PS-1

# Quantitative Non-Nutritive Sucking Measurement as a Predictor of Oral Feeding Readiness in Newborns

Jae Sik Seo[1], Tae Woong Yang[1], Kyeong Jae Lee[2], Daun Hong[2], Jean G. de Oliveira[2], Sohee Kim[2], Suro Choi[3], Yong Beom Shin[4], Jin A Yoon[4]

[1]Department of Rehabilitation Medicine, Biomedical Research Institute, Pusan National University Hospital
[2]Department of Robotics Engineering, Daegu Gyeongbuk Institute of Science and Technology (DGIST), Daegu, Republic of Korea
[3]College of Transdisciplinary Studies, Daegu Gyeongbuk Institute of Science and Technology (DGIST), Daegu, Republic of Korea
[4]Department of Rehabilitation Medicine , Biomedical Research Institute, Pusan National University Hospital, Pusan National University School of Medicine

## Objective

Non-nutritive sucking (NNS) is a predictable and rhythmic primitive reflex that is a precursor skill to oral feeding. Most previous studies predicted the oral feeding transition through quantitative analysis of the NNS, but a qualitative evaluation conducted at a single time point is insufficient to evaluate more complicated sucking ability. Therefore, in this study, we analyzed the relationship between the parameters of the silver nanowire-based flexible pressure sensor developed for measuring the NNS performance of premature infants and the state of nutrient aspiration to predict a stable sucking pattern and confirm it as a clinical index.

## Methods

This study enrolled 58 premature infants who were born between 25 and 36 weeks' gestational age (GA) and were referred to the division of pediatric rehabilitation for feeding difficulty during the transition period from tubal feeding to oral feeding. A flexible pressure sensor was used to measure the non-nutritive sucking parameters of neonates. The evaluator stimulated the infants' lips and tongue with a pacifier with a sucking pressure sensor inserted to check whether non-nutritive sucking had occurred. When the sucking reflex was induced, it was measured. Quantitative NNS measurement according to the feeding state was compared between groups.

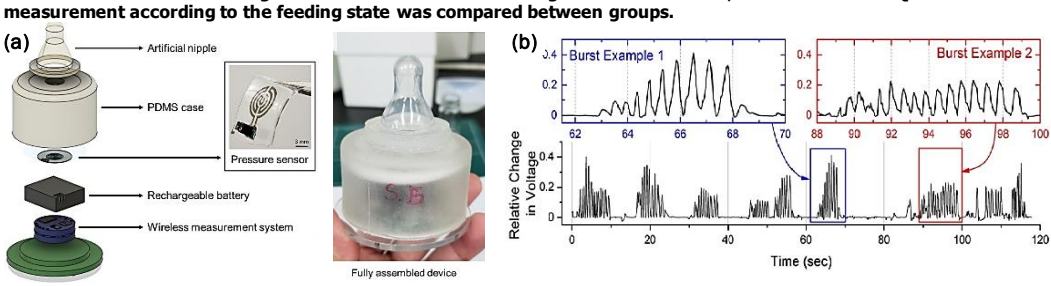


Fig 1. (a) Fully assembled device of a flexible pressure sensor and components (b) A representative example of the measured sucking pressure of a neonate

## Results

When comparing the quantitative NNS measurement by feeding characteristics, the average sucking pressure was significantly higher in infants in the full oral feeding (FOF) capable group than those in the incomplete FOF group. In addition, the maximum and average sucking pressure was significantly higher in infants with a normal sucking pattern compared to those with a disorganized sucking pattern. The average NNS pressure was divided over the range of 0 to 3 and the same weight was assigned to each item. When the optimal cut-off value for the sensitivity and specificity of the average NNS pressure to estimate the FOF was set, a pressure of 1.5 kPa yielded the highest sensitivity (84.62%) and specificity (67.65%) on the Receiver operating characteristic (ROC) curve. The Area under the curve (AUC) was 0.786, and this result was statistically significant. This study shows that when estimating FOF capability, an NNS pressure of 1.5 kPa yielded the highest sensitivity and adequate specificity on the ROC curve. Quantitative indicators like this will be useful when determining the appropriate time to attempt safe oral feeding.

Table 1. Comparison of quantitative NNS measurement by feeding characteristics

| Characteristics | FOF status | | | NOMAS finding | | |
|---|---|---|---|---|---|---|
| | Complete FOF (N=23) | Incomplete FOF (N=8) | *p*-value | Normal (N=12) | Disorganized (N=19) | *p*-value |
| Total number of sucks | 61.25 ± 30.30 | 56.00 ± 43.68 | 0.484 | 67.16 ± 47.45 | 51.15 ± 34.98 | 0.389 |
| Average number of sucks per minute | 19.61 ± 9.67 | 25.01 ± 23.01 | 0.842 | 33.13 ± 27.30 | 17.61 ± 11.80 | 0.120 |
| Maximum pressure of suck (kPa) | 4.14 ± 2.25 | 2.87 ± 2.20 | 0.222 | 5.53 ± 2.04 | 2.83 ± 1.66 | 0.046* |
| Average pressure of suck (kPa) | 2.22 ± 1.07 | 1.12 ± 0.51 | 0.033* | 2.83 ± 1.15 | 1.66 ± 0.89 | 0.046* |
| Total number of suck bursts | 11.87 ± 10.82 | 10.82 ± 7.13 | 0.550 | 10.58 ± 6.50 | 11.42 ± 7.13 | 0.921 |
| Average number of sucks per burst | 4.03 ± 1.35 | 3.85 ± 2.06 | 0.411 | 4.66 ± 2.53 | 3.41 ± 1.15 | 0.252 |
| Maximum length of bursts (sec) | 5.25 ± 3.21 | 4.59 ± 2.52 | 0.580 | 5.17 ± 3.07 | 4.50 ± 2.45 | 0.589 |
| Average length of bursts (sec) | 2.32 ± 0.99 | 2.34 ± 1.06 | 0.877 | 2.56 ± 1.40 | 2.19 ± 0.71 | 0.734 |

NOMAS; Neonatal Oral-Motor Assessment Scale, FOF; Full Oral Feeding

Table 2. Criterion values of average sucking pressure and coordinates of the ROC curve

| Cut off value of average sucking pressure (kPa) | Sensitivity | 95% CI | Specificity | 95% CI |
|---|---|---|---|---|
| 0.00 | 100 | 75.3 - 100.0 | 0 | 0.0 - 10.3 |
| 0.5 | 100 | 75.3 - 100.0 | 0 | 0.0 - 10.3 |
| 1.00 | 100 | 75.3 - 100.0 | 26.47 | 12.9 - 44.4 |
| 1.50 | 84.62 | 54.6 - 98.1 | 67.65 | 49.5 - 82.6 |
| 2.00 | 46.15 | 19.2 - 74.9 | 94.12 | 80.3 - 99.3 |
| 2.50 | 7.69 | 0.2 - 36.0 | 100 | 89.7 - 100.0 |
| 3.00 | 0 | 0.0 - 24.7 | 100 | 89.7 - 100.0 |

CI; confidential interval, kPa; kilopascal

## Discussion

This study presents a quantitative parameter for non-nutritive sucking in preterm infants with the use of a flexible pressure sensor. Results show possible quantitative indicators that can aid in predicting when preterm infants can transition to oral feeding and their prognosis. This will serve as a basis for future research on determining the feeding transition period of newborns with health conditions that affect oral feeding.