or numbers (%) unless specified otherwise**

	Preterm with BPD	Preterm without BPD	*p* value
Male/female	7/9	5/10	ns
Gestational age, weeks	27.8	28.7	ns
	(24.9- 29.6)	(25.1-29.9)	
Birth weight, grams	925	1200	ns
	(560-1340)	(560-1575)	
Apgar 1 min	6 (1-8)	7 (1-9)	ns
Apgar 5 min	8 (3-9)	9 (2-10)	ns
Number of infants on IPPV	15 (94 %)	7 (47%)	.006
Days on IPPV (d)	30 (1-150) (n=16)	13.5 (1- 46) (n=7)	.001
1 - 6 days	2	3	
7 - 13 days	1	1	
14 - 20 days	4	0	
21 - 27 days	1	0	
> 28 days	7	3	
Duration of oxygen dependency (PMA, weeks)	40 (36-60)		
Duration CPAP or low flow (PMA, weeks)	40(37-60)	33 (30-42)	.001
Ultrasound findings:			
Normal	4	10	.04
GMH grade 1-2	1	none	ns
GMH grade 3-4	1	none	ns
PVL grade 1	10	5	ns
PVL grade 2	none	none	ns
NBRS	6 (3-11)	3 (1-9)	.001

BPD: Bronchopulmonary dysplasia

IPPV: Intermittent positive pressure ventilation

PMA: Postmenstrual age

CPAP: Continuous positive airway pressure

NBRS: Nursery Neurobiologic Risk Score

episodes. This difference was significant (Fisher's exact test p= 0.004). This was not the case after 40 weeks. From the term-equivalent date until ten weeks' PMA, six infants with BPD and seven infants without BPD normalised their sucking pattern (not significant). Five (31%) of the 16 preterm infants with BPD changed abruptly from a definitely abnormal sucking pattern to a normal sucking pattern. This was the case for only one infant in the group of preterms without BPD. In this group 94% first had one or more episodes with an 'arrhythmical only' sucking pattern.

Effectiveness of oral feeding

Preterms with BPD started feeding orally entirely later than preterms without BPD, but the difference was small (median 39 versus 37 weeks' PMA, $p<0.05$). Almost all the preterms with BPD, i.e. 15 (94%), and 14 (93%) of the preterms without BPD, fed orally entirely by the age of 10 weeks postterm. Frequently, an infant was already fed orally entirely even though it still had an abnormal sucking pattern for weeks afterwards. Other infants acquired a normal sucking pattern as soon as they no longer needed tube-feeding. For the 11 preterms with BPD and the eight preterms without BPD who had acquired a normal sucking pattern by ten weeks' post-term, we found no relationship between the duration of tube-feeding and the age at which they acquired a normal sucking pattern.

The relation between the sucking patterns and the clinical characteristics

In neither of the two groups did gestational age, birth weight, the NBRS, and the Apgar score at 1 and 5 minutes influence the age at which an infant stated sucking normally. Nor were there any differences between boys and girls in the two groups. In the preterms with BPD the duration of artificial ventilation correlated with the duration of tube-feeding (Spearman's rho = .55, $p < .01$), but not with the age at which normal sucking commenced. Duration of nasal low flow also did not correlate with the age at which sucking patterns normalised, nor did the presence of PVL exert an influence on whether the infant acquired normal sucking or not.

Discussion

This study demonstrated that prior to reaching term-equivalent age, preterm infants with BPD have much difficulty coordinating their breathing with sucking and swallowing. Reckoned from birth they depended on tube-feeding longer, although the difference is limited to two weeks. It was remarkable that after the term-equivalent age had been reached, there were no longer any differences between the preterm infants with BPD in comparison to

Table 2a Prevalence of clusters of NOMAS items before 40 weeks' PMA for preterm infants with and without BPD

		Normal / Slightly abnormal		Definitely abnormal	
N of episodes 34-40 weeks' PMA, and number of infants		**Normal sucking pattern**	**Arrhthmical sucking pattern only**	**Arrhythmical + unable to sustain**	**Arrhythmical + unable to sustain + incoordination**
Preterms with BPD	62 (6 no judgement possible, 10%) N=16	3 (5%) N=2	10 (16%) N=8	23 (37%) N=11	5 (8%) N=5
Preterms without BPD	74 (2 no judgment possible, 3%) N=15	8 (11%) N=7	32 (43%) N=11	26 (35%) N=12	2 (3%) N=1
p value* (N of episodes)		ns	<.01	ns	ns
p value** (N of infants)		ns	ns	ns	ns

Table 2b Prevalence of clusters of NOMAS items between 42 and 50 weeks' PMA for preterm infants with and without BPD

		Normal / Slightly abnormal		Definitely abnormal	
N of episodes 42-50 weeks' PMA, and number of infants		**Normal sucking pattern**	**Arrhthmical sucking pattern only**	**Arrhythmical + unable to sustain**	**Arrhythmical + unable to sustain + incoordination**
Preterms with BPD	90 (4 no judgement possible, 4%) N=16	27 (30%) N=15	33 (37%) N=14	11 (12%) N=8	7 (8%) N=6
Preterms without BPD	85 (1 no judgment possible, 1%) N=15	28 (33%) N=11	41 (48%) N=14	10 (12%) N=4	3 (4%) N=3
p value* (N of episodes)		ns	<.01	ns	ns
p value** (N of infants)		ns	ns	ns	ns

Definitely abnormal

Arrhythmical + incoordination	**Difficulty inititating movements**	**Dysfunctional**	
8 (13%) N=5	16 (26%), of which 9 (15%) in combination with another abnormal sucking pattern N=10	none	
1 (1%) N=1	9 (12%), of which 7 (9%) in combination with another abnormal sucking pattern N=4	1 (1%) N=1	During some episodes an infant may have two diagnoses
<.01 ns	ns ns	ns ns	Incoordination = stress signals as: colour change, nasal flaring, head turning or extraneous movements are visible
			N= number of infants concerned

Definitely abnormal

Arrhythmical + incoordination	**Difficulty inititating movements**	**Dysfunctional**	
			BPD, bronchopulmonary dysplasia
			ns = not significant
5 (6%) N=3	4 (4%), of which 2 (2%) in combination with another abnormal sucking pattern N=4	1 (1%) N=1	* chi-squared test ** chi-squared test, Yates correction
1 (1%) N=1	2 (2%), of which 2 (2%) in c ombination with another abnormal sucking pattern N=1	1 (1%) N=1	
ns ns	ns ns	ns ns	

the preterm infants matched for gestational age. The difference was found especially in the period prior to term-equivalent age. Preterms without BPD needed just as much time to acquire a normal sucking pattern.

We also found reports in the literature that preterms with BPD have more difficulty learning to coordinate breathing with sucking and swallowing than do preterms without BPD [9-11;21]. From our study it appeared that prior to reaching term-equivalent age, preterms with BPD more often had an abnormal sucking pattern with coordination problems than preterms without BPD. It was not so much that they were unable to sustain sucking, or that they had more difficulties initiating sucking movements than the preterms without BPD. Rather, they had more problems coordinating breathing with sucking and swallowing. Even after reaching the term-equivalent age, some of the infants with BPD still had difficulties coordinating their breathing with sucking and swallowing, but by this time it no longer differed from our findings on the preterms without BPD. Thus it would seem that, especially prior to reaching term-equivalent age, preterms with BPD had more problems with organising neurobehavioral functioning than preterms without BPD.

Our findings are difficult to explain. We found no differences between the relevant clinical variables, such as abnormal neuro-imaging results or duration of nasal low flow or CPAP. Possibly, our study group had a relatively mild BPD as a result of which the differences with the control group, who were matched for gestational age, were limited. As previously described by Gewolb, [11], the development of sucking seems irregular and unpredictable. On the one hand, there were the large differences between the fastest and the slowest infants and, on the other hand, the fact that many infants in the BPD group developed a normal sucking pattern in just four weeks, from 44 to 48 weeks' PMA. This finding could not be explained by taking into account the difference in gestational age. The fact that BPD is a chronic disorder characterised by a clinical picture that can vary from day to day, might also have exerted an influence.

Within ten weeks' post-term, many very preterm infants had normalised their sucking patterns, and nearly all of them no longer depended on tube-feeding. Dysfunctional patterns which, according to the NOMAS, are found in neurologically abnormal children [22] were rare.. The longitudinal design of our study permits us to state that the abnormalities of the sucking patterns, mostly diagnosed as disorganised, were resolved in a considerable proportion of very preterm infants after reaching term-equivalent age.
Our study was unique for its design. To our knowledge no other studies to date on preterm infants with BPD, have followed the development of sucking and sucking patterns during the entire neonatal period and on into early infancy. We recorded and assessed preterm infants from two or three days after starting oral feeding until they reached 50 weeks' PMA. In addition,

we studied both breastfeeding and bottle-feeding infants. During video-recording no interventions with regards to feeding took place.

There were some limitations to our study. Since it was a single-centre study, caution should be taken in generalising our results to the general population. Our study groups were small, and differences might have been concealed by the fact that our infants with BPD generally only had mild symptoms. Nevertheless, prior to term-equivalent age, we did find significant differences in the development of sucking patterns.

Our study may have implications for starting and scheduling oral feeding. The difference in the course of sucking development prior to term-equivalent age means that, especially when starting preterms with BPD on oral feeding and setting up their feeding schedules, account should be taken of the fact that they have more difficulty sustaining their oxygen saturation while drinking due to their lung problems. It is not improbable that decreases in oxygen saturation levels during feeding play an important role in the origin of feeding problems, for which preterms with BPD are at risk [2;3;23;24]. In this respect, breathlessness could lead to refusing to swallow and even to refusing teat or nipple. Such a defence is, therefore, also linked to the development of eating problems later on [1;3;10]. Particularly in the case of these infants we recommend careful consideration of the necessary preconditions for starting oral feeding. Moreover, we recommend to only start teaching the infant to drink while at the same time carefully monitoring its physiological parameters (oxygen saturation, heart rate, neurobehavioral functioning including muscle tone, and behavioural state), as well as its potential to recover during the first five minutes after feeding (oxygen saturation, heart rate, neurobehavioural functioning) [25].

To conclude, we found that the development of sucking patterns in preterms with and without BPD differed, but only prior to term-equivalent age. Preterms with BPD, in particular, had difficulty coordinating sucking and swallowing. After reaching term-equivalent age their sucking ability normalised and closely resembled that of preterms without BPD. Apparently, BPD after the due date exerted less influence than we are led to expect from the literature [9-11;21;26]. After reaching term-equivalent age, gestational age in both groups influenced the developmental course of sucking more than did BPD.

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