Sigma Theta Tau International Henderson Repository Final Report

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Title of Project _The relationship between duration of tube feeding and oral feeding success in preterm infants_

Mechanism of project: STTI Small Grants

I. Summary of project aims

Preterm infants often require extended tube feeding and are challenged to achieve oral feeding success (OFS, ability to consume 100% of the prescribed volume by mouth). The relationship between duration of tube feeding and OFS is not well documented. The overall purpose of the study was to identify the potential relationships between duration of tube feeding and (1) OFS in preterm infants; (2) alert behavioral states, orally-directed behaviors, and nutritive sucking. The primary aim of this study was to identify the potential relationship between duration of tube feeding and OFS in preterm infants during their initial hospitalization. We hypothesized that preterm infants who had a longer duration of tube feeding would have a lower OFS during the transition from first to full oral feeding. A secondary aim was to identify the potential relationships between duration of tube feeding and alert behavioral states, orally-directed behaviors, and nutritive sucking at a one-time oral feeding evaluation within 48 hours after the removal of the feeding tube. We hypothesized that preterm infants who had a longer duration of tube feeding would have at least one of the following characteristics: a lower percentage of time spent in alert behavioral states, pre- and intra-feeding, a lower frequency of pre-feeding orally-directed behaviors, and/or less mature nutritive sucking.

II. Theoretical/conceptual framework

In the effort to understand the relationship between tube feeding and OFS in preterm infants, we designed a conceptual model based on evidence in the literature to guide our study (Figure 1). Various infant characteristics have been shown to be associated with the duration of tube feeding, OFS, behavioral states, orally-directed behaviors, and nutritive sucking.[1-3] Younger GA and PMA are correlated with less proportion of time spent in alert behavioral states, immature sucking patterns, lower rate of transfer, and smaller bolus size.[1-3] Several factors can be used to predict prolonged oral feeding transition in preterm infants, such as younger GA, lower birth-weight, younger PMA at initial oral feeding, and a higher morbidity score.[2] In preterm infants, male sex was a significant biological risk factor for poor cognitive and motor development when compared to female sex,[2,4] thus sex may predict oral feeding transition. Preterm infants who are actively engaged during an oral feeding episode [5,6] often demonstrate alert behavioral states and orally-directed behaviors prior to feeding.[7] Infants may then need to maintain intra-feeding alert behavioral states while performing nutritive sucking.[7] This active oral feeding process is learned and refined with oral feeding experience, allowing the infant to achieve OFS.[7]

While oral feeding is an active process, tube feeding is a passive process.[5,6] Currently, in many NICUs, preterm infants are tube fed according to a schedule, with a prescribed volume.[5,6] When infants begin the transition to oral feeding, they need to have the opportunity to develop a pattern of demonstrating orally-directed behaviors pre-feeding and maintaining alert behavioral states pre- and intra-feeding. However, previous research has shown that some preterm infants received tube feedings instead of oral feedings due to reasons that were unrelated to the infants' readiness or ability to oral feed, including "time management reasons" or unspecified

"other reasons."[8,9] Thus, the opportunity to learn and refine the active oral feeding process may be delayed.[10-13] We speculate that a longer duration of tube feeding may hinder the oral feeding experience and be correlated with delayed OFS.[8,9,14-18]

Additionally, alert behavioral states, orally-directed behaviors, and nutritive sucking patterns have consistently shown to be predictors of OFS.[2,7,16,19-22] Orally directed behaviors and alert behavioral states are positively associated with high feeding efficiency and high oral feeding intake,[7,16,19-21,23,24] and have been recommended by numerous researchers as part of the assessment carried out, prior to oral feeding.[5,20,25-31] Nutritive sucking is an early oral feeding skill, and is critical for achieving OFS.[32-36]

Accordingly, in our conceptual framework, the established (as evidenced in the literature) and speculated relationships are illustrated by straight lines and dotted lines, respectively, while arrows, and positive (+) or negative (-) signs, indicate the direction of the relationships. The conceptual framework illustrates the established relationships between infant characteristics and (1) duration of tube feeding, (2) alert behavioral states, (3) orally-directed behaviors, (4) nutritive sucking, and (5) OFS, as well as the established relationships among these five parameters. The conceptual framework also illustrates our speculation regarding the relationships between duration of tube feeding and alert behavioral states, orally-directed behaviors, nutritive sucking, and OFS.

III. Methods, procedures and sampling

1. Design

A descriptive correlational study was conducted. All preterm infants in the study received the study site's standard of care (e.g., clustered nursing care, developmental care). The decision for initiation and advancement of oral feeding was made by the nurses and physicians. Each preterm infant in the study was followed throughout his/her initial hospitalization. Their oral feeding progression was monitored daily. Within 48 hours after the removal of the feeding tube, the infant's oral feeding was evaluated. The study was approved by the Institutional Review Board.

2. Setting and Sample

The study was conducted in a level III NICU at an inner-city hospital. The inclusion criteria were infants who were born between 28 to 32 weeks gestational age (GA), clinically stable, and expected to have at least one week of tube feeding during their initial hospitalization. The exclusion criteria were the diagnosis of necrotizing enterocolitis, sepsis, intraventricular hemorrhage (grade III or IV), periventricular leukomalacia, cardiovascular defects, congenital anomalies of the oral cavity, gastrointestinal defects, and/or chromosomal abnormalities. We enrolled 35 infants who met the inclusion criteria. However, after enrollment, seven infants were withdrawn due to the development of exclusion criteria. Thus, data from 28 infants were analyzed.

3. Measures

Infant characteristics

Infant characteristics, including GA, birthweight, sex, and health status, were collected from the electronic medical record at enrollment and discharge. Health status was measured by the 5-minute Apgar score at birth and the Neonatal Medical Index Classification (NMI). NMI assesses infant illness status during hospital stay.[37] NMI ranges from 1 to 5, with 1 describing infants without serious medical problems and 5 describing infants with the most serious complications.[37]

Duration of tube feeding

Duration of tube feeding was measured by two different approaches: the *total* duration of tube feeding and duration of *exclusive* tube feeding (Figure 2). The *total* duration of tube feeding

was defined as the total number of days that infants received tube feeding during their initial hospitalization. The duration of *exclusive* tube feeding was defined as the number of days that infants received *all feedings by tube* prior to the initiation of oral feeding. Duration of tube feeding was collected from the electronic medical record at discharge.

Oral feeding success

An oral feeding was classified as "successful" when the infant consumed 100% of the prescribed volume orally (100% PO intake feeding). The primary outcome, OFS, was calculated as the total number of 100% PO intake feedings from the first day of oral feeding attempts to the first day of full oral feeding divided by the total number of feedings during the transition (Figure 2). There are different approaches and units of measurement to evaluate OFS.[5,16,22,36,38-42] The chosen method of calculation was most appropriate for the available feeding data from the infants' electronic medical record which were collected retrospectively. It also ensured the standardization of OFS regardless of the variability in the total number of feedings between infants. The first day of oral feeding was defined as the first day of at least two consecutive days when the infant was able to orally consume ≥ 10% of the prescribed volume.[2] This definition eliminates early brief oral attempts that were followed by long stretches of tube feeding only.[2] The first day of full oral feeding was defined as the first day of at least two consecutive days when the infant was able to consume 100% of the prescribed volume for the day by mouth.[2] Success at an oral feeding was determined based on the infants' oral feeding intake (mL) and prescribed volume (mL), which were collected from the infants' electronic medical records. For example, Figure 3 illustrates an infant's OFS calculation as 27 (total number of 100% PO intake feedings) divided by 80 (total number of feedings) during the transition from the first day of oral feeding attempts to the first day of full oral feeding, yielding an OFS of 0.34.

Alert behavioral states

Alert behavioral states were evaluated during the one-time oral feeding evaluation within 48 hours after the removal of the feeding tube. Pre- and intra-feeding alert behavioral states were evaluated using the modified Thoman's State Scoring System.[19,43-46] This system includes eight categories of behavioral states: quiet sleep, active sleep, sleep-wake transition, drowsy, quiet alert, active alert, non-alert-waking activity, and fuss/crying.[19,20,43-46] This system exhibits valid individual differences and an accurate profile of the behavioral states of preterm infants during the neonatal period.[19,20,46-48] Previous researchers have showed the intra-class correlation coefficient (ICC) for inter-rater reliability to be excellent and ranged from 0.98 to 0.99.[46]

Orally-directed behaviors

Pre-feeding orally-directed behaviors were evaluated during the one-time oral feeding evaluation within 48 hours after the removal of the feeding tube using the Cagan Videotape Coding System.[19,23,46,49,50] Any occurrence of mouthing, rooting, tonguing, yawning, sucking-on-tongue, empty-sucking, swipe-at-mouth, hand-to-mouth, and suck-on-hand was recorded.[19,23,46,49,50] The reported ICCs from previous research were good to excellent and ranged from 0.87 to 0.93.[46]

Coding alert behavioral states and orally-directed behaviors

For each video recording, there were three main coding segments: 15-minute pre-feeding (S1), 1-minute immediately pre-feeding (S2), and 5-minute intra-feeding (S3). The video recordings were processed and coded using the Mangold Interact 15.1 software (Mangold International, Arnstorf, Germany). The video recordings used to evaluate alert behavioral states were segmented into 15-second epochs. Each 15-second epoch was played and paused at the end. The dominant behavioral state (≥ 8 seconds) was recorded for each epoch. After the videos were coded, the percentage of time spent in the quiet and active alert states for each segment was calculated and used in the final analysis. The video recordings used to evaluate orally-directed behaviors were segmented into 5-second epochs. Each 5-second segment was played and paused at the end. The frequency of each orally-directed behavior was recorded for

each 5-second epoch. After the videos were coded, the frequency for all orally-directed behaviors was calculated and used in the final analysis.

The two coders were blinded to the purpose of the study.[51] They were trained to recognize the criterion for coding both behavioral states and orally-directed behaviors and established 100% agreement prior to coding. The primary coder coded 100%, while the secondary coder recoded a random 25% of the videos. Inter-rater reliability was established via ICC.[52] ICCs for behavioral states were 0.99 (S1), 0.95 (S2), and 0.99 (S3). ICCs for orally-directed behaviors were 0.94 (S1), and 0.91 (S2). Inter-rater reliability is considered very good to excellent when the ICC is 0.75 or higher.[52]

Nutritive sucking

Nutritive sucking was evaluated using the Neonur (Figure 4).[53] Infants were orally fed using the Enfamil® standard-flow soft nipple and 60 mL bottle. There were no major complications during any of the feedings. The pressure transducer in the Neonur has been utilized in previous research.[54-58] The Neonur recorded the nutritive sucking data over 120 seconds. The data were downloaded to a computer using the Neonur Graphic User Interface and processed using MatLab R2016a (MathWorks, Massachusetts, USA). The following parameters were calculated: number of sucks, number of sucks per burst, duration of burst, adjusted mean maximum sucking pressure, and sucking maturity index.[33,34] The sucking maturity index was computed as the mean of the *z* scores of number of sucks, number of sucks per burst, and adjusted mean maximum sucking pressure.[33,34]

4. Procedure

The study timeline is portrayed in Figure 2. Mothers gave written informed consent for their infants' participation the study. Each preterm infant's oral feeding progression was followed throughout his/her initial hospitalization. Infants were evaluated once within 48 hours after the removal of the feeding tube. At this oral feeding evaluation, we video recorded infants for 15 minutes prior to feeding, 1 minute immediately prior to feeding, and during the first 5 minutes of feeding. Shortly before feeding, the NICU nurses carried out their routine care tasks (e.g., vital signs, diaper change, etc.). To standardize the feeding method, the principal investigator (PI) was the feeder for all oral feeding evaluations throughout the study. Infants were swaddled from the waist down allowing for movement of their arms and hands, held in a semi-upright position, and remained on the cardiac/respiratory monitor during feeding. The PI fed the infants with the Neonur feeding system (Figure 4). After approximately five minutes of continuous feeding, the nipple was removed from the infant's mouth to allow for rest. The feeding was ended when the feeding time reached the 30-minute limit (standard maximum length at the study site), or when the infant stopped sucking or fatigued based on the PI's assessment. Preterm infants completed their participation upon hospital discharge.

5. Statistical Analysis

Utilizing G-Power analysis software, the final sample size of 28 preterm infants was estimated to achieve 80% power and 0.31 effect size in a linear multiple regression model using a two-sided test and type I error of 0.05.[59,60] This power analysis was estimated for the main outcome variable, OFS. Data reduction and analyses were performed using Stata 13.1 (StataCorp, Texas, USA). For all analyses, we considered a type I error of 0.05 as significant and 0.10 as marginally significant. Descriptive statistics were employed to understand the sample characteristics. Bivariate analyses (Pearson's correlation, *t*-test, and ANOVA) were conducted to investigate the relationship among the duration of tube feeding and infant characteristics to anticipate any multicollinearity. For each outcome variable, a preliminary multiple regression model was fitted with duration of tube feeding (*total* or *exclusive*) as the main independent variable. Non-significant covariates in the preliminary models were dropped from the final multiple regression models. The effect size omega squared (ω^2) was computed

for statistically significant findings. The effect size ω^2 estimates the population's variance of the dependent variable that is accounted for by the independent variable while considering the bias often associated with small sample sizes.[61-64] Suggested benchmarks for small, medium, and large effect sizes ω^2 are 0.01, 0.06, and 0.14, respectively.[61-64] A small effect size indicates a trivial effect, whereas a large effect size indicates substantial effect and practical significance.[61-64] Various diagnostic tests to check for multicolinarity, specification errors, outliers on the outcome variable, and normality of the residuals were conducted for the final multiple regression model.

IV. Summary of findings

Descriptive Statistics for Sample Characteristics

The analysis was completed with 28 infants (80% of the original study sample). Sample characteristics are portrayed in Table 1. Notably, preterm infants were primarily African American (75%). Infants were born at the mean GA of 30.32 weeks (SD = 1.44 & range 28-32 weeks), with a mean birthweight of 1358 grams (SD = 324.97 & range 640-1870 grams), and mean 5-minute Apgar score of 8 (SD = 0.81 & range 6-9). The majority of the sample (53.57%) had moderate severity of illness (NMI = 3), while 25% had mild complications (NMI = 1 or 2), and 21.46% had severe complications (NMI = 4 or 5). Within the sample, 14.29% were diagnosed with intrauterine growth restriction (IUGR). Infants' sex was evenly distributed between male (50%) and female (50%). During hospitalization, the mean *total* duration of tube feeding was 35 days (SD = 15.65 & range 13- 62) and the mean duration of *exclusive* tube feeding was 22 days (SD = 14.71 & range 1- 50).

Descriptive Statistics for Outcome Variables

Descriptive statistics for the outcome variables are presented in Table 2. Infants had an average of 14 days (SD = 6.98 & range 3-39 days) for the transition time from first to full oral feeding. From the first day of oral feeding attempts to the first day of full oral feeding, out of an average of 109 feedings (SD = 54.44 & range 31-311), infants had a mean number of 100% PO intake feedings of 25 (SD = 11.72 & range 10-72), thus yielding a mean OFS of 0.28 (SD = 0.15 & range 0.05-0.62). The mean post-menstrual age at the oral feeding evaluations, was 35.6 weeks (SD = 1.31 & range 34-39 weeks). The mean percentage of time spent in alert behavioral states was 17.98% (SD = 24.68) for S1, 40.18% (SD = 43.22) for S2, and 44.64% (SD = 39.34) for S3. Mean frequency of orally-directed behaviors was 49 (SD = 47.03) for the S1, and 9 (SD = 7.70) for S2. Mean number of sucks, number of sucking bursts, duration of burst, adjusted mean maximum sucking pressure, and sucking maturity index were 82 (SD = 39.24), 6 (SD = 2.77), 11.33 (SD = 11.32), 151.75 (SD = 87.01), and 0.0007 (SD = 0.86), respectively.

Bivariate Analyses

We observed significant differences in the mean *total* duration of tube feeding and duration of *exclusive* tube feeding between infants with different NMI classifications (Table 3). The 5th NMI classification had the highest mean *total* duration of tube feeding (59, SD = 1.41) and duration of *exclusive* tube feeding (45.5, SD = 6.36) (Table 4). Significant negative correlations between *total* duration of tube feeding and GA and birthweight were identified (Table 5). Significant negative correlations between duration of *exclusive* tube feeding and GA and birthweight were also identified (Table 5).

Multiple Regression Analyses

After adjusting for GA, birthweight, NMI, and sex in the preliminary multiple regression models, a significant correlation between *total* duration of tube feeding and OFS ($\beta = -1.21$, $P = 0.002$, $\omega^2 = 0.35$) was identified.

A final multiple regression model was fitted, including OFS as an outcome, *total* duration of tube feeding as an independent variable, and birthweight as a covariate. A significant negative correlation between total duration of tube feeding ($\beta = -1.10$, $P = 0.000$, $\omega^2 = 0.41$) and OFS was observed (Figure 5 and Table 6).

Birthweight was a significant covariate in the correlation between *total* duration of tube feeding ($\beta = -.98$, $P = 0.001$, $\omega^2 = 0.35$), with smaller infants exhibiting higher OFS. A crude correlation between birthweight and OFS was tested, yielding a nonsignificant correlation, however trending in a negative direction ($\beta = -.10$, $P = 0.614$).

GA, birthweight, NMI, and sex were adjusted for in the preliminary multiple regression model for duration of *exclusive* tube feeding and OFS. No significant relationship was identified.

There was no significant relationship between either *total* duration of tube feeding or duration of *exclusive* tube feeding with percentage of time spent in alert behavioral states, pre- and intra-feeding, frequency of pre-feeding orally-directed behaviors, number of sucks, number of bursts, number of suck per burst, duration of burst, adjusted mean maximum sucking pressure, or sucking maturity index.

V. Recommendations

Practice.

Clinicians may use our OFS calculation for the assessment of infants' oral feeding progression during the transition from tube to oral feeding. While the duration of tube feeding is a non-modifiable factor, preterm infants who are anticipated to have longer duration of tube feeding may be at risk for delayed OFS. Thus, clinicians should focus on other modifiable factors, including planning to provide appropriate and timely assessment and interventions for introduction and advancement of oral feeding, to facilitate OFS for these at-risk preterm infants. Clinicians have long used GA to as a guide to initiate oral feeding and should continue to do so while ensuring accurate assessment of the infants' ability to oral feed safely and efficiently. It is crucial to support preterm infants during the important transitional period from tube oral feeding, ensuring their highest chance of achieving OFS. Efforts are needed to offer regular oral feeding attempts and provide a positive oral feeding experience, which have been shown to be the keys to the achievement of OFS.[8,9,14-18] Interventions should be implemented to support the introduction of oral feeding and the transition from tube to oral feeding; interventions to consider include non-nutritive sucking, swallowing exercises, oral motor stimulation, multisensory massage, cheek and jaw support, positioning, and a self-paced system.[23,27,34,46,65-76] The current recommendation for NICUs is to implement infant-directed feeding allowing preterm infants to feed orally, as early and as often as they exhibit signs of oral feeding readiness,[5,28,77-83] should be considered to facilitate an individualized feeding plan and support infants during the transition from tube to oral feeding.

Research.

The findings and our innovative measures offer researchers a new approach to identify preterm infants who are at risk for delayed OFS. This research lays foundation for future research to develop and test assessment and early interventions that support the transition from tube to oral feeding and facilitate the achievement of OFS.

Preterm infants who are anticipated to have longer duration of tube feeding may be at risk for delayed OFS. In order to facilitate their OFS, an accurate assessment of the infants' ability to oral feed safely and efficiently is a key. However, current clinical tools are predominantly descriptive, subjective, and not considered reliable or valid, i.e., the Early Feeding Skills Assessment [84] and the Neonatal Oral-Motor Assessment Scale (NOMAS).[85] Particularly, the NOMAS was originally designed for full-term infants, so its validity, when applied in preterm infants, has been questioned.[86-88] There are quantitative measures of non-nutritive and nutritive sucking patterns that objectively assess the infants' oral feeding skills.[53,89-94] Yet, these research instruments are neither readily available to clinicians nor user friendly in the NICU. Future research is needed to develop standardized, reliable, and valid instruments that are objective, user-friendly, and readily available for NICU clinicians.[95,96] Our data may be utilized as a baseline parameters for future research.

Standardized measures of OFS are needed. Additional measures regarding oral feeding skills, oral feeding readiness, caregivers' assessment, and oral feeding experience may also be beneficial to comprehensively evaluate OFS. There is also a need for future research to understand whether the predictors of OFS, including alert behavioral states, orally-directed behaviors, and nutritive sucking, are related to the duration of tube feeding. This information will assist in the development and implementation of assessment and early interventions for preterm infants who are anticipated to receive extended duration of tube feeding. Such comprehensive assessment and interventions have the potential to prevent or reduce avoidable adverse effects of extended tube feeding and facilitate OFS.

VI. Tables and Figures and

Table 1

DESCRIPTIVE STATISTICS FOR THE SAMPLE CHARACTERISTICS

Variables	Mean	*SD*	Min	Max	Freq.	Percent
Race/ethnicity						
White					1	3.57
African-American					21	75.00
Latino					6	21.43
Sex						
Male					14	50.00
Female					14	50.00
Neonatal medical index classification						
I					1	3.57
II					6	21.43
III					15	53.57
IV					4	14.29
V					2	7.17
IUGR						
Yes					4	14.29
No					24	85.71
5-minute Apgar score at birth	8	0.81	6	9		
GA (weeks)	30.32	1.44	28	32		
Birthweight (grams)	1358	324.97	640	1870		
Duration of *exclusive* tube feeding (days)	22	14.71	1	50		
Total duration of tube feeding (days)	35	15.65	13	62		

Number of days from first to full PO (days)	14	6.98	3	39
PMA at first PO (weeks)	33.68	1.28	31	38
PMA at full PO (weeks)	35.54	1.48	33	39
PMA at observation (weeks)	35.61	1.31	34	39
Length of initial hospitalization (days)	44	17.40	20	80

Abbreviations: IUGR, intrauterine growth restriction; GA, gestation age; PMA, post-menstrual age; PO, oral feeding; *SD*, standard deviation; Freq., frequency

TABLE 2

DESCRIPTIVE STATISTICS FOR THE OUTCOME VARIABLES

Variables	Mean	*SD*	Min	Max
Total number of feedings from first to full PO (feedings)	109	54.44	31	311
Number of 100% PO intake feedings from first to full PO (feedings)	25	11.72	10	72
Oral feeding success from first to full PO	0.28	0.15	0.05	0.62
Percentage of alertness 15-min pre-feeding (%)	17.98	24.68	0	95.00
Percentage of alertness 1-min pre-feeding (%)	40.18	43.22	0	100.00
Percentage of alertness 5-min intra-feeding (%)	44.64	39.34	0	100.00
Frequency of orally-directed behaviors 15-min pre-feeding	49	47.03	0	192
Frequency of orally-directed behaviors 1-min pre-feeding	9	7.70	0	35
Number of sucks	82	39.24	0	139
Number of bursts	6	2.77	0	10
Number of sucks per burst	16	11.32	0	43
Duration of burst (seconds)	11.33	8.51	0	35.99
Adjusted mean maximum sucking pressure (mmHg)	151.75	87.01	0	317.70
Sucking maturity index	0.0007	0.86	-1.73	1.49

Abbreviations: PO, oral feeding; *SD*, standard deviation

TABLE 3

MEAN DIFFERENCE OF DURATION OF TUBE FEEDING BETWEEN NEONATAL MEDICAL INDEX CLASSIFICATION VIA ANOVA

Variables	SS	MS	*F*	*P*
Duration of *exclusive* tube feeding (days)	3242.81	810.72	7.16	0.0007
Total duration of tube feeding (days)	3144.85	786.21	5.21	0.0039

Abbreviation: SS, sum of squares; MS, mean square

TABLE 4

MEAN DURATION OF TUBE FEEDING BY NEONATAL MEDICAL INDEX CLASSIFICATION

Neonatal Medical Index Classification	Duration of *Exclusive* Tube Feeding (days) (mean, SD)	*Total* Duration of Tube Feeding (days) (mean, SD)
I	2, n/a[a]	19, n/a[a]
II	11, 5.97	23, 4.49
III	20, 12.39	33, 14.93
IV	38, 8.89	50, 9.11
V	46, 6.36	59, 1.41

[a]Only 1 observation

Abbreviation: SD, standard deviation

TABLE 5

CORRELATION BETWEEN DURATION OF TUBE FEEDING AND INFANT CHARACTERISTICS VIA PEARSON'S CORRELATION

	Variables[a]	1	2	3	4
1	Duration of *exclusive* tube feeding (days)				
2	*Total* duration of tube feeding (days)	0.91 0.0000			
3	Gestational age	-0.85 0.0000	-0.80 0.0000		
4	Birthweight	-0.88 0.0000	-0.80 0.0000	0.77 0.0000	
5	5-minute Apgar score at birth	-0.29 0.1347	-0.16 0.4057	0.39 0.0400	0.27 0.1723

[a]Reported statistics are correlation coefficient *r* and *P* values

TABLE 6

FINAL MULTIPLE REGRESSION ANALYSIS OF ORAL FEEDING SUCCESS FROM FIRST TO FULL ORAL FEEDING

Independent/Covariate Variables	*df*	R^2	Adjusted R^2	*F*	Standardized Coefficient	SE	ω^2	*P*
	27	0.44	0.39	9.75				
Total duration of tube feeding (days)					-1.10	0.002	0.41	0.000
Birthweight					-0.98	0.0001	0.35	0.001

Abbreviations: *df*, degrees of freedom; SE, standard error; ω^2, effect size omega squared

Figure 1.

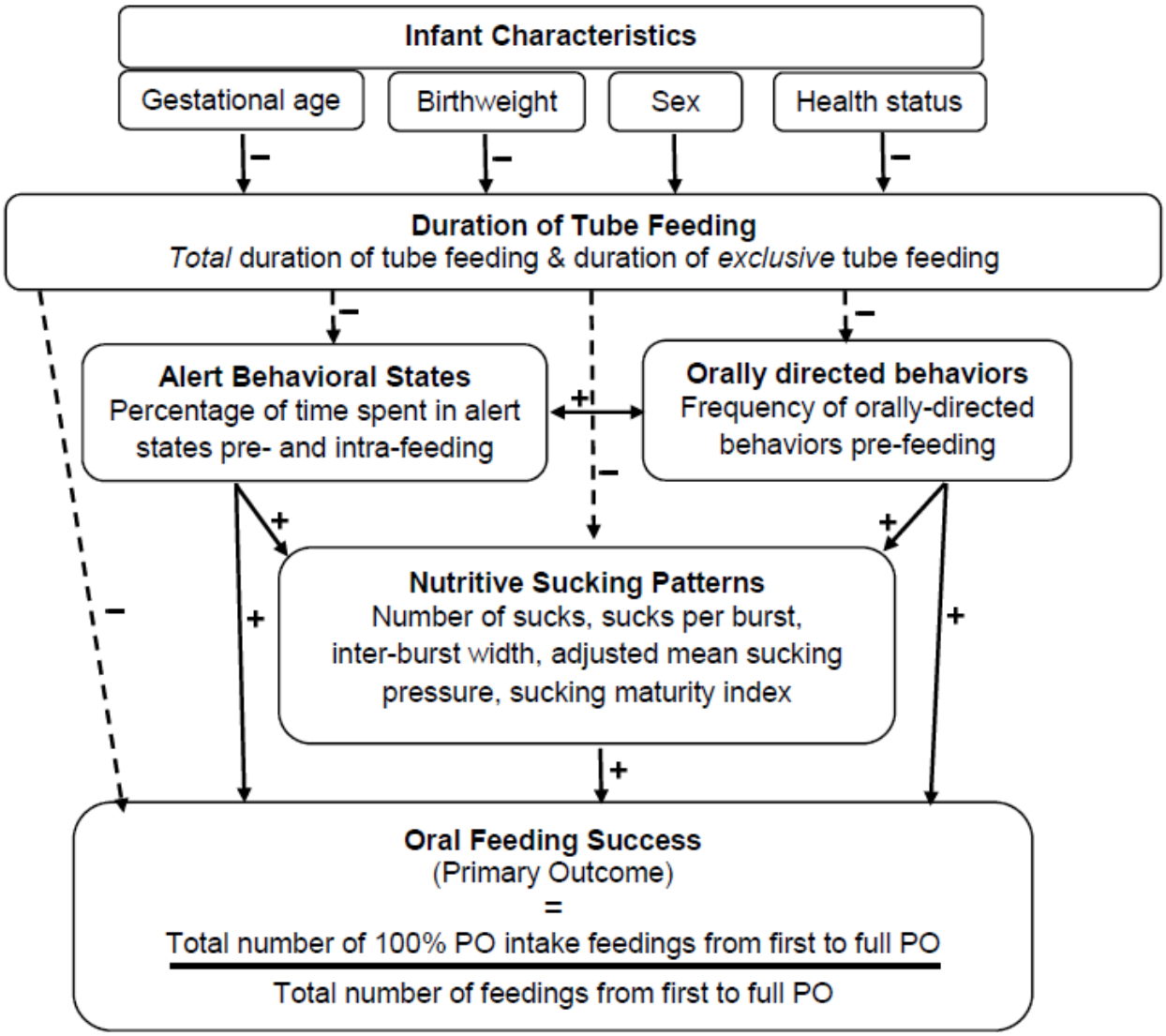

Infant Characteristics
Gestational age
Birthweight
Sex
Health status
Duration of Tube Feeding
Total duration of tube feeding & duration of *exclusive* tube feeding
Alert Behavioral States
Percentage of time spent in alert states pre- and intra-feeding
Orally directed behaviors
Frequency of orally-directed behaviors pre-feeding
Nutritive Sucking Patterns
Number of sucks, sucks per burst, inter-burst width, adjusted mean sucking pressure, sucking maturity index
Oral Feeding Success
(Primary Outcome)
=
Total number of 100% PO intake feedings from first to full PO
Total number of feedings from first to full PO

Figure 2. Study Timeline

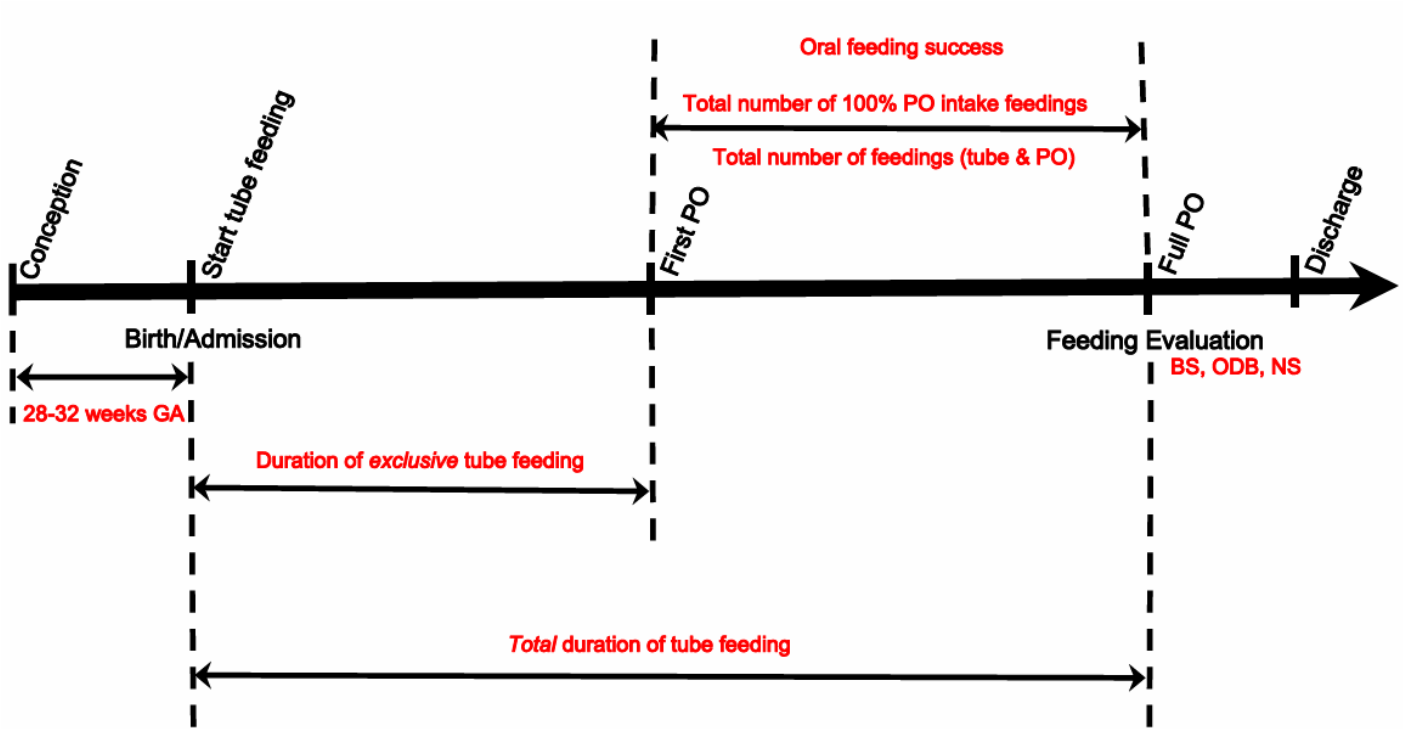
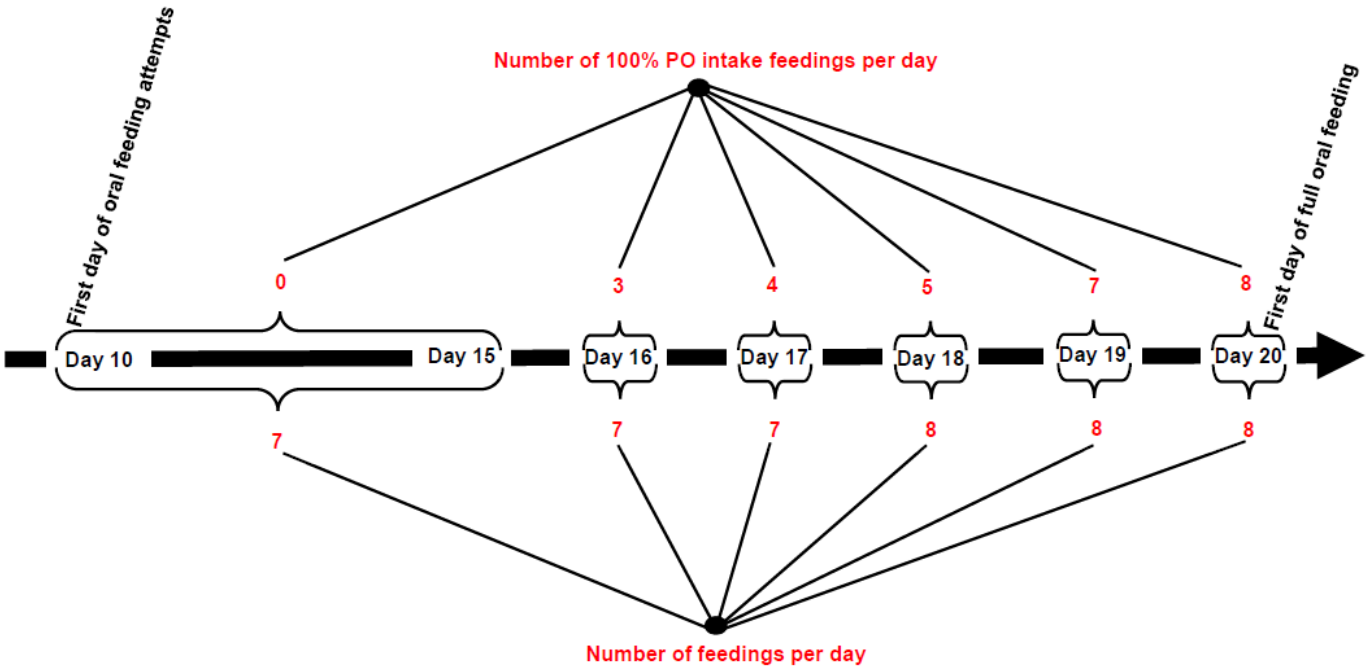


Figure 3. Example Calculation of Oral Feeding Success for a Preterm Infant



$$\text{Oral Feeding Success} = \frac{\text{Total number of 100\% PO intake feedings from 1}^{st}\text{ to full PO}}{\text{Total number of feedings from 1}^{st}\text{ to full PO}} = \frac{27}{80} = 0.34$$

Figure 4. Neonur Feeding System

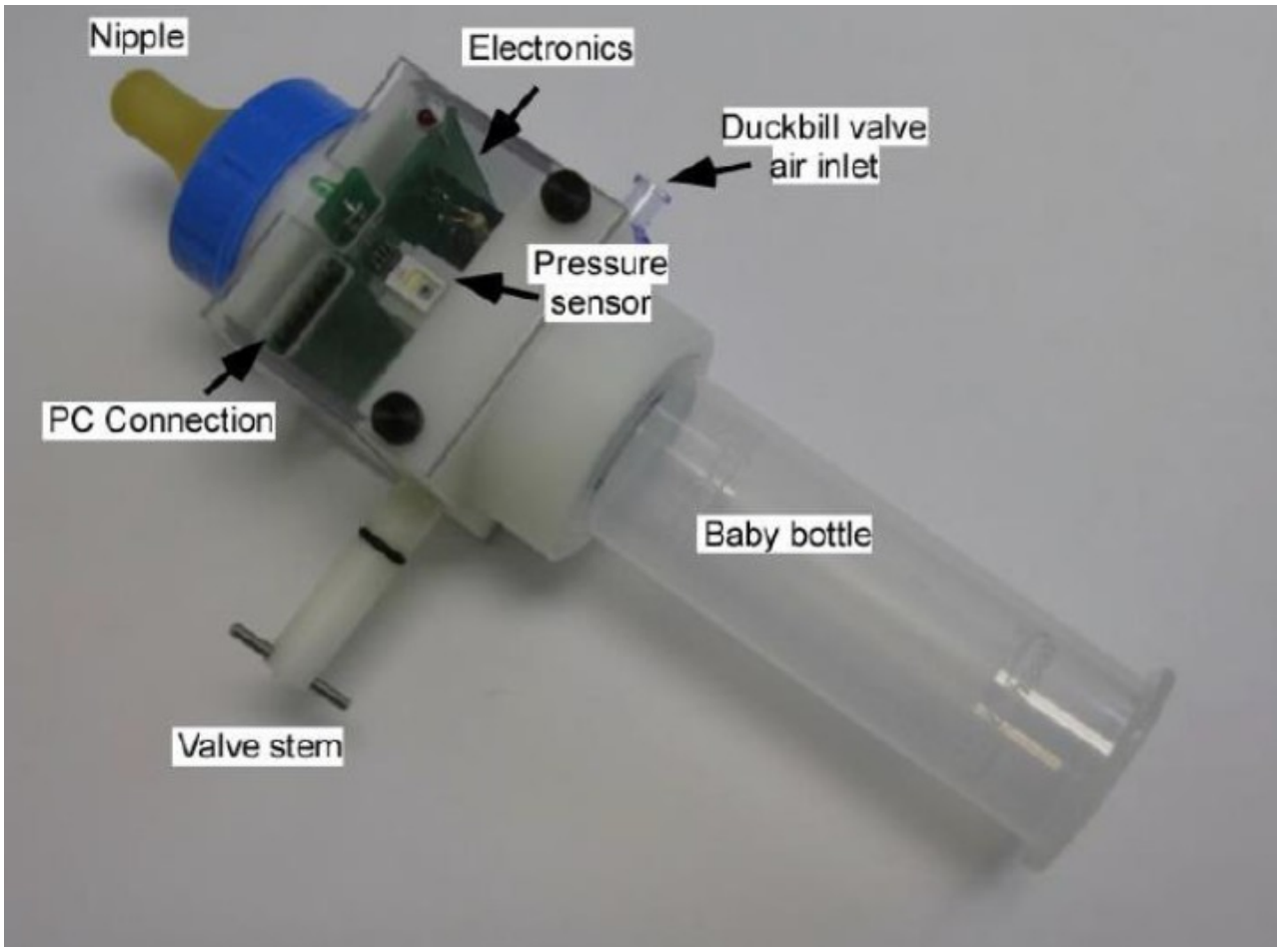
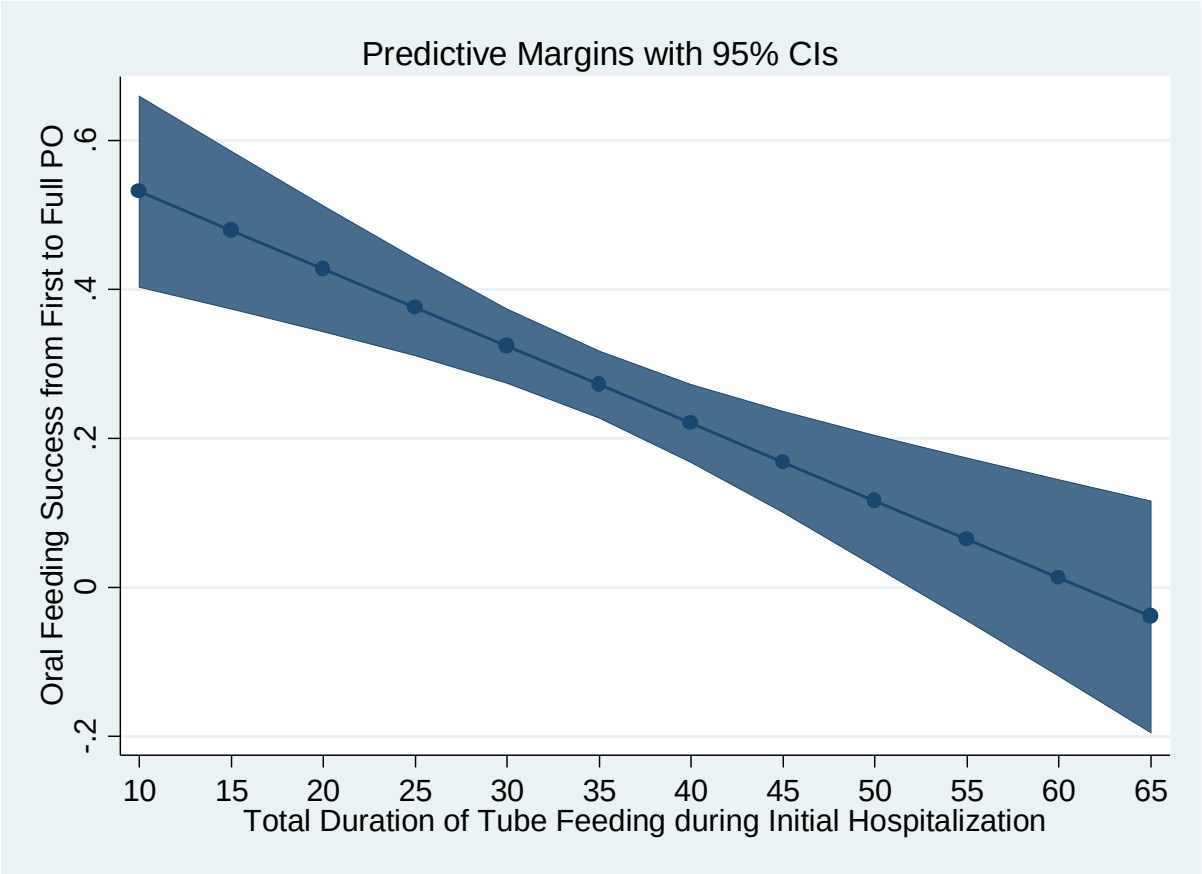


Figure 5. The Relationship between *Total* Duration of Tube Feeding and Oral Feeding Success in Preterm Infants



VII. **ReferencesX**

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