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Development of sucking patterns in preterm infants

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1 General introduction

Healthy, fullterm infants are able to suck and swallow from birth. This enables them to take in all the nourishment they need from suckling at the breast or from feeding from a bottle. Oral feeding in infants needs to be efficient in order to preserve energy for growth. In addition, it should be safe so as to avoid aspiration, and it should not jeopardise respiratory status. This is only possible if sucking, swallowing, and respiration are properly coordinated. Coordination means that the infant can suck efficiently and can swallow rapidly as the boluses are formed in the mouth in order to minimise the duration of airflow interruption. Oral feeding skills are defined as the infant's ability to organise and coordinate oral-motor functions efficiently so that it consumes enough calories for growth ¹.

There are several circumstances that may compromise the normal development of coordinated sucking and swallowing. Congenital or acquired damage of the central nervous system may lead to feeding problems in the neonatal period such as slow or weak sucking. This could be the first indication that the infant has neurological problems ². Dysphagia is common in infants suffering from cerebral palsy or other neurological developmental disorders. Several clinical conditions and side-effects of treatments may threaten the integrity of the central nervous system in foetuses and preterm infants ³. Preterm infants are at high risk for problems in achieving oral feeding skills and frequently have feeding problems during their first year of life ^{4;5}. It is unclear whether these problems are also related to the neurological problems these infants often exhibit when they are older. Preterm birth entails an increased risk for abnormal neurological development. Preterms that require artificial respiration have more difficulty stabilising their physiological parameters, as a result of which non-nutritive sucking degrades ⁶, it takes longer before they are ready to start feeding orally, before they are no longer dependant on tube-feeding, and before they are able to process oral feeding entirely ⁷⁻¹². Particularly for preterms suffering from bronchopulmonary dysplasia (BPD), successful feeding can be hampered, on the one hand, by decreased oxygen saturation during feeding, deglutition apnoea ¹³, and a higher respiratory rate (which is worse for preterms with BPD as the condition worsens) ¹⁰. On the other hand, it may be hampered by the higher risk of neurological damage that leads to impaired sucking. The developmental course of sucking may be a predictor for neurological outcome later. Studies of children between eight and eighteen months point towards such a relationship ^{14;15}.

Annually, in the Netherlands, on average 15,000 infants are born preterm, i.e. prior to the 37th week of gestation (8.1 % of the total number of births). Of these preterms 0.3 % are born after \leq 25 weeks' gestation, 0.7 % after 26.0 to 31.6 weeks' gestation and 4.7 % after 32.0 to 36.6 weeks'

gestation ¹⁶. They often depend on tube-feeding for a varying lengths of time depending on their gestational ages and birth weights. Many preterms can suck and swallow from approximately 34 weeks' PMA. Subsequently, it often takes another few weeks before the infant can coordinate sucking and swallowing with respiration and before it can handle all its nourishment orally. For some preterms it takes longer, or sometimes much longer, before they can cope with oral feeding. Gestational age and birth weight play a role in successful oral feeding, as do conditions like BPD and necrotising enterocolitis (NEC). To date, however, we do not yet fully understand which infants are most at risk for learning problems with feeding.

The reasons for carefully studying the preconditions for sucking and how an infant sucks, are to determine the infant's readiness to feed orally and to detect the nature of its feeding problems. In addition, an abnormal sucking pattern may be an indication that the infant's neurological development is not progressing normally. We used the Early Feeding Skills Assessment ¹ to determine whether an infant was ready to feed orally. This observational scale is used to monitor the infant before, during and after each feeding. In general, to assess the way infants suck, a distinction is made between clinical feeding assessment and swallowing assessment ¹⁷. Seven other diagnostic tools have been described in the literature: four are designed for breastfeeding only, two for bottle-feeding only, and one is applicable to both feeding situations ¹⁸. The reliability and user-friendliness of these tools are fair to poor.

To date, we lack a user-friendly, reliable, and non-invasive tool that can be used for both breastfeeding and bottle-feeding and that objectively measures the coordination between sucking, swallowing and breathing, and sucking and swallowing movements. On the one hand, such a diagnostic tool would be useful to determine what kinds of interventions are required to facilitate sucking and swallowing. On the other hand, it would be useful if it could make some predictions regarding the future development of the infant. In addition, infants could be followed-up in order to determine if, and to what extent, sucking behaviour has predictive value for the infant's outcome at a later age. It appears that healthy, fullterm infants develop efficient sucking and swallowing, and patterns of respiration during the first month of life ¹⁹. Aspects of sucking and the development of sucking that have been studied in preterms include the maturation of nutritive and non-nutritive sucking ¹⁹, the relation between non-nutritive and nutritive sucking ²⁰, the maturation of respiration ²¹, the maturation of the swallowing process ²²⁻²⁴, and the coordination of sucking, swallowing, and respiration ²⁵⁻²⁷. More specifically, sucking pressure, sucking bursts ^{16;25;27}, intraburst development ¹⁹, and volume per suck have been studied. Nevertheless, although several studies were performed on the development of sucking behaviour, most studies were based on one or two recordings or cover a short period of time.

What is lacking is knowledge about how sucking develops longitudinally during the entire neonatal period, to what extent it is a matter of maturation, what the normal developmental course is, and what can be considered abnormal. In addition, it is important to determine which groups of preterms are at greater risk of developing abnormal sucking and to identify the risk factors. More insight in and knowledge of the developmental course of sucking possibly creates more opportunities to intervene, besides determining whether the infant is ready to start feeding orally, or whether the amount and frequency of feeds can be extended. This would apply to SGA preterms, preterms with BPD, and extremely preterm infants.

Aims of the study

Various questions arose with regards to sucking, swallowing and respiration in preterm infants. Within the perspective of the literature we reviewed, our aim was to determine the longitudinal development of sucking patterns in fullterm and preterm infants from birth until the age of ten weeks post-term. Our findings are presented in this thesis.

The study groups were:

- Healthy, fullterm infants
- Preterm, appropriate-for-gestational age (AGA) infants
- Preterm, small-for-gestational age (SGA) infants (birth weight < P10)
- Preterm infants with bronchopulmonary dysplasia (BPD)

The specific questions we addressed were:

- 1 What methods are available to diagnose sucking and swallowing problems, and which of these were most suitable?
- 2 What is the developmental course of sucking patterns in healthy, fullterm infants from birth until ten weeks' post-term?
- 3 What is the developmental course of the development of sucking patterns in preterm infants from the time oral feeding commenced until ten weeks' post-term?
- 4 Are there differences in the developmental courses of sucking patterns between AGA preterms, SGA preterms, and preterms with BPD?
- 5 Which factors influence the development of sucking patterns?

To answer these questions, we started an extensive, longitudinal research project in 2003 on the development of sucking patterns in fullterm and preterm infants with a view to plotting the spontaneous course of oral feeding in different groups of preterm infants from the time oral feeding commenced until ten weeks' post-term. We reviewed the literature to find adequate diagnostic tools and investigated these longitudinally in several fullterm and preterm groups of infants at variable risk, until they

had reached the age of ten weeks post-term. Knowledge on the typical development of sucking patterns in these groups might lead to a better understanding of problems with sucking, swallowing, and respiration, and might also lead to appropriate interventions.

Chapter Outlines

In Chapter 2 we review recent insights into the development of sucking and swallowing in infants and we examine the factors that play a role in acquiring this skill. In addition, we present a search of the literature for diagnostic tools that focus on the readiness for oral feeding.

In Chapter 3 we consider the Neonatal Oral-Motor Assessment Scale (NOMAS) including the test-retest agreement and its inter-rater reliability. In Chapter 4 we describe the sucking patterns in healthy, fullterm infants from birth until ten weeks' post-term.

In Chapter 5 we deal with the maturation of sucking in small-for-gestational age (SGA) preterm infants in comparison with adequate-for-gestational age (AGA) preterm infants. We also investigated which factors influenced the maturation of sucking patterns.

In Chapter 6 we describe the maturation of sucking patterns in preterm infants with bronchopulmonary dysplasia (BPD) in comparison with age preterm infants without BPD matched for gestational age. In this chapter we also investigated whether clinical factors influenced the maturation of sucking patterns.

In Chapter 7 we place the investigations in a general perspectives and we give directions for future studies.

Chapter 8 provides a summary of the thesis in English.

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