# ORAL INTAKE IN PRETERM CHILDREN

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## *Abstract*

The oral intake of premature babies is made more difficult by their immaturity, so it is necessary to pay more attention to their oral intake. Globally, these babies are approached by focusing on the quality of oral intake, rather than the quantity, as a prerequisite for the formation of the mother-child bond, the optimal development of oral-motor skills, facial parts (splanchnocranium) and other related areas. For this reason, a clinical speech and language pathologist (SLP) specialising in this area features increasingly as part of the comprehensive care of premature babies with feeding problems. This often begins immediately after birth, when the newborn has difficulties with sucking, where the SLP then evaluates the quality of oral intake and, through systematic and individually designed interventions, the development of not only sucking but also of subsequent related areas is very significantly and positively influenced. This article provides some basic insight into the issues of premature babies' sucking from the point of view of a clinical speech and language pathologist, together with an overview of diagnostic and therapeutic options.



## *Keywords*

newborn, preterm, feeding, sucking, sucking development, sucking-swallowing-breathing coordination, early intervention


## Introduction

Oral intake, including swallowing, is a highly complex coordinated sensorimotor and dynamic process that is generated by multiple levels of the nervous system and develops progressively from the intrauterine period (Lau et al., 1997; Lau and Hurst, 1999; McFarland and Tremblay, 2006). One very significant and overriding factor is the central [sucking] pattern generator, which generates activity-specific motor patterns, in this case suction (Barlow et al., 2009). The interaction of the five cranial nerves (trigeminal nerve, facial nerve, glossopharyngeal nerve, vagus nerve, hypoglossus nerve), of the cervical and thoracic spinal nervous systems, leads to at least 30 pairs of muscles being precisely coordinated. This activates the orofacial region (lips, cheeks, jaws, tongue, palate), head and neck (hyoid bone, pharynx and larynx), as well as the muscles needed for respiration and the corresponding protective mechanisms or indeed the gastrointestinal system. Posture is not to be forgotten among other important related factors that can potentially affect oral food intake (Matsuo and Palmer, 2008). In addition to neuromotor function, sensory experience is also essential for optimizing motor pattern formation and central nervous system development during the expected critical period (Mistry and Hamdy, 2008). This complex process is therefore very adaptive and subject to brain plasticity, depending on the lived experience (Martin, 2009). During intrauterine and postnatal development, muscle activity plays a significant role, having the potential to affect the function of the orofacial system during sucking and subsequently to determine bone remodelling and development of the facial part of the skull (splanchocranium) (Pancherz, 1980; Lowe and Takada, 1984).

Safe and high-quality food intake, including swallowing, thus requires the integration of physical and neurophysiological functions. To have the option to offer the child oral feeding, their sufficient developmental maturity is paramount (Nicholls and Bryant-Waugh, 2010). Premature babies thus have a much more difficult

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https://doi.org/10.36833/lkl.2024.021 Accepted for review: September 16th, 2024 Accepted for publication: October 8th, 2024 

initial position compared to children born at term, due to the immaturity of many interconnected systems. Although premature babies develop and are formed by an environment completely unlike in-utero, it is possible to help the most optimal development of oral food intake with early and sensitive professional guidance and taking into account all factors (Amaizu et al., 2008). In the absence of such professional guidance on oral food intake, the premature baby is at risk of significant consequences in several areas, impacting not only themselves but also their family.

## Sucking in premature babies

Sucking consists of two components, the positive component of sucking (expression) and the negative component of sucking (suction). The positive component of sucking develops first and is present after birth. It is the pressing of the nipple/teat with the tongue against the hard palate, allowing the milk to be expressed. The negative component of sucking is developmentally younger, and by lowering the jaw, closing the entrance to the nasal cavity by elevation of the soft palate, and sufficient bilabial closure, it allows a negative pressure to be created in the oral cavity, allowing the individual to actively suck milk into the mouth. The maturation and coordination of these two components can be assigned five stages of maturation: 1) arrhythmic positive component of sucking, absent negative component of sucking, 2) more organized positive component of sucking, absent or weak sporadic negative component of sucking, 3) stronger positive component of sucking, more organized negative component of sucking, 4) negative component of sucking well defined, positive component of sucking strengthens and becomes consistent, 5) negative component of sucking is strong (amplitude increases), both suction components well defined and alternate in rhythmic pattern (Lau, 2015; Lau, 2016).

Two types of sucking are distinguished, nutritive and non-nutritive, whose development is significantly related to the individual's neurobehavioural maturation and organization (Lau et al., 2003).

*Non-nutritive sucking* is sucking where the baby does not obtain nutrition, but is provided with positive and reassuring experiences in the oral area, in which orofacial structures are strengthened by sucking on a nipple, finger, pacifier or other object. Usually, two sucks per second occur in short and fast cycles/bursts lasting varying lengths of time from 2 to 12 seconds, interspersed with pauses of 3 to 13 seconds. Non-nutritive sucking matures over time, during which the level of oral-motor skills of premature babies rises (Hafström et al., 1997; Hafström and Kjellmer, 2000). During intrauterine development, indicative sucking movements can be observed around the 15$^{th}$ week (Nijhuis, 2003). Anteroposterior movements of the tongue develop between the 18$^{th}$ and 28$^{th}$ week of gestation, and from about the 28$^{th}$ week onwards the central groove in the tongue begins to develop (Miller et al., 2003). Initially, a premature baby is unable to organize sucking cycles, gradually developing arrhythmic short cycles that become more regular and prolonged with maturation. At week 32, approximately 5 sucks per cycle/burst and 21 sucks per minute appear, at 38 weeks the number of sucks per cycle/burst increases to 6 (+/- 3), and at 43 weeks 12 sucks per cycle/burst and 51 sucks per minute already appear (Pineda et al., 2019).

*Nutritive sucking* is by contrast the kind of sucking by which baby obtains nutrition. The *physiological sucking pattern* can be characterized as a pattern of continuous sucking of more than 10 sucks with short pauses between cycles and with coordinated sucking, swallowing and breathing usually in a ratio of 1:1:1. In contrast to non-nutritive sucking, nutritive sucking occurs at a slower pace, around one suck per second (Palmer et al., 1993). The first minute of nutritive sucking usually involves no pause, or a very brief one, but during feeding there is a progressive stabilization of cycles and pauses between them, towards the end of feeding the pauses are conversely longer, due to fatigue (Poore and Barlow, 2009). As far as the development of nutritive sucking is concerned, the early components of sucking appear in utero. Between the 12$^{th}$ and 16$^{th}$ week, the oral and gag reflex appears, swallowing amniotic fluid can be noticed between the 15$^{th}$ and 18$^{th}$ week, some authors state even earlier. From the 28$^{th}$ week onwards, it might seem that sucking and swallowing are mature enough for oral food intake, but sucking and swallowing are not yet coordinated with breathing, until the 32$^{nd}$ week. This coordination begins to appear around the 34$^{th}$ week, matures significantly from the 36$^{th}$ week and can continue to mature until the due date, in some children even after the due date. In addition to the ability to coordinate sucking-swallowing-breathing, before starting oral food intake it is necessary to monitor readiness signs, such as the stability of vital functions (heart and respiratory rate, saturation, etc.), the state of alertness, sufficient body muscle tone, hunger signals, etc. Until full oral intake is achieved, the inadequate peroral intake needs to be replaced by an alternative method, most commonly nasogastric tube (Lau et al., 2000; Mizuno and Ueda, 2003; Da Costa et al., 2010). Thus, similar to non-nutritive sucking, nutritive sucking involves a gradual maturation of the ability to suck described (Lau, 2015) at 5 developmental levels. Palmer et al. (1993) characterized three types of sucking pattern according to maturity, namely the immature, transitional and mature sucking pattern. During the first oral food intake, sucking cycles may not be present at all initially; these may develop gradually as the organism matures. An immature sucking pattern contains only ≤ 5 sucks per cycle/burst, a transitional sucking pattern contains five to ten sucks per cycle/burst and a mature sucking pattern contains ten or more sucks. The maturity of the sucking pattern in premature infants correlates with the achieved gestational age and overall maturity of the organism, which must always be taken into diagnostic account. If sucking cycles/bursts contain less than 10 sucks per burst after the due date, this condition is considered risky.

In addition to physiological sucking, we also distinguish two types of pathological sucking, namely disorganized and dysfunctional sucking (Palmer et al., 1993).

A *disorganized sucking pattern* is characterized by a lack of rhythmicity and a reduced ability to coordinate sucking, swallowing and breathing, although jaw and tongue movements may be physiological. Typically, this type of sucking occurs in premature babies or individuals who have respiratory, cardiovascular or gastrointestinal problems. This type of sucking is also more common in bottle-fed babies, due to the continuous flow of milk, in contrast to breastfeeding (Mizuno et al., 2006). Da Costa et al. (2010, 2016) further divide disorganized sucking into 1) arrhythmic sucking only (i.e. sucking with variability of jaw range of motion, without the presence of low endurance or uncoordinated sucking, swallowing and breathing), 2) arrhythmic and uncoordinated sucking (i.e. sucking with variability of jaw range of motion and impaired coordination of sucking, swallowing and breathing), 3) arrhythmic sucking with low endurance (i.e. sucking

with the occurrence of non-nutritive sucks, variability of jaw range of motion and low endurance, including shortened sucking time, pauses between sucking cycles that are longer than the cycle itself, or sucking cycles that are shorter than three sucking phases) and 4) arrhythmic uncoordinated sucking with short duration.

The second pathological type of sucking is *dysfunctional sucking*, which is the most severe type of dysfunction and is characterized by abnormal muscle tone in the orofacial region and different movements of the jaw and tongue leading to significant disruption or interruption of the feeding process. Not only is there disorganisation of sucking, swallowing and breathing and atypical movements of the jaw and tongue, but there is also a very marked limitation of endurance due to the weakness of the preterm babies. All these factors significantly increase the risk of a possible loss of autonomic stability (Da Costa, 2010). This type of sucking occurs e.g. in those having neurological, more serious gastrointestinal or cardiac problems or syndromic diseases.

## Tools to assess food intake

As already mentioned, the former quantitative approach, described in the literature as "volume-driven" or "scheduled feeding", which is based on the evaluation of the ability to take in the prescribed volume of food and maintaining a fixed time interval between meals, is giving way more-and-more to a preferred qualitative approach. Concepts within the qualitative approach include 'cue-based feeding' (food intake based on key child's behavioural cues) or, for example, 'infant-driven feeding' (infant-led food intake). Within this concept, food intake is an interactive and developmental process, a complex activity that is essential for maintaining safety, physiological and autonomic stability, active participation and general behavioural organization. It seeks to support the feeding child's positive experience as much as possible and at the same time to respond sensitively to the individual's rich non-verbal communication. This topic was very clearly and thoroughly elaborated on by Červenková (2021).

Unfortunately, there are currently no standardized diagnostic materials in the Czech Republic that would evaluate the food intake of newborns. The only adapted tool assessing the current condition of the child, and one which can only be administered after training abroad, is the *Infant Driven Feeding Scale* (IDFS). It is an evidence-based neurodevelopmental model of care created to support the oral food intake of newborns. It evaluates both readiness for oral intake (IDFS 1) and its course (IDFS 2) using a five-point scale (Ludwig and Waitzman, 2007).

Numerous diagnostic procedures have already been developed abroad to evaluate food intake and nutritive and non-nutritive sucking in newborns, including babies born prematurely. For example, in the USA the *Neonatal Oral-Motor Assessment Scale* – NOMAS (Palmer et al., 1993) has been developed and modified for the assessment of premature babies. It assesses normal, disorganized, and dysfunctional movements of the tongue and jaw. In Europe, *The Early Feeding Skills For Preterm Infants* – EFS scale (Thoyre et al., 2005) is used to assess readiness for feeding and also to assess its progress and monitor the stage of maturation of oral-motor skills. As for newer tools, we can mention the *Oral Feeding Scale* – OFS (Lau et al., 2011), which evaluates the child's oral-motor skill index and endurance index divided into four levels. Furthermore, we cannot omit the SOFFI – *Supporting Oral Feeding in Fragile Infants* (Ross and Philbin, 2011) based on Synactive Theory (Als, 1986), the *Premature Infant Oral Motor Intervention* – PIOMI (Lessen et al., 2015) based on Debra Beckman's oral-motor intervention, as well as the *Preterm Oral Feeding Readiness Assessment Scale* – POFRAS (Fujinaga et al., 2013) evaluating 18 items categorized by gestational age, the individual's behavioural organization, oral posture, oral reflexes and non-nutritive sucking.

## Therapeutic approaches and options

Food intake in premature babies is influenced by variety of factors. For this reason, it is important to first ensure the most optimal conditions for newborns and their mothers. That is why the concepts of developmental individualized care were created. There are currently several models of developmental care. Some child-centered models can be mentioned, e.g. – *Stages of behavioral organization in the high-risk neonate* (Gorski et al., 1979), which describes three developmental phases of the interaction of the premature baby with the environment; *Synactive Theory* (Als, 1982), which was the basis for the creation of the NIDCAP (Newborn Individualized Developmental Care and Assessment Program) and emphasizes the interaction of several hierarchically related subsystems, including their development within gestational weeks, and also draws attention to the importance of observing the child's nonverbal expressions. Models focused on both the child and the parent include the *General Model of Developmental Care* (Gibbins, 2008), which extends the Synactive Theory to include the concept of shared care, where the feelings and needs of the parent are also taken into account; the *Neonatal Integrative Developmental Care Model* (Altimier and Phillips, 2013) as a holistic approach identifying 7 areas important for positively influencing the neuroplasticity of the child's brain. Among the models focused simultaneously on the child, parents and nursing staff is the *Empowerment Model* (Spreitzer, 1995), which brings together information from different areas and allows easier decision choices. The last model is the *Diffusion of Innovation Theory* (Rogers, 2003), which draws attention to the need to constantly educate oneself, the need to build on EBP (Evidence Based Practice) and to be open to new possibilities and technologies.

In general, the sensory stimuli coming from the environment must be specifically adjusted to ensure optimal conditions for the development and self-regulation of the preterm infant. This involves the domains of thermoregulation, tactile perception and proprioception, vestibular perception (positioning and manipulation), auditory, visual and olfactory perception and oral perception (food intake), as well as stress, pain, sleep and wakefulness management. Within these basic measures, we need to maintain uniform procedures within all the professions involved in the care of premature babies. Of course, the mother's presence with the preterm baby should be as frequent as possible, ideally continuous, as well as psychological support and education of the parents regarding the infant's non-verbal communication and the appropriate choice of responses to this communication (Dort et al., 2013; Staníčková and Šaňáková, 2020; Červenková, 2021; Marková and Chvílová Weberová, 2021a; Červinková, 2023).

In the context of eating management, the clinical speech pathologist can then build on previous nursing and rehabilitation care and apply therapeutic procedures specific to their own profession. Within the concept of cue-based feeding, oral food intake is approached in alignment with the child's key behavioural signs.

Understanding the *key behavioural signs/cues* is essential to being able to use this concept. Key signs can be divided into two categories, namely acceptance signals/cues (ability to respond to stimuli), coping cues (ability to accept and tolerate stimuli); and then to the signals of rejection (inability to cope with incoming stimuli), which are manifested sequentially at the different levels of development described within the framework of the Synactive Theory. It is important not only for the parents of premature babies, but also the nursing staff to learn to recognize these key behavioural signs. Based on their recognition, the ability to respond appropriately to them can also be cultivated (Ludwig and Waitzman, 2007; Červenková, 2021c). Regarding the *feeding position*, it is not only important in breastfeeding but also in bottle feeding. The elevated side position is safer compared to the supine position, as it involves placing the bottle in a horizontal position, which reduces the flow rate by limiting the influence of gravity, allowing the infant to better control the bolus of fluid in the oral cavity and, in effect, receive a higher volume of milk (Raczyńska and Gulczyńska, 2019). This position supports breathing and eliminates the risk of vital sign instability (Park et al., 2014). When bottle feeding, it is paramount to select the *correct type of bottle and teat* for the individual. This covers not only the size of the teat, the width of its base, the material and its elasticity, the presence or absence of a ventilation system distinguished, but above all the flow rate and its variability (Červenková, 2022). Another therapeutic option is *external interruption of sucking* to allow regulation the flow of milk into the baby's mouth, which will affect the coordination of breathing, sucking and swallowing, and thus it supports the baby's physiological stability (Lau et al., 2000). There are two variants of this technique, namely the external interruption of sucking where the number of sucks in the sucking cycle is determined a priori before the start of feeding based on the previous evaluation of nutritive sucking, or cue-based external interruption of sucking, where the interruption of sucking is chosen individually according to the child's reactions. Sucking is paused by lowering the bottle, not by removing it from the child's mouth. This technique is most commonly used for disorganized sucking and specifically for the prolonged sucking subtype in children who are unable to integrate sucking into their sucking cycles (Palmer, 2020). We can also use the technique of *neurological music therapy* (Patterned Sensory Enhancement – PSE), which has been shown to have a very positive effect on the behavioural organization of the individual and oral food intake, as this method has a positive effect on the stability of heart rate, respiratory rhythm, including reducing the risk of apnoea, etc. (Červenková, 2021b). Within the overlapping expertise of the respective professions, *respiratory physiotherapy* (handling) cannot be overlooked, which is based on the principles of developmental kinesiology and also on a neurophysiological basis. It is a very mild and gentle method influencing the depth and frequency of breathing using tactile and proprioceptive stimuli associated with positioning and specific manipulation (Smolíková, 2017).

## Conclusion

Food intake in premature babies is one of the important areas that deserve to be given due attention. As it is a skill based on sensory and motor patterns and predicting the development of many areas from the mother-infant attachment, oral-motor skills, craniofacial development, feeding, speech, to the development of social and emotional skills, we need to continue to focus on and develop this topic. With early prevention and guidance, very positive outcomes can be achieved, while eliminating more serious consequences. Feeding and eating disorders, including swallowing disorders, are an increasingly discussed topic for many parents, who can be significantly helped by a clinical speech pathologist. In addition, by cooperating with other professionals, we can ensure the necessary comprehensiveness and level of care for premature babies, because quality input enables quality output.

## Acknowledgements

Partial outputs of this research were supported by project IGA_PdF_2024_017 "Investigation of multi-dimensional determinants of phatic, phonation and articulation functions in relation to selected communication disorders from the perspective of a speech pathologist" [Principal investigator: prof. Kateřina Vitásková].

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