

Association between readiness for oral feeding and feeding performance in preterm neonates

Relação entre prontidão para início da alimentação oral e desempenho alimentar em recém-nascidos pré-termo

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ABSTRACT

Purpose: To verify whether readiness for oral feeding as evaluated by the Preterm Oral Feeding Readiness Scale (POFRAS) is associated with performance on the first oral feeding; length of transition from tube to full oral feeding, and duration of hospitalization. **Methods:** This was a longitudinal study involving 65 preterm infants. Participants were divided into groups according to readiness for oral feeding as determined by the POFRAS, and gestational age (29-33 weeks and 34-36 weeks). Performance on the first oral feeding (proficiency, transfer rate and overall transfer), number of days from introduction to full independent oral feeding, and length of hospital stay were compared between groups. Continuous variables were compared using Student's t-test or Wilcoxon's signed-rank test. Categorical variables were compared using Fisher's exact test. **Results:** Readiness for oral feeding was associated with higher proficiency and transfer rates on the first oral feeding, resulting in a shorter transition from tube to independent oral feeding in preterm infants with 29 to 33 weeks of gestational age at birth. **Conclusion:** The POFRAS contributed to the prognosis of oral feeding outcomes in preterm neonates with less than 34 weeks of gestational age at birth. However, its use does not eliminate the need for an assessment of swallowing mechanisms.

Keywords: Sucking behavior; Infant, Premature; Aptitud; Diagnostic techniques and procedures; Feeding

RESUMO

Objetivo: Verificar se a presença de prontidão para iniciar a alimentação oral, obtida por meio do *Preterm Oral Feeding Readiness Scale* (POFRAS) se relaciona com o desempenho alimentar na primeira oferta oral de leite, com o tempo de transição da sonda para a via oral plena e o tempo de internação hospitalar. **Métodos:** Estudo longitudinal, que envolveu 65 recém-nascidos pré-termo. Foi realizada a avaliação da prontidão para início da alimentação oral, por meio do POFRAS, constituindo-se dois grupos: com e sem prontidão para iniciar a alimentação por via oral, em dois estratos de idade gestacional ao nascer: de 28 a 33 semanas e de 34 a 36 semanas. Em cada estrato, os grupos foram comparados entre si, quanto ao desempenho alimentar na primeira oferta oral de leite (por meio das variáveis proficiência, taxa de transferência e desempenho alimentar oral) e quanto ao tempo de transição da sonda para a via oral plena e o tempo de internação hospitalar. O teste t-Student ou o teste de Wilcoxon foram utilizados para comparar as variáveis contínuas e o teste exato de Fisher, para as variáveis categóricas. **Resultados:** A prontidão para iniciar a alimentação por via oral se relacionou com melhores resultados de proficiência e taxa de transferência na primeira alimentação, contribuindo para a transição mais rápida da sonda para a via oral plena, nas crianças nascidas com idade gestacional entre 28 a 33 semanas. **Conclusão:** a avaliação por meio do POFRAS permite estabelecer um prognóstico da alimentação oral em recém-nascidos pré-termo, menores de 34 semanas. No entanto, não exclui a necessidade de avaliação da biomecânica da deglutição.

Descritores: Comportamento de sucção; Prematuro; Aptidão; Técnicas e procedimentos diagnósticos; Alimentação

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INTRODUCTION

Preterm neonates (PTN) are often admitted to neonatal intensive care units due to the immaturity of their organs or functions, with circulatory, neurological, thermoregulatory, respiratory and gastrointestinal issues being the most commonly reported^(1,2). In most cases, these infants must be fed via tubes due to their inability to coordinate sucking, swallowing and breathing⁽³⁾.

The achievement of safe and efficient oral feeding (OF) minimizes the risk of aspiration and consists of a necessary criterion for hospital discharge in PTN^(2,4,5,6). The ability or capability to initiate OF depends on several factors, including weight, the maturation of organs and systems⁽⁷⁾, corrected gestational age⁽⁸⁾, clinical status, as well as behavioral organization state at the time of feeding⁽⁹⁾. As a result, it is essential to evaluate the infant prior to the initiation of OF. Non-nutritive sucking parameters, together with corrected gestational age, posture, muscle tone, and behavioral state, are often used to determine the onset of the transition from tube to OF⁽¹⁰⁾. Several instruments are available in the literature to assist with this process^(10,11,12,13,14,15,16).

The Preterm Oral Feeding Readiness Scale (POFRAS)^(10,12) was developed and validated for use in Brazilian children. It is easy to administer, and allows for an assessment of both physical and behavioral aspects of non-nutritive sucking, which act as indicators of readiness for OF⁽²⁾. The instrument was developed using the transfer of 10 ml of milk as a gold standard for adequate OF. However, variables such as proficiency, transfer rate and overall transfer on the first OF have also been used as important quantitative indicators and predictors of rapid attainment of full OF.

Proficiency refers to the volume of milk consumed in the first 5 minutes of the feeding session relative to the total amount prescribed. This variable is considered an indicator of oral motor skill, and is assumed to be unaffected by fatigue given the short time required for its assessment. The transfer rate, sometimes referred to as efficiency, is an indicator of neonate endurance, and is calculated as the ratio of milk consumed relative to the length of the feeding session (ml/min). Lastly, the overall transfer describes the percentage of milk consumed relative to the total amount prescribed throughout the entire feeding session (rather than the first 5 minutes). This value accounts for both oral motor skills and endurance⁽¹⁷⁾. In addition to these variables, the length of the transition from tube to independent OF and the duration of hospitalization are also used as indicators of OF outcomes in preterm infants^(18,19,20). PTN who present with a more organized sucking pattern, for instance, consisting of sucking bursts alternated with breathing pauses together with an organized behavioral state, tend to show better proficiency, transfer rates and overall transfer values^(21,22), achieving full OF earlier and staying in hospital for a shorter time than their peers⁽²³⁾ although the

length of hospitalization may also be influenced by additional factors⁽²⁴⁾.

The aim of the present study was to verify whether readiness for OF as assessed by the POFRAS is associated with performance on the first OF, the length of transition from tube to full OF, and the duration of hospitalization.

METHODS

This was an observational, descriptive and longitudinal study involving 65 clinically stable PTN admitted to a neonatal intensive care unit between November 2014 and June 2015. Exclusion criteria consisted of head, neck and/or cardiac malformations; genetic syndromes; grade III and IV intracranial hemorrhage; perinatal asphyxia (as defined by a 5-minute Apgar score ≤ 5); bilirubin encephalopathy; pulmonary dysplasia; and shortened or tight frenulum of the tongue.

This study was approved by the Research Ethics Committee of *Univeridade Federal de Santa Maria*, under protocol number 11155312.7.0000.5346. All parents and/or legal guardians provided written consent for the participation of their children in the study.

Upon meeting criteria for initiating OF as determined by the neonatal care unit (clinical stability, weight of at least 1500 grams and a corrected gestational age of at least 32 weeks), PTN were evaluated by a speech therapist with expertise in neonatal orofacial development using the POFRAS^(10,12). For the assessment, infants were placed in lateral decubitus position, with upper and lower limbs flexed, and the head in line with the body.

The instrument includes 18 items distributed into five categories. Each item is scored on a scale of zero to 2. Total scores on the POFRAS range from zero to 36, with scores ≥ 30 suggesting readiness for OF and scores <30 indicating insufficient readiness^(10,12).

After the administration of the POFRAS, PTN were allowed to rest for 15 minutes prior to engaging in their first OF session. For this procedure, PTN were placed in supine position at a 45 degree angle and their head in midline with the body. Feeding sessions had a maximum duration of 20 minutes, and were interrupted upon the identification of any signs of fatigue or distress, such as oxygen desaturation (≤ 88)⁽²⁵⁾, bradycardia (≤ 100)⁽²⁵⁾, cyanosis, apnea, nausea, choking, pallor, skin mottling, hiccups, vomiting or loss of interest in sucking. The following variables were recorded: volume of milk prescribed, volume consumed in the first 5 minutes of the feeding session, total milk intake, and length of the feeding session. These data were used to calculate the following indicators of feeding performance: proficiency, transfer rate and overall transfer. In the present study, adequate OF was defined as a proficiency of at least 30%, a transfer rate of at least 1.5 ml/min and an overall transfer $\geq 80\%$ ⁽¹⁷⁾.

The number of days required to transition from tube to full OF, as well as the length of hospitalization, were also recorded.

The transition time was calculated as the number of days from the introduction of OF to the first 24-hour period in which all nutrition was taken orally.

The following data were then collected from the medical records of participating infants: weight and gestational age at birth, gender, adequacy of intrauterine growth (small for gestational age, adequate for gestational age and large for gestational age), as well as weight and corrected gestational age at the introduction of OF, the attainment of full OF, and hospital discharge.

Data were stratified according to gestational age at birth (28 to 33 weeks and 34 to 36 weeks). Infants in each age group were then classified according to their readiness for OF (POFRAS scores ≥ 30 vs. < 30).

Data were analyzed using the Stata 10.0 software. Normality was assessed using the Shapiro-Wilk test. Groups were compared using Student's t-tests or Wilcoxon's signed rank tests for continuous variables, and Fisher's exact test for categorical variables. Results were considered significant at $p < 0.05$.

RESULTS

PTN in either age group who demonstrated readiness for OF did not differ from those who showed insufficient readiness with regard to gender, adequacy of intrauterine growth, weight and gestational weight at birth, or weight and corrected gestational age at the introduction of OF and hospital discharge. However, PTN with 28 to 33 weeks of age who demonstrated readiness for OF achieved full OF approximately one week earlier, on average, than remaining infants of a similar age (36.4 ± 1.4 vs. 35.6 ± 1.0 weeks for PTN with scores < 30 and ≥ 30 , respectively; $p = 0.04$). The characteristics of infants with POFRAS scores < 30 and ≥ 30 in each age gestational age group, from birth to hospital discharge, are shown in Table 1.

The groups did not differ with regard to proficiency, transfer rates and overall transfer, although PTN in the 28 to 33 age group with insufficient readiness for OF obtained the lowest scores for all three variables. The transition from tube to full

Table 1. Characteristics of PTN from birth to hospital discharge according to POFRAS scores

Variables	Gestational age at birth (w)					
	28 - 33 (n=28)		p-value	34 - 36 (n=37)		p-value
	Score <30	Score ≥ 30		Score <30	Score ≥ 30	
n	11	17		10	27	
Gender (%)						
Male	7 (63.6)	11 (64.7)	0.6	4 (40)	20 (74)	0.06
Female	4 (36.4)	6 (35.3)		6 (60)	7 (26)	
Adequacy of IUG (n, %)*						
SGA	2 (18.2)	3 (17.6)	0.6	3 (30)	10 (37)	0.5
AGA	9 (81.8)	14 (82.4)		7 (70)	17 (63)	
At birth						
GA (w)**	33.4 (32.4 -33.6)	33 (31.5-33.6)	0.6	35.3 (34.2-35.5)	34.5 (34.2-36)	0.8
Weight (g)***	1698 (± 373)	1736 (± 441)	0.4	1855 (1710-2020)	2170 (1690 -2685)	0.9
Beginning of OF						
CGA (w)**	34.2 (33.2-34.5)	34.1 (34-34.6)	0.5	35.4 (± 0.7)	35.4 (± 0.9)	0.5
Weight (g)***	1729 (± 292.2)	1829 (± 331.4)	0.2	1875.5 (± 398)	2053 (± 479.9)	0.2
Full OF						
CGA (w)***	36.4 (± 1.4)	35.6 (± 1)	0.04	37 (± 1.5)	36.4 (± 1.22)	0.1
Weight (g)***	2341 (± 377)	2226 (± 238)	0.2	2270 (± 506.5)	2240 (± 438.7)	0.4
Hospital discharge						
CGA (w)***	36.5 (± 1)	36.4 (± 1.4)	0.4	37.6 (± 1.3)	37.2 (± 1.4)	0.2
Weight (g)**	2410 (2205-2520)	2355 (2140-2545)	0.4	2291 (± 631.3)	2461 (± 351.3)	0.1

* Values expressed as percentages, analyzed using Fisher's exact test; ** Values expressed as median and interquartile range, analyzed using Wilcoxon's signed-rank test; ***Values expressed as mean and standard deviation, analyzed by Student's t-test

Subtitle: w = weeks; SGA = small for gestational age; AGA = adequate for gestational age; IUG = intrauterine growth; GA = gestational age; CGA = corrected gestational age; g = grams; PTN = Preterm neonates; POFRAS = Preterm Oral Feeding Readiness Scale; OF = oral feeding

Table 2. Performance on first oral feeding session, length of transition from tube to full oral feeding and duration of hospitalization, according to POFRAS score

Variables	Gestational age at birth (w)					
	28 - 33 (n=28)		p-value	34 - 36 (n=37)		p-value
	Score<30	Score ≥30		Score<30	Score ≥30	
n	11	17		10	27	
Proficiency (%)*	22.2 (9-40)	39.1 (17.14-42.1)	0.4	100 (100-100)	100 (44.4-100)	0.23
Transfer rate (ml/min)*	0.7 (0.33-1)	1.4 (0.83-1.71)	0.07	1.3 (0.8-2)	1.5 (0.9-2.85)	0.30
Overall transfer (%)*	50.3 (±27.7)	63.7 (±31.1)	0.13	100 (100-100)	100 (88.9-100)	0.39
Transition from tube to full OF (days) *	19.5 (±9.8)	11.3 (±10.9)	0.02	9.5 (5-17)	2.5 (1-10)	0.09
Hospital stay (days) **	27.3 (±10.9)	27.9 (±14.4)	0.45	17.5 (±8.1)	16 (±9)	0.32

* Values expressed as median and interquartile range, analyzed using Wilcoxon's signed-rank test; **Values expressed as mean and standard deviation, analyzed by Student's t-test

Subtitle: OF = oral feeding; POFRAS = Preterm Oral Feeding Readiness Scale

OF, on the other hand, was approximately seven days shorter for PTN who showed readiness for OF than those with insufficient readiness in the 28 to 33 week age group ($p=0.02$). A similar pattern was observed in the 34 to 36 week age group, but did not reach statistical significance. Although readiness scores were associated with a shorter transition from tube feeding, they did not appear to influence the length of hospitalization. Infant performance on the first OF session, the length of the transition from tube to full OF and the length of hospitalization are shown in Table 2. Data are stratified by PROFAS scores and gestational age at birth.

The analysis of PROFAS item scores in infants with total scores ≥ 30 (readiness for OF) and < 30 (insufficient readiness) showed that muscle tone, lip position, biting reflexes, vomiting reflexes and stress indicators did not differ between PTN who demonstrated readiness for OF and those with insufficient readiness. As such, they did not contribute to the assessment of readiness for OF. The results of this analysis are shown in Table 3.

DISCUSSION

Corrected gestational age is considered an important indicator of readiness for OF, although it may not guarantee its efficiency, since the coordination of sucking, swallowing and breathing is closely related to the clinical stability of the neonate^(22,25). In the present study, PTN were evaluated at approximately 34 weeks of corrected gestational age, at which point it is generally believed that infants with normal intrauterine growth are able to engage in OF. However, 39.3% ($n=11$) of PTN with 28 to 33 weeks of age and 27% ($n=10$) of PTN with 34 to 36 weeks did not show sufficient readiness for OF according to the POFRAS. These findings underscore the importance of assessment instruments which allow for the

identification of neonates who may require oral motor intervention to transition from tube feeding and facilitate the early achievement of independent OF.

The present results showed that PTN with 28 to 33 weeks of age who demonstrated readiness for OF according to the POFRAS achieved full OF at a younger corrected gestational age than their peers (Table 1). A similar pattern was observed in the transition from tube to full OF, which was approximately seven days shorter in children who demonstrated readiness for OF (Table 2). This finding may be attributed to the increased proficiency and transfer rates observed in these individuals, which are much closer to normal values. According to the literature^(17,26,27), a proficiency of at least 30% is indicative of adequate oral skill while a transfer rate of at least 1.5 ml/min suggests sufficient endurance (low fatigue) for OF.

In late PTN, readiness for OF was not associated with feeding performance. However, the length of transition from tube to full OF was approximately seven days longer in infants with insufficient readiness for OF. Although this difference did not reach statistical significance, it has clear clinical relevance due to the importance of early attainment of OF for breastfeeding outcomes and hospital discharge, not least due to the role of independent OF as a necessary criterion for hospital discharge⁽²⁸⁾.

Overall, it appears that behavioral data and non-nutritive sucking parameters may not be sufficient indicators of successful OF⁽²⁹⁾, since nutritive sucking involves additional processes such as the coordination of sucking, swallowing and breathing⁽¹⁹⁾. As such, readiness for OF should be evaluated based on both behavioral assessments and an evaluation of swallowing mechanics, so as to provide additional information regarding oral motor interventions in this population.

The present study also examined which POFRAS items would be able to distinguish PTN who demonstrate readiness

Table 3. Frequency of item scores in infants with a total POFRAS score <30 (insufficient readiness) and ≥30 (readiness for oral feeding)

POFRAS items	POFRAS		p-value
	Score <30 % (n)	Score ≥30 % (n)	
	32.3 (21)	67.7 (44)	
CGA			
Behavioral state organization			
State of Consciousness			
Alert	28.6 (6)	84.1 (37)	<0.0001
Light sleep	71.4 (15)	15.9 (7)	
Global Posture			
Flexed	14.3 (3)	63.6 (28)	<0.0001
Semiflexed	85.7 (18)	36.4 (16)	
Global Muscle Tone*			
Normal	100 (21)	100 (44)	-
Mouth Position			
Lip position *			
Closed	52.4 (11)	43.2 (19)	0.73
Half-open	47.6 (10)	54.5 (24)	
Open	-	2.3 (1)	
Tongue position*			
Flat	90.5 (19)	95.4 (42)	0.39
Raised	9.5 (2)	4.5 (2)	
Oral reflexes			
Seeking	14.3 (3)	70.4 (31)	<0.0001
Sucking	19.0 (4)	88.6 (39)	<0.0001
Biting*	100 (21)	100 (44)	-
Vomiting*	90.5 (19)	95.4 (42)	0.49
NNS			
Adequate tongue movements	52.4 (11)	97.7 (43)	<0.0001
Tongue channeling	28.6 (6)	84.1 (37)	<0.0001
Adequate jaw movements	47.6 (10)	97.7 (43)	<0.0001
Sucking strength	4.8 (1)	72.3 (32)	<0.0001
Sucks per burst			
More than 8	0	25 (11)	<0.0001
5 to 8	14.3 (3)	38.6 (17)	
Rhythm maintained	9.5 (2)	63.6 (28)	<0.0001
Alertness maintained	28.6 (6)	68.2 (30)	<0.0001
Absence of stress indicators *	57.1 (12)	72.7 (32)	0.21

Fisher's exact test (p<0.05)

* Items which did not differ between infants who demonstrated readiness for oral feeding and those with insufficient readiness

Subtitle: POFRAS = Preterm Oral Feeding Readiness Scale

for OF from those with insufficient readiness. The discriminant validity of the POFRAS was already investigated in a longitudinal study of 19 PTN. Infants were administered the instrument when fed exclusively by tube, and reexamined after achieving full OF. Most items differed significantly between assessments, confirming the discriminant validity of the POFRAS. However, posture and muscle tone, lip and tongue position, as well as biting and vomiting reflexes did not differ between time points. As such, the authors suggested that the items be removed from

the POFRAS⁽³⁰⁾. The present findings revealed that muscle tone, lip and tongue position, biting and vomiting reflexes, as well as stress indicators did not differ between groups, and as a result, had no discriminant ability. Four of these items were already described in the previous study as having no discriminant validity⁽³⁰⁾. The relevance of maintaining these items in the POFRAS should be evaluated by future research, as it is beyond the scope of the present study.

CONCLUSION

The PROFAS contributed to the prognosis of OF outcomes in PTN younger than 34 weeks of gestational age. However, it does not replace the need for an assessment of swallowing mechanics prior to the onset of OF.

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