The Association between Sucking Behavior in Preterm Infants and Neurodevelopmental Outcomes at 2 Years of Age

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Objective To evaluate whether a specific period after birth (in weeks postmenstrual age [PMA]) and specific elements of sucking are associated with abnormal neurodevelopmental outcomes at age 2 years using a longitudinal approach.

Study design Fifty-two preterm infants participated in this longitudinal cohort study (mean gestational age, 29.5 weeks; mean birth weight, 1197 g). We assessed the infants' sucking patterns at 37-50 weeks PMA using the Neonatal Oral-Motor Assessment Scale. At age 2 years, based on a neurologic examination and the Dutch version of the Bayley Scales of Infant and Toddler Development, Second Edition, we categorized the children as developing normally (n = 39) or abnormally (n = 13). ORs, including 95% CIs, were calculated to ascertain the risk of abnormal neurodevelopmental outcomes.

Results The inability to sustain sucking at 46 weeks PMA (OR, 6.25; 95% CI, 1.29-30.35) and the absence of a mature sucking pattern at 44 weeks PMA (OR, 6.30; 95% CI, 1.40-28.32) significantly increased the odds of abnormal neurodevelopmental outcomes at age 2 years. The ORs of the Neonatal Oral-Motor Assessment Scale items assessing rhythmic jaw movements, rhythmic tongue movements, and coordination among sucking, swallowing, and respiration were high shortly after term, but failed to reach significance.

Conclusion Specific elements of sucking at 4-6 weeks postterm are associated with abnormal neurodevelopmental outcomes in preterm infants at age 2 years. This period might be a sensitive time of infant development in which sucking behavior is an early marker of abnormal developmental outcomes. This finding may offer opportunities for early intervention. *(J Pediatr 2015;166:26-30)*.

Preterm infants have more developmental difficulties at school age compared with full-term infants.[1] One challenge for these children is to master the skills required for oral feeding. Preterm infants have more difficulty coordinating sucking, swallowing, and breathing, and in some cases the tongue and jaw movements are inadequate as well.[2-5] Although several studies have suggested that inadequate sucking behavior in preterm infants may serve as a marker of abnormal development,[6-8] few studies have investigated the direct association between sucking behavior and neurodevelopmental outcomes.[9-11]

The present study is part of a prospective, longitudinal study concerning the development of sucking behavior of 65 preterm infants in relation to neurodevelopment.[2,12] In this study, we first addressed the question whether a specific period, expressed in weeks' postmenstrual age (PMA), may be associated with abnormal neurologic development. Insight into the development of sucking patterns between 37 and 50 weeks PMA will contribute to our understanding of the association between sucking patterns and neurodevelopmental outcomes. We then focused on investigating whether specific elements of sucking patterns are associated with abnormal neurologic development. In addition to the overall diagnosis of the Neonatal Oral-Motor Assessment Scale (NOMAS),[4] investigating the individual items on the scale afforded a more detailed understanding of the association between specific elements of sucking patterns and neurodevelopmental outcomes at age 2 years. In short, our aim was to evaluate the hypothesis that a specific period after birth, expressed in weeks of PMA, and specific elements of sucking, as assessed by items of the NOMAS, are associated with abnormal neurodevelopmental outcomes.

Methods

This study was part of a prospective, longitudinal study on the developmental course of sucking patterns in 65 preterm infants in relation to neurodevelopmental

BPD	Bronchopulmonary dysplasia
MDI	Mental Developmental Index
NOMAS	Neonatal Oral-Motor Assessment Scale
PDI	Psychomotor Developmental Index
PMA	Postmenstrual age
SGA	Small for gestational age

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outcomes.[2,12] The focus of the original study was on 2 groups: infants who were small for gestational age (SGA)[2] and infants with bronchopulmonary dysplasia (BPD).[12] Preterm infants without these conditions were included as controls. All of the infants had been admitted to University Medical Center Groningen or to Martini Hospital Groningen shortly after birth. Recruitment of infants extended from 2004 until the end of 2006, with follow-up between 2006 and 2009. The NOMAS was used to assess sucking patterns longitudinally from 37 to 50 weeks PMA. The Medical Ethics Review Committee of University Medical Center Groningen approved the study, and written informed consent was obtained from the parents of all infants participating in the study.

Fifty-two of 65 preterm infants were included in the follow-up study. Of the 13 infants not included, 11 infants' parents had declined the invitation to participate in the follow-up study or had not been contacted in time, 1 infant was excluded owing to congenital defects that manifested after inclusion, and 1 infant had died. Owing to the original study design the study group consisted of a relatively large proportion of infants with BPD (n = 18; 35%) and SGA infants (n = 12; 23%).

NOMAS

Sucking behavior was assessed using the NOMAS, an observational method consisting of 28 items that assess sucking of newborn infants. The NOMAS is a noninvasive and user-friendly tool for assessing both nutritive and nonnutritive sucking in both breastfed and bottle-fed infants.[13] da Costa and van der Schans[14] assessed the intrarater agreement as "fair" to "almost perfect" and interrater reliability as "moderate" to "substantial." To strengthen the reliability of the NOMAS, the video recordings (see below) were assessed independently by various pairs among 4 certified assessors.[4,15] In cases of disagreement about an episode in the recordings, the particular recording was discussed among all 4 assessors until consensus was reached.

Assessment resulted in 1 of 3 possible diagnoses: normal sucking pattern, disorganized sucking pattern, or dysfunctional sucking pattern. A normal sucking pattern is characterized by rhythmic movements of the jaw and tongue and appropriate coordination between sucking, swallowing, and breathing. If the jaw and tongue movements are arrhythmic, the sucking pattern is classified as disorganized. Infants whose jaw and tongue movements are abnormal and interfere with sucking are classified as having a dysfunctional sucking pattern.

NOMAS Recordings and Analyses

Between 37 and 40 weeks PMA, weekly video recordings were made of the first 2 minutes of nutritive sucking; between 40 and 50 weeks PMA, these recordings were made every 2 weeks. The recordings were assessed independently by various pairs among the 4 certified assessors.[2,12] These assessors were Dutch speech and language therapists, as described in the NOMAS literature.[4,15] We defined the scores on the NOMAS items as either positive (yes = 1) or negative (no = 0). A positive score was awarded if the infant was seen to perform a specific element of sucking and swallowing (eg, rhythmic jaw excursions), whereas a negative score was awarded if this element of sucking and swallowing was not performed adequately. Sometimes 2 separate items on the NOMAS represent the same element of sucking and swallowing but are formulated as opposites (inconsistent vs consistent, rhythmic vs arrhythmic). For the purpose of investigating whether the infants were or were not able to perform a specific element of sucking and swallowing, the scores on these opposite items were combined.

Follow-Up at Age 2 Years

At 27 months (corrected age), we administered the Bayley Scales of Infant Development, Second Edition, Dutch version[16] to assess the children's mental and motor development. Scores were obtained on the Mental Developmental Index (MDI) and the Psychomotor Developmental Index (PDI). We also performed a neurologic examination following Touwen's method[17] to assess neurologic outcomes at age 2 years. Based on the results of the neurologic examination and the scores on the Bayley Scales of Infant Development, Second Edition, Dutch version, the 52 children were divided into 2 groups: normal development and abnormal development. A child was assigned to the abnormal development group if his or her neurologic examination was abnormal or if he or she had an MDI or PDI score <85.

Statistical Analyses

Analyses were performed using the statistical software package SPSS for Windows, version 17.0 (SPSS, Chicago, Illinois). First, the data were analyzed at the level of the diagnoses. The proportions of infants with normal sucking behavior and those with abnormal sucking behavior (ie, a disorganized or dysfunctional sucking pattern) were determined for each group and for each measurement. ORs and 95% CIs were calculated to determine the risk of abnormal sucking patterns on subsequent abnormal neurologic development. Second, NOMAS data were analyzed at the level of the items. Each item's OR and 95% CI were calculated to establish the risk of subsequent abnormal neurologic development.

Whether differences in sucking patterns between the normal development and abnormal development groups were related to potential confounders was investigated using the independent-samples t test and the Pearson χ^2 test. Gestational age, birth weight, and variances in the distribution of appropriate for gestational age infants, SGA infants, and infants with BPD were considered potential confounders. Statistical significance was predetermined at $P < .05$.

Results

Fifty-two preterm infants participated in the follow-up study. At age 2 years, 39 infants were classified as developing normally and 13 infants were classified as developing abnormally