Non-nutritive sucking evaluation in preterm newborns and the start of oral feeding: a multicenter study

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OBJECTIVES: The assessment of early sucking by preterm infants provides information on the ability of these infants to efficiently and safely receive nutrients via an oral route (oral feeding). To analyze the application and reliability of an instrument in assessing non-nutritive sucking that indicates a capacity for oral feeding in the routine care of different neonatal units.

METHODS: A multicenter, prospective cohort study was conducted in seven neonatal units. A non-nutritive sucking assessment with a formulary validated by Neiva et al (2008) (variables evaluated: rooting reaction; easy initiation of sucking; labial sealing; tongue central groove; peristaltic tongue movements; jaw raising and lowering movements; labial, tongue and jaw coordination; sucking strength; sucking rhythm; bites; excessive jaw excursion; stress signals) was applied to 199 pre-term newborns, who had a chronological age $\geq$ 2 days and were clinically stable. These infants were divided into two groups based on their corrected gestational age at the first assessment, as follows: Group I-infants with a gestational age $\leq$ 33 weeks and Group II-infants with a gestational age between 34 and 36 6/7 weeks.

RESULTS: The mean gestational age was 31.66$\pm$2 weeks, and the mean birth weight was 1494 $\pm$ 373 g. The mean scores on the non-nutritive sucking assessment were 46 $\pm$ 25 in Group I and 49 $\pm$ 24 in Group II. The beginning of oral feeding was successful in 43 (67.2%) infants in Group I and 64 (81%) infants in Group II ($p = 0.089$).

CONCLUSION: The method identified preterm infants who were able to feed orally based on 33 points in the non-nutritive sucking assessment and a corrected gestational age of 32 weeks or more. The corrected gestational age was the most important factor in predicting the success of oral feeding.

KEYWORDS: Preterm Infants; Sucking Behavior; Feeding Behavior.

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INTRODUCTION

The development of sucking/swallowing by preterm infants (PTs) is an indicator of greater maturity and, consequently, better evolution. Therefore, an earlier introduction of nutrition via the oral route in PT may contribute to an earlier development of body functions, such as those related to the gastrointestinal tract.

Identifying the time in which these infants have already developed the conditions necessary to safely and efficiently start oral feeding is a requirement to begin oral feeding. Therefore, the development of objective methods and scores that can contribute to this indication should be encouraged.

There is a consensus in the literature that PTs with a gestational age (GA) of 34 weeks who show maturity and can coordinate sucking, swallowing and breathing can safely start oral feeding (1-3). With the advances of studies examining the oral motor skills of PTs, other factors are now considered important in performing this determination, such as the infant's non-nutritive sucking ability (4). Thus,

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safe oral feeding could be started before a corrected GA of 34 weeks (3,5-7).

Therefore, several authors have tried to use, discuss and propose methods and sufficient protocols/sucking assessment scores that would indicate when oral feeding can be performed safely (6,8,9-12). These protocols have been the subject of several studies, including reassessments of some previously validated methods. For example, Costa Schans (2008) (11) reevaluated the neonatal oral-motor assessment scale (NOMAS) and made suggestions for the adjustment of the scale. In Brazil, Fujinaga (12) presented an instrument including the evaluation of global position; global tonus; the position and movement of the lips, tongue and jaw; oral reflexes; biting and gagging; and the strength and rhythm of sucking and stress signals, but a minimum score for oral feeding start was not indicated.

However, it is essential to assess the sucking function of a PT during the early postnatal period and to provide information about the infant's ability to safely and efficiently perform the functions of sucking and swallowing in the near future. These assessments may also indicate the need for intervention at this stage to ensure the success of receiving nutrition orally when it is started.

In this context, Neiva, Leone and Leone (2008) (6) developed and validated a scoring system to assess non-nutritive sucking (NNS) in very low birth weight PTs. In this system, a minimum score of 50 points is the indication to begin efficient oral feeding. This is a safe and accurate method of evaluating this ability in addition to identifying the earliest abilities necessary to begin oral feeding or, conversely, the need for early intervention to stimulate sucking.

Thus, a multicenter study in several neonatal units was developed with the aim of analyzing the implementation of a previously validated instrument (6) within the unit's routine and determining the reliability of this method in successfully indicating the capacity for oral feeding in different neonatal units.

MATERIALS AND METHODS

This was a multicenter, prospective cohort study that evaluated the application of an NNS assessment method, the NNS scoring system of Neiva et al. (6), in the routine care of the following neonatal units: University Hospital, Jundiaí College of Medicine, SP; Fernandes Figueira Institute, Rio de Janeiro, RJ; Clinic Hospital, Lutheran University of Brazil, Porto Alegre, RS; Marilia College of Medicine, Famema; Pedro Ernesto University Hospital, RJ; University Hospital, College of Medicine, University of São Paulo, SP; and São Vicente de Paulo Hospital of Passo Fundo, Rio Grande do Sul.

The selection of the neonatal units was based on the following inclusion criteria: at least 100 PTs admitted per year; a Speech Therapist working in the unit; NNS assessments allowed to be performed on PTs who have not yet been fed orally (transition or complete) and allowed to be performed when indicated by a Speech Therapist; and oral nutrition offered independent of the corrected GA and weight of the PT. In addition, the units were required to receive approval from the Committee on Ethics in Research of their respective hospitals.

The following were the inclusion criteria for the Speech Therapists: availability to participate for a minimum period of 12 months; practice in a neonatal unit with PT; and experience working on aspects of oral motor development.

The study included 199 PTs who were selected by convenience sampling and who were admitted to these units between February 2007 and October 2009. All infants met the following criteria: GA at birth less than 36 6/7 weeks; corrected GA less than or equal to 37 weeks; postnatal age equal to or greater than 2 days of life; clinically and hemodynamically stable; not on respiratory support; no episodes of apnea and not receiving analgesic or anesthetic medications. Infants were excluded if they were diagnosed with severe metabolic disorders, genetic syndromes, oral-motor or cognitive defects, neurological disorders or infections.

The gestational age at birth was defined based on the criteria of the respective neonatal unit, including one or more of the following: last menstrual period (LMP), fetal ultrasonography, the New Ballard method and the Capurro method.

For the analysis, the infants were divided into two groups according to their corrected GA at the first NNS assessment: Group I (G1) included infants whose GA was $\leq$ 33 weeks, and Group II (G2) included infants whose GA was between 34 and 36 6/7 weeks. The infants were analyzed according to the following characteristics: GA at birth, birth weight, nutritional classification, Apgar score, sex and chronological age. Infants were considered small for gestational age when their birth weight was below the 10^{th} percentile on the curve described by Alexander in 1996 (14).

All the infants received an NNS assessment based on the NNS scoring system (6) method, which was performed by the neonatal units' Speech Therapists on PTs who were receiving exclusive enteral nutrition (breast milk and/or formula) via a gastric tube or parenteral nutrition without oral administration (Figure 1).

In all the neonatal units, the timing of the NNS assessment was standardized so that PTs could show a readiness for sucking and be in an appropriate behavioral state, i.e., not in a deep sleep and not showing signs of stress (crying, hiccupping, choking, etc.).

The NNS was performed with a gloved finger (fingers and palm down) of the right hand of the Speech Therapists approximately 30 minutes before feedings. The duration of the NNS varied, but a minimum of 6 minutes was recommended to observe changes in the sucking rhythm and whether the observed characteristics were sustained. If necessary, and based on the physiological parameters and signs that were manifested, the NNS assessment could be interrupted.

This assessment was started using a stimulating touch on the perioral region, more specifically near the angle of the mouth, to test the rooting reflex and then a touch on the anterior portion of the palate or lower gum and the tip of the tongue was used to trigger the sucking reflex.

Immediately following each NNS assessment, the observed data were recorded on the sucking assessment form (6). Afterwards, oral feeding was not offered to the infants who received a score less than 33 points. For the PTs with a score of 50 or more points, oral feeding was offered. For the PTs who obtained scores between 33 and 49 points and in an effort to ensure the infant's safety, the personal judgment of the Speech Therapist was used to indicate or

Positive items	Mark the suitable				Converted value
1) rooting reaction	Yes ( ) (4)		No ( ) (0)		
2) easy beginning of sucking	Yes ( ) (4)		No ( ) (0)		
3) labial sealing	always ( ) (12)	most part ( ) (8)	sometimes ( ) (4)	never ( ) (0)	
4) tongue central groove	always ( ) (9)	most part ( ) (6)	sometimes ( ) (3)	never ( ) (0)	
5) peristaltic tongue movements	always ( ) (9)	most part ( ) (6)	sometimes ( ) (3)	never ( ) (0)	
6) jaw raising and lowering movements	always ( ) (9)	most part ( ) (6)	sometimes ( ) (3)	never ( ) (0)	
7) labial, tongue and jaw coordination	always ( ) (15)	most part ( ) (10)	sometimes ( ) (5)	never ( ) (0)	
8) sucking strength	always ( ) (12)	most part ( ) (8)	sometimes ( ) (4)	never ( ) (0)	
9) sucking rhythm	always ( ) (12)	most part ( ) (8)	sometimes ( ) (4)	never ( ) (0)	
	Total positive items:				
Negative items					
10) bites	always ( ) (-3)	most part ( ) (-2)	sometimes ( ) (-1)	never ( ) (0)	- .....
11) excessive jaw excursion	always ( ) (-3)	most part ( ) (-2)	sometimes ( ) (-1)	never ( ) (0)	- .....
12) stress signals	always ( ) (-15)	most part ( ) (-10)	sometimes ( ) (-5)	never ( ) (0)	- .....
	Total negative items:				
	T O T A L:				

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Figure 1 - Non-nutritive sucking score system- NNS.

contraindicate oral feeding based on their impressions and the clinical condition of the infant.

In the latter group of PTs, the same procedure was adopted for the infants who had a score of 50 or more points, i.e., the Speech Therapist or a professional on the hospital staff offered 5 ml of milk by bottle. The success of that first oral feeding was then recorded for the PT. The oral feeding was considered successful when the PT had an efficient oral feeding by ingesting the prescribed volume of milk within an appropriate period of time without signs of stress or changes in his/her physiological parameters.

Statistical Analysis

The data are described and presented as the mean and standard deviation as well as relative frequencies. They were calculated using SPSS software (15).

The mean or median comparisons were based on Student's t-test or the Mann-Whitney test; the latter was used when the variance did not have a normal distribution based on the Kolmogorov-Smirnov test. The proportions were evaluated using the chi-square or Fisher's exact test.

For the regression analysis of factors associated with successfully beginning oral feeding, the odds ratio and 95%

Table 1 - Characteristics of infants at birth and at the 1st assessment according to group classification.

Characteristics		G1	G2	*p*-value
		n = 95	n = 104	
Gestational age at birth (weeks)		30.5 ± 1.87	32.7 ± 2.46	$p<0.0001$
(Maximum - minimum)		(33.6 - 24.6)	(36 - 20)	
Birth weight (grams)		1.417 ± 305	1.565 ± 414	$p=0.0043$
Classification	Adequate for GA	71 (85.54%)	62 (68.88%)	$p=0.0157$
	Small for GA	12 (14.45%)	28 (31.11%)	
APGAR 5′	<6	1 (1.07%)	5 (4.9%)	$p=0.2583$
	≥ 6	92 (98.92%)	97 (95.1%)	
Sex	Male	50 (52.63%)	57 (54.8%)	$p=0.8688$
Corrected gestational age (weeks)		32.7 ± 1	35 ± 0.9	$p<0.0001$
Weight (grams)		1471 ± 232	1641 ± 285	$p<0.0001$
Postnatal age (days)				$p=0.5788$
Average score for the NNS assessment		46 ± 25	49 ± 24	$p=0.4560$

*GA was converted to weeks to calculate the mean and SD.
**NNS: non-nutritive sucking, GA: gestational age.

confidence intervals were calculated using a binary logistic regression test with a stepwise backward-Wald elimination. The following variables were also included in the analysis: weight and GA at birth; chronological and corrected gestational age; weight and score at the first assessment. The software MedCalc Version 12.1.4.0 was used for these analyses.

The data were considered significant at $p<0.05$.

RESULTS

Seven neonatal units participated in the study, and the 199 PTs included in the study were born at the participating institutes, as follows: 40 (20%) at the University Hospital, Jundiaí College of Medicine (São Paulo); 20 (10%) at the Fernandes Figueira Institute, Rio de Janeiro (Rio de Janeiro); 20 (10%) at the Clinic Hospital, Lutheran University of Brazil, Porto Alegre (Rio Grande do Sul); 34 (17%) at the Marilia College of Medicine, Famema; 30 (15%) at the Pedro Ernesto University Hospital (Rio de Janeiro); 18 (9%) at the University Hospital, College of Medicine, University of São Paulo (São Paulo); and 37 (19%) at the São Vicente de Paulo Hospital of Passo Fundo (Rio Grande do Sul).

At birth, the mean gestational age of the PTs included in the study was 31.66 ± 2 weeks, the mean BW was 1494 ± 373 grams and the Apgar score at 5 minutes was greater than or equal to six in 96.9% of the cases. Of all infants studied, 40 (23%) were SGA, while 132 (77%) were AGA (appropriate for gestational age). Additionally, 107 infants (53.77%) were male.

Table 1 shows the characteristics of the infants at birth according to the group. These data demonstrated that the study groups were homogeneous regarding sex and Apgar score. However, they differed in relation to GA, birth weight and the corrected GA and weight at the 1st assessment, which was expected because the infants were divided into groups according to their GA at birth ($p<0.0001$). Additionally, in relation to the nutritional classification, the proportion of PTs who were SGA was higher in G2 ($p=0.0157$). However, there were no differences in the postnatal age or the mean score for the NNS assessment.

Of the PTs with more than 33 points for the NNS assessment, oral feeding was offered to 64 (67%) infants in G1 and 79 (76%) infants in G2. In Table 2, data on which PTs were successfully fed during the first oral feeding and in Table 3, the associated factors are provided.

DISCUSSION

The implementation of the NNS scoring system method for PTs in the standard procedures of several Brazilian neonatal units reinforced the method's reliability as an indicator of oral feeding for infants with a corrected GA of over 32 weeks who scored more than 33 points in this assessment. In this analysis, the corrected GA was identified as the most important factor, followed by birth weight, for the ability of an infant to be successfully fed orally.

Thus, in the seven neonatal units selected by the defined criteria, the protocol was used by seven different Speech Therapists who did not receive any training regarding the implementation of the method, except for reading what had been previously published on the method (6), as stipulated by the study design.

For this analysis, a population was selected that was not homogeneous, particularly in terms of GA and birth weight, although it consisted of PTs who followed the inclusion and exclusion criteria per the study design. The PT were divided into groups according to GA to minimize the influence of weight and GA, although they did not differ with respect to the birth conditions or sex distribution. However, a higher

Table 2 - Distribution of infants (Groups 1 and 2) according to the score obtained and the results of the oral feeding.

NNS Score	G1		G2		*p*-value
	successful	failure	successful	failure	
≥ 33 and ≤ 49 points	13 (68.42%)	6 (31.57%)	15 (78.94%)	4 (21.1%)	$p=0.7140$
≥ 50 points	30 (66.66%)	15 (33.33%)	49 (81.66%)	11 (18.33%)	$p=0.1094$
TOTAL	43 (67.2%)	21 (32.8%)	64 (81%)	15 (19%)	$p=0.0891$

**NNS: non-nutritive sucking.

Table 3 - Multiple regression analysis of the factors associated with the success of the oral feeding after the first assessment.

Factors	OR	CI 95%	*p*-value
Corrected gestational age	1.4510	1.0764 - 1.9560	0.0146
Birth weight	1.0013	1.0001 - 1.0025	0.0322

*Binary Logistic Regression - Stepwise Backward (Wald).

proportion of small GA infants were observed in the more mature group.

If only the mean score of the NNS assessment was considered for both groups, the data indicated that scores close to 50 points, as proposed by the authors in a previous article (6), provide evidence that there is sufficient suction to begin oral feeding. However, if we consider the infants with scores between 33 and 50 points, the proportion of successful oral feedings was similar.

Based on the results obtained, particularly those related to the mean score in the first NNS assessment, which did not differ between groups, the initial hypothesis that the performance on the NNS assessment is better and the score is higher in more mature infants or those with an older postnatal age was not confirmed. This finding was also evident after examining the distribution of the scores, which were similar between the groups.

However, we were able to determine using the logistic regression that the corrected GA and birth weight were directly related to the success of starting oral feedings, whereby there was a 1.45-fold higher chance of success with an increased corrected GA. The influence of birth weight, although statistically significant, was only one order of magnitude higher.

These results suggest that the corrected GA factor interferes with NNS performance and, consequently, can be a factor that determines the capacity of infants for oral feeding.

Considering the success of oral feeding among all PTs in each group with a score higher than 33 points, those with a higher corrected GA succeeded more often, which was close to being statistically significant. This result was likely not significant due to the small number of cases that were considered for this study, which was expected because more mature infants might show greater functional maturity.

Therefore, according to these results, when a score greater than 33 points is associated with a GA, at birth or corrected, of greater than 32 weeks, the chance of successful oral feeding may be greater than 50%.

In evaluating these results, however, some limitations were identified, specifically in terms of the selected methodology. The most obvious limitation was the lack of prior training for the Speech Therapists who implemented this protocol, which led to some variation in the results between the neonatal units. Alternatively, considering that one of the purposes of the study was to assess the external validity of the method, this situation was preferable.

Nevertheless, based on this assessment of the implementation of the NNS scoring system method in the different neonatal units, it was determined that these units were capable of identifying PTs who had adequate sucking and swallowing abilities based on a score of 33 points and a GA at birth or corrected to 32 weeks. These data may signify that the start of oral feeding may be moved forward by at least two weeks compared to the usual 34 weeks that is followed in the various neonatal units.

The NNS scoring system method, however, needs to be assessed further, and the influence of other factors needs to be considered, including any prior training completed by the Speech Therapists and the use of more homogeneous groups of PTs.

AUTHOR CONTRIBUTIONS

Neiva FC participated in the study design, results analysis, drafting of the manuscript and coordination of the data collection in the neonatal units. Leone CR participated in the study design, results analysis and drafting of the manuscript. Leone C participated in the design, results analysis, drafting of the manuscript text and statistical analysis. Siqueira L, Uema KA, Evangelista D, Delgado S, Rocha A and Buhler KB participated in the data collection in the neonatal units.

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