The Relationship between Duration of Tube Feeding and Oral Feeding Success in Preterm Infants

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THESIS

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This thesis is dedicated to my loving husband, Brian Griffith, who works very hard to provide for our family, allowing me to concentrate on the dissertation project when I needed. Without him, my success in this dissertation project and in everything else are not possible.

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GA	Gestational age
NICU	Neonatal Intensive Care Unit
PMA	Post-menstrual age
OFS	Oral Feeding Success
NMI	Neonatal Medical Index Classification
IUGR	Intrauterine Growth Restriction

SUMMARY

The purpose of this dissertation research was to determine the relationship between the duration of tube feeding and oral feeding success in preterm infants during\their initial hospitalization. The specific aims of the dissertation research were to (1) determine the potential relationship between duration of tube feeding and oral feeding success in preterm infants during their initial hospitalization; and (2) determine the potential relationships between duration of tube feeding and alert behavioral states, orally-directed behaviors, and nutritive sucking at a one-time feeding evaluation within 48 hours after the removal of the feeding tube.

This dissertation thesis includes an introduction of literature review and conceptual model (Chapter 1) involving preterm infants and their challenges in the achievement of oral feeding, a concept analysis of oral feeding success (Chapter 2), and the findings of the dissertation research (Chapter 3) demonstrating the relationship between duration of tube feeding and oral feeding success in preterm infants. The appendices include the approval letter for this research from the Institutional Review Board of the University of Illinois at Chicago, the research site's letter of support, and the award letters. The final appendix contains my curriculum vitae.

I. INTRODUCTION

A. Incidence of Preterm Birth, and Cost of Care for Preterm Infants

Premature, or preterm, birth is defined as birth before 37 weeks gestational age (GA).[1] Approximately 15 million infants are born prematurely each year around the world,[2] with the United States being one of the top 10 countries with the highest number of preterm births.[2] Nationally, the preterm birth rate was 9.62% in 2015, an increase from 9.57% in 2014,[3] and is higher than the March of Dimes 2020 goal of 8.1%.[1] The cost of preterm births to the United States is in excess of $26 billion annually, which includes the cost of medical care, early interventions, and loss productivity due to disabling conditions.[4,5]

The medical and technological advances in healthcare have allowed for a significant increase in the survival rate of infants born prematurely,[6] however the healthcare system now has the challenge of providing intensive care for younger and more fragile preterm infants who are more vulnerable and often experience complex health issues and complications.[7] This means that the long-term healthcare cost for preterm infants is markedly high.[8] Approximately 8% of all the 4.6 million infant hospitalizations in the United States are preterm infants,[8] with the cost of hospitalization for these preterm infants totaling $5.8 billion, including infant (47%) and pediatric (27%) hospitalization.[8] According to one study, the mean length of stay for the initial hospitalization of a preterm infant was 14 days compared to 2 days for a healthy full-term newborn, and cost an average of $15,000 versus $600.[8] During the first year of life, the average healthcare cost for a preterm infant, without major problems, can be up to $49,000, while a healthy full-term newborn costs only $4,500.[9] Additionally, healthcare costs can easily reach up to $200,000 when preterm infants are diagnosed with severe medical problems, such as extreme prematurity, respiratory distress syndrome, and/or other major problems.[6]

B. Common Risks of Preterm Infants

Due to advances in medical management and technology, the mortality rate of preterm infants has significantly decreased,[10] nonetheless, preterm birth is still the leading cause of perinatal and neonatal mortality and morbidity, both nationally and globally.[7,11] Preterm infants who survived are at increased risk for respiratory distress, jaundice, anemia, infection, and oral feeding difficulty.[2,5,7,11] Long-term complications can include failure to thrive and developmental delays.[2,5,7,10,11] Preterm infants also experience a much higher rate of hospital re-admission during the first year of life compared to healthy full-term infants.[10,12-14] Given these statistics, it is critical to understand and address the determinants of poor outcomes in preterm infants in order to achieve further reduction in mortality and morbidity.[7]

C. Challenge of Achieving Oral Feeding Success in Preterm Infants

Oral feeding is one of the first developmental milestones that preterm infants must achieve to ensure adequate growth and development,[10] and the ability of preterm infants to achieve oral feeding success (OFS) is one of the gold standards for discharge at the initial hospitalization.[10] One might consider that when a preterm infant is able to consume 100% of their intake orally, that OFS is achieved, however, this is not always the case. Given that the amount of consumption is a concrete definition, OFS contains additional aspects, such as physiologic stability, weight gain, maturation, etc. OFS is frequently used in research and clinical practice to evaluate preterm infants' oral feeding outcomes. However, there is a lack of consensus regarding the definition of OFS. Therefore, there is a need to further analyze and clarify the concept of OFS in preterm infants. In chapter 2, the concept analysis of OFS is discussed in detail.

Oral feeding success comes more naturally for healthy full-term infants, yet for preterm infants OFS is a significant milestone.[15,16] Due to physical and neurological immaturity, delayed OFS encountered by preterm infants is common and can be serious.[10,17] Preterm infants' hospital discharge is often delayed due to their inability to achieve OFS.[18] Delayed OFS may lead to failure to thrive, potential long-term oral feeding aversion, developmental delays, or may contribute to increased parental stress, and high healthcare costs.[6,8,19-27] It is critical to understand the complexity of oral feeding in preterm infants, and the developmental and environmental challenges that contribute to delays in OFS in preterm infants.

In an effort to facilitate OFS in preterm infants, research has focused on understanding the development of oral feeding skills in preterm infants. Although breastfeeding may present fewer physiological challenges, and is encouraged for all infants,[28,29] the majority of hospitalized preterm infants are bottle-fed with pumped breastmilk/formula.[30] Measurement of bottle feeding is more readily available in the Neonatal Intensive Care Unit (NICU), and is considered an accurate reflection of preterm infants' inherent oral feeding skills because of the constant flow of milk rather than the changeable flow of milk in breastfeeding.[18] Therefore, studies of oral feeding skills in preterm infants have centered on bottle-feeding.[18]

The primary focus of preterm infants' oral feeding skills has been on sucking, swallowing, breathing, and their coordination. During oral feeding, an interruption or delay to any of these activities, or their coordination, increases the risk of adverse events (e.g., choking, oxygen desaturations, and/or aspirations),[19,31-33] and thus is the primary cause of oral feeding issues in the NICU. The growing evidence-based understanding of oral feeding skills plays a significant role in the diagnosis of delayed OFS, development of assessment tools, and testing of preventative and therapeutic interventions to facilitate OFS in preterm infants.

Sucking is evidenced *in utero* during the second trimester,[34-36] and requires a complex integration of muscular activities the lips, cheeks, jaws, tongue, and palate.[37] Sucking may be nutritive (liquid ingestion) and non-nutritive (no liquid ingestion).[18] The bursts of non-nutritive sucking occur at a faster frequency (two sucks per second) when compared to nutritive sucking (one suck per second).[18] Rhythmic alternation of suction and expression is often observed in mature sucking patterns.[38,39] Suction involves negative intra-oral pressure to draw liquid into the mouth,[40-42] whereas expression consists of compression and stripping of the nipple to eject liquid into the mouth.[40-42] For nutritive sucking, Lau & colleagues developed a descriptive scale to represent the maturation process of nutritive sucking in preterm infants.[23] The maturational process of sucking consists of five primary stages based on the presence/absence, and the rhythmicity of suction and expression.[23] Stage 1 consists of sucking patterns where arrhythmic expression is present with very infrequent suction of low amplitude.[23] Stage 2 includes rhythmic expression with the appearance of arrhythmic suction of larger amplitude (compared to stage 1).[23] Stage 3 comprises rhythmic expression alone, as well as the emergence of not yet rhythmic alternation of suction and expression.[23] In stage 4 and 5, rhythmic alternation of suction and expression is evidenced; the primary difference between stage 4 and 5 is the amplitude and duration of sucking burst.[23] Other researchers have also described the maturation of nutritive sucking based on various sucking parameters, including increased number of sucks, number of sucks per burst, sucking pressure, and shorter inter-burst width.[43-48]

In utero, the fetus first develops its swallowing skills at the 11th week of gestation, allowing it to swallow amniotic fluid.[49] At birth, the ability to swallow while protecting the airway is critical for the survival of neonates.[49,50] During oral feeding in infancy, the proper coordination of muscles from the mouth, palate, pharynx, larynx, and esophagus is necessary for the formation of the milk bolus, and its smooth transfer to the stomach.[51] The swallowing process consists of six phases: (1) oral phase – bolus formation;[52-54] (2) pre-pharyngeal phase – moving of bolus to the back of the pharyngeal wall in order to initiate reflex;[55] (3) pharyngeal phase – bolus is transported to the upper esophageal sphincter (UES);[56-58] (4) pre-esophageal – opening of the UES so the bolus can move to the esophagus;[59] (5) esophageal phase – bolus is transported down to the esophagus and moves down to the stomach;[60-68] and (6) entry of the bolus through the lower esophageal sphincter into the stomach.[64,67,68] The entire process of swallowing could take from 0.35 up to 0.7 second.[52,69] However, preterm infants are at high risk for a process known as immature swallowing.[31,70]

Respiration is essential to supply adequate oxygen, however, due to respiratory immaturity; preterm infants are at high risk for immature respiratory patterns.[2,5,7,11] A preterm infant's average respiratory rate is 1 – 1.5 breaths/second.[18] However, given that a swallowing event may last between 0.35 and 0.7 seconds,[52,69] there may be insufficient time between swallow to breathe. Therefore, some infants may exhibit episodes of oxygen desaturation and/or apnea during oral feeding, causing intolerance to prolonged periods of oral feeding time.[18]

In non-nutritive sucking, no swallowing is required; therefore sucking, swallowing, and breathing are independent of each other.[52] In nutritive sucking, swallowing is required making sucking, swallowing, and breathing highly dependent on each other.[52] The ability of infants to coordinate sucking, swallowing, and breathing is crucial in order to minimize aspiration, optimize oxygen-carbon dioxide exchange, and oral feed safely and efficiently, without any adverse event.[23,25,52,71] It is reflective of efficient sucking and rapid swallowing to minimize the airflow interruption.[52] The optimal ratio of suck-swallow-breathe is 1:1:1 or 2:2:1,[49,52,72] which is observed with maturation in preterm infants.[52] Intake quantity over the entire oral feeding improves with the mature nutritive sucking, increasing swallowing frequency, and the ability to cope with a larger bolus size.[69,73,74]

In preterm infants, maturation of the suck-swallow-breathe process takes place in two stages: (1) the coordination of suck-swallow is often attained prior to the initial episode of oral feeding, and (2) the coordination of swallow-breathe is slowly developed and refined with oral feeding.[69,73,74] The uncoordinated swallow-breathe stage is suggested to be the main cause for immature suck-swallow-breathe process.[69,73,74] Swallow-breathe coordination is defined as the point when swallowing occurs and breathing pauses (0.5 to 1.5 seconds).[75] Post-swallow breathing resumes with an expiratory cycle to prevent aspiration.[69,76,77] However, breathing pauses may last an additional 30 seconds during the period of continuous sucking.[72] The risk of oxygen desaturation, choking, and aspiration increases as the interruption of air flow is prolonged.[72]

Additional research is needed to further advance the science of oral feeding. By expanding our knowledge of the complexity of oral feeding skills in preterm infants, we can better identify determinants of oral feeding skills that may be amenable to intervention.

E. Complexity of Oral Feeding Readiness in Preterm Infants

A critical dimension of OFS is oral feeding readiness. Oral feeding readiness can be defined as either the readiness for the initiation of an infant's oral feeding or the readiness for a particular oral feeding event.[78] The former can help to determine if oral feeding should be started, whereas the latter can help to determine if oral feeding can be offered, or whether oral feeding needs to stop if offered. Parameters used for assessing readiness for initial oral feeding may typically include post-menstrual age (PMA), severity of illness, physiological and motor stability, receptivity to non-nutritive sucking, behavioral states, and orally-directed behaviors.[15,78,79] Parameters used for assessing readiness for a particular oral feeding event may include physiologic and motor stability, receptivity to non-nutritive sucking, behavioral states, and orally-directed behaviors.[15,78,79] Oral feeding readiness as part of a developmental care approach is also recommended, including the infant's physiologic stability, organization, competence, physiological and behavioral expression.[80]

Post-menstrual age is an important factor in determining oral feeding readiness in preterm infants, because it has a direct effect on the maturity of nutritive sucking and coordination of suck- swallow-breathe.[18,37,81,82] Preterm infants are unable to coordinate their sucking, swallowing, and breathing until at least 32 weeks PMA,[15,78,79] and at 34 weeks PMA, their coordination is significantly improved making it safer to oral feed. Initiation of oral feeding is typically recommended between 33 and 34 weeks.[15,78,79] Although preterm infants at 32 weeks PMA could oral feed, they may encounter more adverse events, thus oral feeding may be less safe.[15,78,79] However, there is evidence suggesting that oral feeding can be introduced as early as 30 weeks PMA.[83] Nonetheless, evidence regarding early introduction of oral feeding may be dependent on the GA at birth as extremely early born preterm infants may not likely ready to oral feed even at 34 weeks PMA. Additionally, the evidence is still limited, thus it is not commonly seen applied in clinical settings. One study found that preterm infants who had their first oral feeding at a younger PMA had a longer transition time to OFS.[84] Pickler and colleagues also reported that PMA predicted oral feeding proficiency, feeding efficiency, and intake quantity, thus is an important predictor of OFS in preterm infants.[79,85] Feeding proficiency is defined as the proportion of intake during the first five minutes of oral feeding (%),[71] whereas feeding efficiency is defined as the amount of intake over the duration of oral feeding (mL/minute).[71,86]

The severity of illness may add even more complications to the already complex oral feeding process.[79] Preterm infants with a higher severity of illness had their first oral feeding, and achieved OFS at older PMAs,[87,88] with their first oral feeding and achievement of OFS often being delayed due to respiratory disorders, particularly those requiring oxygen and/or ventilator support.[79,89] Other medical complications, including infection, neurological risk, necrotizing enterocolitis, and/or patent ductus arteriosus can also delay OFS in preterm infants.[79,89,90] A longer transition time from first oral feeding to achievement of OFS has also been reported in preterm infants who had higher severity of illness.[84,88,90]

Physiological stability is the preterm infant's ability to maintain their baseline color, heart rate, respiratory rate, and oxygen saturation.[50,83,91-94] Motor stability is characterized as mature muscle tone, flexion and midline posture, smoothness of activity, and appropriate response to caregiver and environment.[15] It is crucial that preterm infants are able to maintain physiological stability and motor stability in order to achieve OFS.[10,78,83,86,91,95]

An additional oral feeding readiness is the receptivity to non-nutritive sucking. Non-nutritive sucking is characterized by shorter bursts and pauses and no liquid ingestion.[18] Receptivity to non-nutritive sucking is often observed by strong and rhythmic non-nutritive sucking on a pacifier.[15,24,96] The transition time to achievement of OFS is shorten when preterm infants demonstrate strong and rhythmic non-nutritive sucking on a pacifier prior to feeding.[15,24,96-99] However, researchers have showed that preterm infants achieve mature non-nutritive sucking at an earlier PMA than mature nutritive sucking.[100] Therefore, non-nutritive sucking may only be a marker for sucking rather than a predictor of the suck-swallow-breathe coordination,[100] so non-nutritive sucking should be considered and assessed carefully when used as an indicator of oral feeding readiness.

Preterm infants must be able to integrate alert behavioral states prior to and during feeding in order to oral feed safely and efficiently.[15,79,83,85,86,98,101-109] Alert states are defined as the infant's eyes open, possibly scanning the environment, evidence of motor activity, and the eyes having a bright/shining appearance.[110-114] In the model of oral feeding readiness for preterm infants, Pickler emphasized the importance of alert states prior to, and during, feeding in achieving OFS.[79] In particular, McCain stated that quiet alert behavioral states prior to feeding are optimal for OFS.[98,108] During feeding, “unsuccessful feeders” spent more than half of their feeding in sleep states, while “successful feeders” were observed in sleep states less than one-third of their feeding time.[103] Alert behavioral states prior to and during feeding were positively associated with the achievement of OFS in preterm infants.[85,86,102,115]

Oral feeding readiness is also often evaluated by the occurrence of mouthing, rooting, tonguing, hand-to-mouth, hand swipes at mouth, empty sucking, sucking-on-hand, and sucking-on-tongue, also known as orally-directed behaviors.[106,107,116-119] In preterm infants, orally-directed behaviors pre-feeding predicts feeding efficiency.[106,107] Kirk and colleagues stating that natural display of orally-directed behaviors is an important prerequisite to OFS.[83]

Additionally, a few researchers have explored the role of salivary gene expression as a biomarker indicator of oral feeding readiness.[120-125] Neuropeptide Y2 receptor (NPY2R) in infants’ saliva significantly changed over time as infants learned to feed orally.[123,124] Specifically, decreased in neuropeptide Y2 receptor expression predicts oral feeding success in preterm infants.[123,124] Zimmerman and colleagues reported that higher expression levels of the forkhead box protein 2 (FOXP2) were significantly associated with OFS in preterm infants.[120] Both NPY2R and FOXP2 are associated with the hypothalamic regulation of feeding behaviors (hunger and satiation), metabolism, and energy homeostasis, in animal and human research, and essential in speech development.[120,123] Although the evidence is limited, this avenue of research holds promise and may offer an approach to quantitatively and objectively assessing oral feeding readiness.

F. Assessment of Oral Feeding Readiness in Preterm Infants

Due to the complexity of oral feeding readiness in preterm infants, a careful assessment prior to the initiation of oral feeding and a particular oral feeding event is crucial to ensure safe and efficient oral feeding. Researchers have developed instruments to assess a preterm infant's oral feeding readiness. The Early Feeding Skills Assessment is used to assess preterm infant's development in relationship to oral feeding skills,[126] The Neonatal Oral-Motor Assessment Scale (NOMAS) is designed to assess non-nutritive and nutritive oral-motor sucking patterns.[127] However, the NOMAS was originally designed for full-term infants, so its validity, when applied in preterm infants, has been questioned.[128-131] Another assessment scale, the Oral Feeding Skills Level is more objective than the Early Feeding Skills Assessment and the NOMAS and it considers two concepts: feeding proficiency (an infant's actual feeding skills when fatigue is minimal) and feeding efficiency (endurance).[71] Feeding proficiency is defined as the proportion of intake during the first five minutes of oral feeding (%),[71] whereas feeding efficiency is defined as the amount of intake over the duration of oral feeding (mL/minute).[71,86] An integrative assessment of oral feeding readiness from multiple disciplines has also been recommended because it may provide a more comprehensive picture.[132,133] There are also instruments to quantitatively measure non-nutritive and nutritive sucking patterns, and their rhythmicity, sucking pressure, and suck-swallow-breathe coordination, [23,52,134-138] however, these research instruments are not readily available to clinicians in the NICU. Because oral feeding readiness is complex and involves multiple factors for consideration, none of the instruments comprehensively assess oral feeding readiness, thus each possesses some advantages and disadvantages.[15,139,140] In order to accurately and easily assess oral feeding readiness in preterm infants, there is an urgent need for a reliable and valid instrument that is user-friendly and readily available.

G. Utilizing Tube Feeding in Preterm Infants

Given the requirement of mature oral feeding skills and oral feeding readiness for safe and efficient feeding, it is understandable that preterm infants are not neurologically or physically mature enough to perform the oral feeding task. In fact, oral feeding is not considered safe until at least 32 weeks post-menstrual age (PMA), preferably 34 weeks.[141-143] Therefore, while these infants mature and learn to oral feed safely and efficiently, tube feeding (nasogastric or orogastric) is temporarily necessary to provide adequate caloric intake, and allow energy conservation for growth and development.[141-143] Typically, when preterm infants have demonstrated an appropriate oral feeding readiness, they begin and gradually make the transition from tube to oral feeding.[89] The transition from tube to oral feeding can last a few days to several months or even years,[89] and in some severe and rare cases the transition never occurs requiring the long-term placement of a gastrointestinal tube.[89]

In contrast to the benefits, research has identified some negative consequences of tube feeding. Early in the tube feeding process, feeding tube insertion induces unpleasant stimulation, such as pain, choking, and gagging, leading to discomfort and rejection of a new oral stimulus.[31,89,144-148] Feeding tubes may also contribute to stimulus desensitization in the oral cavity, leading to delayed triggering of the chewing and swallowing mechanism, causing choking or aspiration.[141,148,149] The long-term placement of feeding tubes irritates the mucosa of the esophagus, causing continuous discomfort,[89,147,149] and numerous studies have suggested impaired oral-motor function and coordination, oral feeding difficulties, and oral aversion, as a common long-term consequence of tube feeding.[89,147-152]

After hospital discharge, extremely preterm infants exhibit an increased incidence of feeding problems (up to 80%).[153-157] Nutritive sucking and breathing performance have been shown to be less effective with the presence of a nasogastric feeding tube during oral feeding, including lower minute ventilation, tidal volume, pulse rate, oxygenation, nutritive sucking pressure, and oral intake.[158,159] Research findings are suggestive that preterm infants who received more than three weeks of tube feedings may be at risk for displaying long-term oral sensitivity, facial defensiveness, and oral feeding difficulties, when compared to preterm infants who received less than three weeks of tube feedings.[141,143] Tube feeding is associated with a reduced amount of oral intake, and immature non-nutritive sucking patterns,[160] and tube feeding has also been found to contribute to prolonged transition from tube feeding to oral feeding.[89] Although tube feeding has been utilized since the 1800s,[161] the consequences of tube feeding are not well documented. In order to utilize tube feeding effectively, without jeopardizing OFS, it is a scientific and clinical priority to have a detailed and clear understanding of tube feeding’s consequences in preterm infants. In chapter 3, a detailed discussion is provided of our investigation of the relationship between duration of tube feeding and OFS in preterm infants.

H. Subjective and Inconsistent Current Oral Feeding Practices in the NICU

Oral feeding readiness cues in preterm infants are very subtle; they may be missed by caregivers unless a careful and frequent assessment is made. At present, an easy to use, quantitative, and objective tool for the assessment of oral feeding readiness is still lacking.[71,162] The initiation and daily provision of oral feeding is loosely based on the clinician's judgment of the infant's oral feeding readiness, which can be very subjective and inconsistent.[163-167] The current recommendation for oral feeding practice is to allow preterm infants to feed based on the infants' demonstration of oral feeding readiness.[83,94,168-170] Typically, an oral feeding schedule is every two to three hours, cue-based, or some combination of these two approaches.[163-167] Oral feeding readiness is often assessed prior to the initiation of oral feeding,[163-167] then after the initiation, the caregivers continue to assess the preterm infant's oral feeding readiness, and determine whether to offer oral feeding.[163-167] The infant is increasingly offered oral feeding as their feedings progress, until OFS is achieved.[163-167] Nonetheless, current oral feeding practices in the NICU are characterized by a high degree of variability, mainly based on a trial and error approach, and may not be aligned with the current recommendation of allowing preterm infants to feed orally, as early and as often as they exhibit signs of oral feeding readiness.[83,94,168-173] Therefore, the current transitional approach may not be conducive to OFS.[163-167]

I. Effects of the Oral Feeding Experience in Preterm Infants

It is well recognized that neurological maturation is primarily responsible for improved oral feeding skills.[134] In the past decade, emerging evidence has called attention to the oral feeding experience provided in the NICU. The oral feeding experience is often defined as the number of oral feeding opportunities or attempts that the preterm infant received, regardless of the intake quantity.[85,115,163-167] Pickler and colleagues consistently report that the oral feeding experience is a predictor of oral feeding outcomes in preterm infants.[85,115,163-167] The number of nutritive sucking episodes are higher when preterm infants received more oral feedings per day.[115] Preterm infants who received a higher mean of oral feeding experiences per day, achieved OFS sooner, thus decreasing the length of time for oral feeding transition.[163,164] A higher proportion of missed oral feeding experiences was associated with an extended time to achieve OFS, and time to discharge.[167] Pickler and colleagues are currently conducting a randomized trial to test the effect of a patterned oral feeding experience.[166] This research will help to shed more light on the importance of the oral feeding experience in preterm infants.

As much as we know of the oral feeding experience, efforts should be put forth to promote a more structured approach to initiation and management of oral feeding that includes more frequent oral feeding experiences. Nonetheless, it must be emphasized that while aiming to provide more oral feeding experiences to preterm infants, clinicians must be aware of, and avoid, “forced oral feeding” when preterm infants are not ready. Forced oral feeding may negatively interfere with the oral feeding experience because early experiences, positive or negative, impact long-term neurological outcomes. Each time that caregivers interact with an infant, they are reinforcing neural pathways (imprinting), which impact the infant’s neurodevelopment.[174] Providing oral feeding when preterm infants demonstrate appropriate oral feeding readiness is critical for a positive oral feeding experience.[109] Positive oral feeding experiences may promote positive imprinting and facilitate successful feeding skills and habits for the infant's entire lifetime.[109,171-173] Forced oral feeding, when preterm infants demonstrate inadequate or complete lack of oral feeding readiness, may lead to a negative oral feeding experience. These negative experiences can lead to long-term consequences such as feeding problems post-discharge, and increased parental stress during mealtimes.[109] Evidence for the importance of oral feeding experience may help us to fully understand oral feeding in preterm infants, however, the evidence is limited and further research is needed.

J. Hindering the Oral Feeding Experience in the NICU

There is a lack of well documented knowledge regarding the daily provision of oral feeding experiences, and substitution of tube feedings for oral feedings in preterm infants who demonstrate oral feeding readiness. While the caregivers should offer oral feeding if an infant demonstrates oral feeding readiness at scheduled feedings,[163-167] this practice is not consistently documented in the literature. Researchers have reported an inconsistency in the provision of oral feeding experiences by nurses in the NICU,[164,167] with some preterm infants receiving tube feedings instead of oral feedings due to reasons that are unrelated to oral feeding readiness, including "time management reasons" or unspecified "other reasons."[164,167] These findings suggest that not providing an oral feeding experience may be related to whether tube feeding is readily available or not, and the need to "save time", making it the chosen method of feeding even if the preterm infant shows oral feeding readiness. Nonetheless, evidence regarding how tube feeding may hinder the oral feeding experience and its association with delayed OFS is limited, and perhaps a crucial aspect that warrants further investigation.

K. Conceptual Model

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.[84,131,175] 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.[84,131,175] 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.[84] In preterm infants, male sex was a significant biological risk factor for poor cognitive and motor development when compared to female sex,[84,176] thus sex may predict oral feeding transition. Preterm infants who are actively engaged during an oral feeding episode [83,93] often demonstrate alert behavioral states and orally-directed behaviors prior to feeding.[79] Infants may then need to maintain intra-feeding alert behavioral states while performing nutritive sucking.[79] This active oral feeding process is learned and refined with oral feeding experience, allowing the infant to achieve OFS.[79]

While oral feeding is an active process, tube feeding is a passive process.[83,93] Currently, in many NICUs, preterm infants are tube fed according to a schedule, with a prescribed volume.[83,93] 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."[164,167] Thus, the opportunity to learn and refine the active oral feeding process may be delayed.[141,146-148] We speculate that a longer duration of tube feeding may hinder the oral feeding experience and be correlated with delayed OFS.[85,115,163-167]

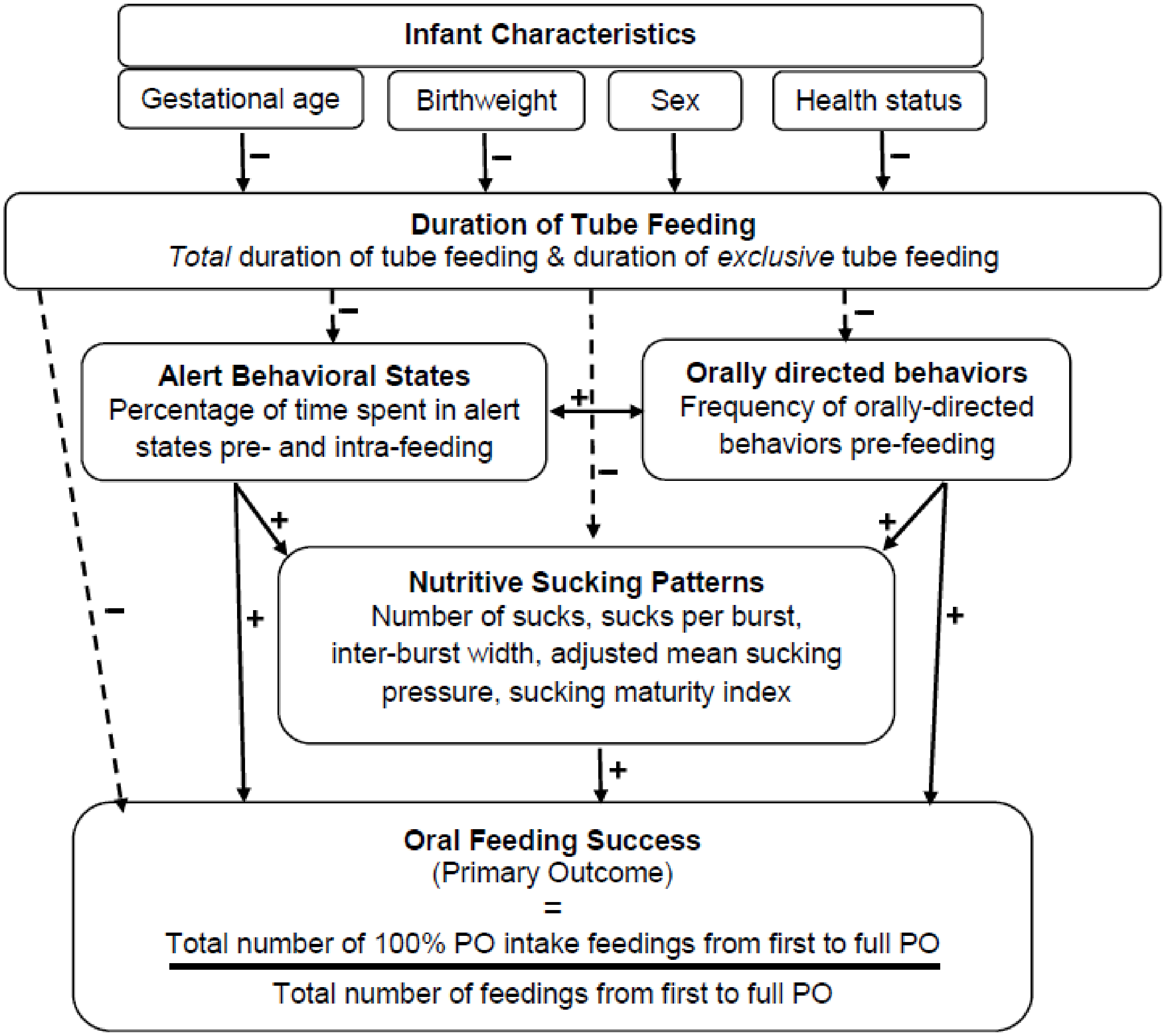
Additionally, alert behavioral states, orally-directed behaviors, and nutritive sucking patterns have consistently shown to be predictors of OFS.[79,84-86,102,107,177] Orally directed behaviors and alert behavioral states are positively associated with high feeding efficiency and high oral feeding intake,[79,85,86,102,103,106,107] and have been recommended by numerous researchers as part of the assessment carried out, prior to oral feeding.[83,86,104,170,178-182] Nutritive sucking is an early oral feeding skill, and is critical for achieving OFS.[24,25,48,142,183]

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.

L. Purpose and Significance

The primary purpose of this dissertation research was to identify the potential relationship between the duration of tube feeding and OFS in preterm infants during their initial hospitalization. In order to conduct research on OFS, a concept analysis was first required to fill a gap on better understanding of the OFS concept. Chapter 2, entitled “Oral Feeding Success: A Concept Analysis,” aims to clarify the meaning of OFS in preterm infants by defining its attributes, antecedents, and consequences using Walker and Avant method for concept analysis. The primary aim of chapter 3, entitled “The Relationship between Duration of Tube Feeding and Oral Feeding Success in Preterm Infants,” is to identify the potential relationship between duration of tube feeding and OFS in preterm infants during their initial hospitalization. The secondary aim of chapter 3 is to identify potential relationships between duration of tube feeding and alert behavioral states, orally-directed behaviors, and nutritive sucking at a one-time feeding evaluation within 48 hours after the removal of the feeding tube. Both of these chapters will clarify the meaning of OFS and offer additional understanding about the relationship between duration of tube feeding and OFS. This research may guide clinicians in the identification of preterm infants who are at risk for delayed OFS. Early identification of infants who are at-risk would allow for appropriate and timely assessment and interventions for introduction and advancement of oral feeding to facilitate OFS. This research also lays the ground work for future research to develop and test early interventions that support the transition from tube to oral feeding and facilitate the achievement of OFS.

Figure 1. Conceptual Framework of the Relationship between Duration of Tube Feeding and Oral Feeding Success in Preterm Infants



II. ORAL FEEDING SUCCESS: A CONCEPT ANALYSIS

A. Abstract

Background. The term oral feeding success (OFS), is frequently used in nursing research and practice. However, OFS is inconsistently defined which impacts our ability to identify risk factors, interventions, and evaluation parameters of OFS.

Purpose. To clarify the meaning of OFS, and develop antecedents, defining attributes, and consequences for the concept of OFS in preterm infants during their initial hospitalization.

Method. PubMed, CINAHL, and PsycINFO databases were searched for English articles containing the keywords "oral feeding success" and "preterm infants." The Walker and Avant method for concept analysis was employed.

Results. Sixteen articles revealed antecedents, defining attributes, and consequences. Two defining attributes were full oral feeding, and the combined criteria of feeding proficiency, feeding efficiency, and intake quantity.

Implications for Practice. The defining attributes, antecedents, and consequences of OFS are useful in providing clinicians a frame of reference to identify risk factors, implement effective interventions, and evaluate OFS.

Implications for Research. The identification of the empirical referents serves as the operational definitions of OFS for use in research. Clarification of antecedents, defining attributes, and consequences helps the investigators to evaluate valid measures of OFS.

B. Background and Significance

The national prevalence of premature or preterm birth (< 37 weeks gestational age) continues to be alarming at 9.62% in 2015, and is higher than the March of Dimes 2020 goal of 8.1%.[1] Preterm birth costs the United States more than $26 billion annually for care, intervention, and loss of productivity.[4,5] The medical and technological advances in the treatment of preterm infants have allowed for a significant increase in the survival rate,[6] however, the healthcare system now has the challenge of providing intensive care for younger and more fragile infants. Preterm infants are vulnerable to complex health issues and complications,[7] including challenges to transition from tube to oral feeding before they can be discharged.[10]

After birth, preterm infants are at increased risk of immediate life-threatening health problems,[2,5,11] and many are admitted to the Neonatal Intensive Care Unit (NICU).[7] Tube feeding (nasogastric or orogastric) is typically required to provide adequate caloric intake and allow energy conservation for growth and development.[141-143] However, when preterm infants have demonstrated appropriate oral feeding readiness, they begin and gradually make the transition to oral feeding,[89] via bottle-feeding or breastfeeding. While breastfeeding is the superior method of feeding, the majority of infants in the NICU are bottle-fed with pumped breastmilk or formula.[184] Our main interest pertains to bottle-feeding, thus, in this concept analysis, we use the term “oral feeding” to address bottle-feeding. While tube feeding is necessary based on medical needs, the goal is to achieve oral feeding success (OFS).[89] The ability of preterm infants to achieve OFS is one of the gold standards for discharge from the initial hospitalization.[10] However, achievement of OFS is often a serious challenge in preterm infants[7,10] due to their physical and neurological immaturity.

When a preterm infant is able to consume 100% of their intake orally, that OFS has been achieved. While the amount of consumption is a concrete definition, OFS pertains to other aspects as well, such as physiologic stability, weight gain, maturation, etc. OFS is frequently used in research and clinical practice to evaluate preterm infants' oral feeding outcomes. However, OFS is inconsistently defined which impacts our ability to identify risk factors, interventions, and evaluation parameters of OFS. Therefore, the concept of OFS in preterm infants requires further clarity and analysis.

The purpose of this concept analysis of OFS was to clarify the meaning, and develop antecedents, defining attributes, and consequences for the concept of OFS in preterm infants during their initial hospitalization using Walker and Avant method.[185] In continuing to build on the scientific basis of the nursing discipline by providing evidence for quality care, and translating the evidence into practice, it is essential to clarify and refine the meaning attached to the different concepts used in nursing.[185,186] In particular, awareness of the concepts used on a daily basis within neonatal research and clinical practice is central to the application of these concepts. This concept analysis will help to clarify the concept of OFS, understand the events that happen before, as well as the outcomes. The antecedents, defining attributes, and consequences of OFS will be useful in providing researchers and clinicians a frame of reference from which OFS can be evaluated and measured.

C. Method

This concept analysis report focuses on the concept of OFS in preterm infants during their initial hospitalization, and was conducted using the Walker and Avant method.[185] The method is effective and sufficient to capture the essence of a concept[185] and uses the following eight steps: (1) select a concept; (2) determine the aims or purposes of the analysis; (3) identify all uses of the concepts that you can discover; (4) determine the defining attributes; (5) identify a model case; (6) identify additional cases, (e.g., borderline, related, contrary, invented, or illegitimate cases); (7) identify antecedents and consequences; (8) define empirical referents.[185,187] The first two steps have already been discussed: selecting a concept (oral feeding success), and determining the aims or purposes of the analysis (clarify the meaning, and develop antecedents, defining attributes, and consequences).

The next step is to identify the uses of the concept. The uses of OFS were first identified using an online dictionary, then a comprehensive literature search was conducted using PubMed, CINAHL, and PsycINFO. The phrases “oral feeding success” and “preterm infants” were used as the keywords to conduct the literature search, and the English language was set as a search criterion. All of the articles retrieved were reviewed for the uses of the phrase “oral feeding success”, limited to preterm infants and during the initial hospitalization only. While reviewing the articles, there were additional phrases that were used interchangeably with “oral feeding success”, which literally conveyed the same meaning. For example, “successful oral feeding”, “successful oral feeding transition”, “successful bottle feeding”, “bottle feeding success”, “complete oral feeding”, and “independent oral feeding”, therefore, these additional terms/phrases were considered surrogate phrases. Articles were selected if the authors used the phrase "OFS" or any of the surrogate phrases, and articles in the reference lists of the primary articles were also examined for these phrases. Ultimately, sixteen articles, published between the years of 1997 and 2017, were used for this concept analysis. All of the articles were analyzed to identify the uses of OFS and its surrogates, to determine the defining attributes, and to identify antecedents and consequences.

D. Results

1. Identify Uses of the Concept Oral Feeding Success

According to Walker and Avant, uses of the concept must be identified, both implicitly and explicitly, using the following sources: dictionary, thesauruses, colleagues, and available literature.[185] After the search for uses of concept OFS, the following uses were identified.

Collins English Dictionary does not provide a meaning for the complete phrase. However, *Collins English Dictionary* provided definitions for each of the terms "oral," "feeding," and "success".[188] Oral is defined as 1) spoken or verbal; 2) relating to, affecting, or use in the mouth; 3) denoting a drug to be taken by mouth; and 4) of, relating to, or using spoken words. Feeding is defined as an act of giving food to a person or an animal. Success is defined as 1) favorable outcome of something attempted; 2) the attainment of wealth, fame, etc.; 3) an action, performance, etc. that is characterized by success; 4) a person or thing that is successful. Successful is the adjective form of success and has the same definition.[188]

In the literature, OFS has been previously described as full oral feeding. Infants who achieved OFS were fully/primarily orally fed at discharge.[189] Lau and colleagues required the infant to be fully oral fed in order to achieve OFS.[70] Simpson and colleagues described OFS as the ability to consume all of the prescribed volume within an allotted time and gain weight adequately.[190] McGrath and Barescu stated specifically that if the infant was able to suck effectively to consume all of the prescribed volume in 30 minutes or less, s/he achieved OFS.[78] Maron and colleagues described OFS when infant consumed 100% of their daily feeding orally.[122,123] Griffith and colleagues defined oral feeding as the ability of the infant to consume full oral feeding while maintaining physiologic stability.[86] Similarly, Jones defined OFS as the ability to take the prescribed volume in an appropriate time period while maintaining physiologic stability.[91] Bingham and colleagues utilized a slightly different approach and defined OFS as if the infant consumed more than 15 ml or g/kg at each of three feedings within a 24 hour period.[24]

Oral feeding progression has also been used as an indicator of OFS. Zimmerman and colleagues denoted the days required to attain full oral feeding as OFS.[120] A shorter oral feeding progression was an indicator of greater success with oral feeding.[120]

Feeding proficiency, feeding efficiency, and intake quantity have been utilized to define OFS. Lau and colleagues specifically defined OFS as being when an infant's intake quantity was greater than 80% of the prescribed volume.[70,71] In a more comprehensive approach, Pickler and colleagues defined OFS as being when feeding proficiency, feeding efficiency, and intake quantity were greater than 30% of the prescribed volume, 1.5 ml/min, and 80% of the prescribed volume, respectively.[85,177] Griffith and colleagues also described that feeding efficiency is crucial for OFS.[86]

Researchers have suggested that OFS could be achieved when infants demonstrate orally-directed behaviors and maintain alert behavioral states prior to and during feeding. Pickler and colleagues described that the quiet alert states is optimal for feeding success.[85,164] Similarly, Kirk and colleagues stated that achievement of quiet alert states and demonstration of orally directed behaviors are important prerequisites to OFS.[83] Griffith and colleagues described that alert behavioral states are crucial for OFS.[86]

In our results, OFS was largely discussed as an outcome of various factors. Pickler and colleagues described that OFS may be influenced by morbidity or illness complications, the number of sucks in the first burst, and number of oral feeding experience.[85,164,177] Pickler and colleagues also described that OFS requires maturity, coordinated suck-swallow-breathe, organized autonomic nervous system, and physiologic stability.[79,85,165] Maron and colleagues described the developmental maturation of hypothalamic regulation of feeding behaviors as an essential component of OFS.[123]

Oral feeding success was described as one of the determining factors of growth and development and the removal of the feeding tube. McGrath and Braescu stated that the achievement of OFS is highly significant for growth and development in preterm infants.[78] Maron and colleagues stated that the inability to achieve OFS places infants at increased risk for developmental disabilities.[122] Infants who achieved OFS had their feeding tube removed.[189] Jacherla and colleagues described the need for a long-term gastrostomy placement as a result of the inability to achieve OFS.[189]

It is well established that OFS is one of the gold standards for discharge from the initial hospitalization. Multiple authors described OFS as one of the criteria for hospital discharge.[70,86,165] McGrath and Braescu described the standards for discharge readiness from the NICU, including physiologic stability, consistent weight gain, and OFS.[78] When preterm infants achieve OFS, they are discharged from the NICU within 24 hours.[78]

2. **Determining Defining Attributes of OFS**

Determining the defining attributes of a concept is crucial for a concept analysis.[185] Defining attributes are the characteristics of the concept that are repeatedly used, and are similar to the criteria for making a diagnosis in medicine, and are susceptible to change and improvement.[185] This concept analysis synthesized the defining attributes of OFS by examining all possible uses of the concept found in our literature search and identifying characteristics that appear over and over again.[185] The defining attributes of OFS include full oral feeding, and the combined criteria of feeding proficiency, feeding efficiency, and intake quantity. All authors who contributed to determining the defining attributes of OFS are listed in Table I.

Identify a model case

A model case can be developed during the defining attribute process, and is a "real life" example of the use of the concept that includes all the critical attributes of the concept.[185] The following model case is representative of a typical example demonstrating the meaning of OFS.

Allie is an African American female infant who was born at 31 weeks gestational age via cesarean section, due to maternal preeclampsia, with a birth weight of 1350 g.

Allie was admitted to a level 3 NICU due to prematurity and respiratory distress. She was placed on tube feeding (nasogastric [NG]) upon her admission, and received NG tube feeding, of pumped breast-milk from her mother, every three hours. The intake quantity at each NG tube feeding was gradually increased from 5 mL to 32 mL, and the method of NG tube feeding was also changed from gravity to pump over the course of her first two weeks of life, as Allie was tolerating the NG tube feeding with minimal residue, and without vomiting/spitting up. At around 33 weeks post-menstrual age, when Allie was able to tolerate 32 ml per NG tube feeding while maintaining physical and motor stability. She was able to show alert behavioral states more frequently and demonstrate some orally-directed behaviors. The healthcare team decided to initiate her first oral feeding (PO) was initiated. At the beginning of the transition, the nurses offered her PO first, and Allie would take as much as she could (0-32 mL), then they would feed any remaining amount via NG. Allie was able to gradually increase her PO intake over the next 15 days of the transition, until she was fed via PO at all feedings, with the exception of a few NG when she was not able to finish 32 mL by PO. During the 15 days of the transition, the speech therapist would evaluate some of her feedings using the combined criteria feeding efficiency, feeding proficiency, and intake quantity. At the evaluations on the 12th and 15th day of the transition, the speech therapist noted that her feeding proficiency was greater than 30% of the prescribed volume, feeding efficiency greater than 1.5 mL/min, and intake quantity greater than 80% of the prescribed volume. Thus, the speech therapist determined that Allie had achieved OFS, and recommended to advance her PO feeding as planned. On the 16th day of the transition, Allie was able to consume 100% of her prescribed volume (32 mL) via PO at all feedings, and continued to do so on the 17th day of the transition. The healthcare team determined that at 35 weeks post-menstrual age, Allie had achieved OFS. The length of her oral feeding transition was 17 days. The parents and healthcare team were very pleased with Allie's transition from NG tube feeding to OFS and began to plan for her discharge.

This model case demonstrates all the defining attributes of OFS, as evidenced by (1) full oral feeding, and (2) satisfying the combined criteria feeding proficiency (> 30% of the prescribed volume, feeding efficiency (> 1.5 mL/min), and intake quantity (> 80% of the prescribed volume) at the speech therapist's evaluation.

Identify a contrary case

Contrary cases are examples that demonstrate what the concept is not.[185] A contrary case "gives us information about what the concept should have as defining attributes if the ones from the contrary case are clearly excluded."[185]

Tony is an African American male infant who was born due to placenta previa, via cesarean at 28 weeks gestational age, with a birth weight of 700 g, and was admitted to a level 3 NICU due to prematurity, intrauterine growth restriction, very low birth weight, and respiratory distress. He was immediately placed in an incubator, and received intravenous feeding during the first two weeks of life. At 30 weeks PMA, Tony's feeding was switched to gravity NG tube feeding, 5 mL intake, Enfamil formula, every three hours. At 32 weeks PMA, Tony was receiving 28 mL every three hours via pumped NG tube feeding. Nonetheless, Tony was not tolerating the NG tube feeding, as evidenced by frequent spitting up after each feeding. His tolerance for NG tube feeding finally improved at 34 weeks PMA, as he was receiving 31 mL every three hours. The healthcare team decided to initiate oral feeding (PO), and he received his first PO at 35 weeks PMA. At the beginning of the transition, the nurses offered him PO first, and Tony would take as much as he could (0-31 mL), then they would feed the remaining via NG. Nonetheless, Tony was having trouble tolerating PO feeding as evidenced by weak sucks, frequent oxygen desaturation/bradycardia episodes, and frequent spitting up after each feeding. Most of the time, the nurses would have to abort PO attempts (with the PO intake quantity often less than 30%), and feed Tony via the NG tube instead. The transition continued to until 39 weeks PMA with minimal improvement, during which time, the speech therapist would evaluate Tony's feedings using the combined criteria feeding efficiency, feeding proficiency, and intake quantity. At all of the evaluations, the speech therapist noted that Tony had not met the criteria for OFS (his feeding proficiency was less than 30%, feeding efficiency was less than 1.5 mL/min, and intake quantity was less than 80%). Therefore it was recommended not to advance his PO feeding, and after considering the prolonged failure to achieve OFS, the healthcare team finally decided to place a G-tube for long-term tube feeding. The length of his oral feeding progression is undetermined. This contrary case is a clear example of "not the concept" as it does not include the two attributes of OFS.

3. Identify Antecedents and Consequences of OFS

Antecedents

Antecedents are events or incidents that must occur prior to the onset of the concept.[185] In the current analysis, antecedents occur prior to the onset of OFS and include (1) alert behavioral states, (2) orally-directed behaviors, (3) morbidity or illness complications, (4) number of sucks in the first burst, (5) number of oral feeding experience, (6) maturity, (7) coordinated suck-swallow-breathe, (8) organized autonomic nervous system, (9) physiologic stability, and (10) developmental maturation of hypothalamic regulation of feeding behaviors. All authors who contributed to the identification of the antecedents are listed in Table II.

Consequences

Consequences are the outcomes of the concept,[185] which in this analysis, occur after OFS. In the current analysis, four consequences of OFS were identified: (1) growth and development, (2) removal of the feeding tube, (3) oral feeding progression; and (4) hospital discharge. All authors who contributed to the identification of the consequences are listed in Table III.

4. Defining Empirical Referents

Empirical referents are actual phenomena that demonstrate the occurrence of the concept.[185] In this concept analysis, OFS can be observed by the following phenomena: (1) full oral feeding, and (2) the combined criteria of feeding proficiency, feeding efficiency, and intake quantity. OFS is observed by full oral feeding, which is characterized as the infant's ability to consume 100% of the prescribed volume within an allotted time (20-30 minutes), for at least 24 to 48 hours continuously.[83,84,91,93,94,103,122-124,189,190] Additionally, when the unit of analysis for OFS is one feeding, there are two approaches to determine the defining empirical referents, as followed. (1) OFS is the ability of infant to consume 100% of the prescribed volume within an allotted time. (2) OFS is observed when feeding proficiency, feeding efficiency, and intake quantity are greater than 30% of the prescribed volume, 1.5 ml/min, and 80% of the prescribed volume, respectively.[70,71,85,177]

Currently, there is no validated instrument that is used to evaluate OFS. Although, researchers have developed instruments to assess a preterm infant's oral feeding. The Early Feeding Skills Assessment is used to assess preterm infant's development in relationship to oral feeding skills,[126] The Neonatal Oral-Motor Assessment Scale (NOMAS) is designed to assess non-nutritive and nutritive oral-motor sucking patterns.[127] However, the NOMAS was originally designed for full-term infants, so its validity, when applied in preterm infants, has been questioned.[128-130] Another assessment scale, the Oral Feeding Skills Level is more objective than the Early Feeding Skills Assessment and the NOMAS and it considers two concepts: feeding proficiency (an infant's actual feeding skills when fatigue is minimal) and feeding efficiency (endurance).[71] Feeding proficiency is defined as the proportion of intake during the first five minutes of oral feeding (%),[71] whereas feeding efficiency is defined as the amount of intake over the duration of oral feeding (mL/minute). An integrative assessment of oral feeding readiness from multiple disciplines has also been recommended because it may provide a more comprehensive picture.[132,133] There are also instruments to quantitatively measure non-nutritive and nutritive sucking patterns, and their rhythmicity, sucking pressure, and suck-swallow-breathe coordination,[23,52,134-138] however, these research instruments are not readily available to clinicians nor user friendly in the NICU.

E. Discussion

Oral feeding success is essential for growth, and is a key determinant of readiness for a preterm infant's discharge from their initial hospitalization.[10] With this concept analysis, we determined the antecedents, defining attributes, and consequences of OFS. These components are useful in providing clinicians a frame of reference from which OFS can be evaluated (Figure 2). The attributes will be useful for determining whether the transition from first to oral feeding has been completed. Subsequently, researchers and clinicians may also use the attributes to determine if OFS is achieved at a particular oral feeding event, during their initial hospitalization. This criterion will aid in the decision-making process during the advancement of oral feeding while transitioning to oral feeding.

A clear understanding of what happens before OFS will be helpful to identify infants who are at risk for delayed OFS. The ability to anticipate risk would allow for implementation of early interventions, (e.g., non-nutritive sucking, swallowing exercise, oral motor stimulation, multisensory intervention, cheek and jaw support, positioning, self-paced system)[48,92,105,106,117,179,191-200] to facilitate OFS and its outcomes.

This concept analysis interfaces with the research process to offer many suggestions to oral feeding in the preterm infant research field. For example, identifying empirical referents provides operational definitions of OFS for use in research. Clarification of antecedents, attributes, and consequences helps the investigators to evaluate valid measures of OFS.

F. Conclusion

The concept of oral feeding success has been used frequently to evaluate the infants' ability to oral feeding. However, it is inconsistently defined which impacts our ability to identify risk factors, interventions, and evaluation parameters of OFS. OFS is one of the main criteria for hospital discharge for the majority of preterm infants in the NICU. Thus, this concept analysis is crucial in providing researchers and clinicians a better understanding regarding the antecedents, defining attributes, and consequences of OFS, optimizing their effectiveness in facilitating OFS.

TABLE I

LITERATURE SUPPORT FOR DEFINING ATTRIBUTES OF ORAL FEEDING SUCCESS

Defining attributes	Citations
Full oral feeding	(Griffith, Rankin, & White-Traut, 2017; Jadcherla, Wang, Vijayapal, & Leuthner, 2010; Jones, 2012; Lau, Sheena, Shulman, & Schanler, 1997; Maron et al., 2015; Maron, Johnson, Dietz, Chen, & Bianchi, 2012; McGrath & Braescu, 2004; Simpson, Schanler, & Lau, 2002)
Combined criteria of feeding proficiency, feeding efficiency, and intake quantity	(Griffith et al., 2017; Lau et al., 1997; Lau & Smith, 2011; Pickler, Best, Reyna, Wetzel, & Gutcher, 2005; Pickler, Chiaranai, & Reyna, 2006)

TABLE II

LITERATURE SUPPORT FOR ANTECEDENTS OF ORAL FEEDING SUCCESS

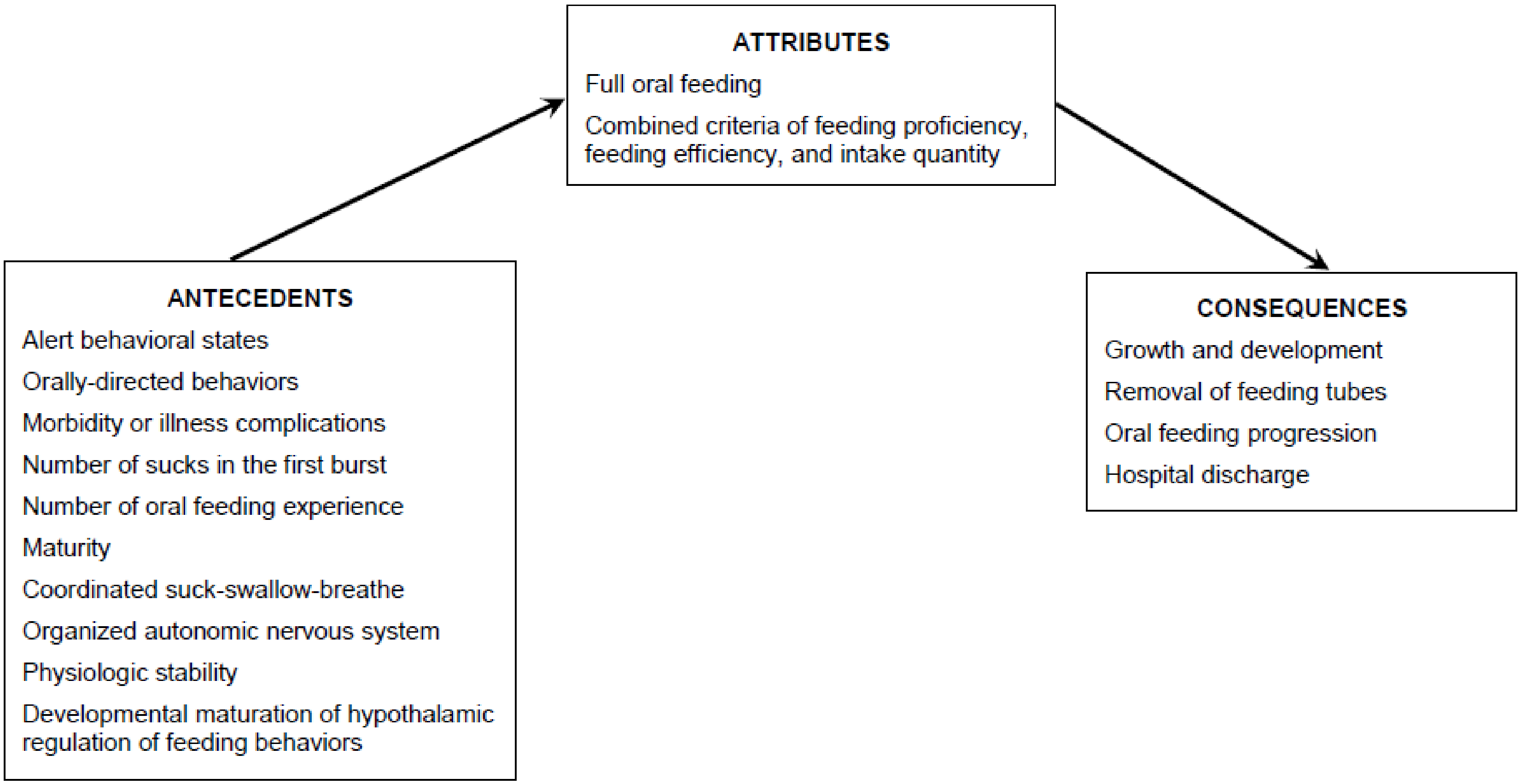
Antecedents	Citations
Alert behavioral states	(Griffith, Rankin, & White-Traut, 2017; Kirk, Alder, & King, 2007; Pickler, Best, Reyna, Wetzel, & Gutcher, 2005; Pickler & Reyna, 2003)
Orally-directed behaviors	(Kirk et al., 2007)
Morbidity or illness complications	(Pickler et al., 2005; Pickler, Chiaranai, & Reyna, 2006; Pickler & Reyna, 2003)
Number of sucks in the first burst	(Pickler et al., 2005; Pickler et al., 2006; Pickler & Reyna, 2003)
Number of oral feeding experience	(Pickler et al., 2005; Pickler et al., 2006; Pickler & Reyna, 2003)
Maturity	(Pickler, 2004; Pickler et al., 2005; Pickler, Reyna, Wetzel, & Lewis, 2015)
Coordinated suck-swallow-breathe	(Pickler, 2004; Pickler et al., 2005; Pickler et al., 2015)
Organized autonomic nervous system	(Pickler, 2004; Pickler et al., 2005; Pickler et al., 2015)
Physiologic stability	(Griffith et al., 2017; Jones, 2012; Pickler, 2004; Pickler et al., 2005; Pickler et al., 2015)
Developmental maturation of hypothalamic regulation of feeding behaviors	(Maron, Johnson, Dietz, Chen, & Bianchi, 2012)

TABLE III

LITERATURE SUPPORT FOR CONSEQUENCES OF ORAL FEEDING SUCCESS

Consequences	Citations
Growth and development	(Maron et al., 2015; McGrath & Braescu, 2004)
Removal of feeding tubes	(Jadcherla, Wang, Vijayapal, & Leuthner, 2010)
Oral feeding progression	(Zimmerman, Maki, & Maron, 2016)
Hospital discharge	(Griffith, Rankin, & White-Traut, 2017; Lau, Sheena, Shulman, & Schanler, 1997; McGrath & Braescu, 2004; Pickler, Reyna, Wetzel, & Lewis, 2015)

Figure 2. Conceptual Model of Oral Feeding Success in Preterm Infants during Initial Hospitalization



III. THE RELATIONSHIP BETWEEN DURATION OF TUBE FEEDING AND ORAL FEEDING SUCCESS IN PRETERM INFANTS

A. Abstract

Background. 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.

Purpose. 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.

Methods. A descriptive correlational study was conducted. Data were collected daily from the infants' electronic medical records and at a one-time oral feeding evaluation within 48 hours after the removal of the feeding tube.

Results. Data from 28 preterm infants were analyzed. A significant negative correlation between duration of tube feeding and OFS ($\beta = -1.10$, $P = 0.000$, $\mathcal{C}\mathcal{I}^2 = 0.41$) was identified. There was no correlation between duration of tube feeding and alert behavioral states, orally-directed behaviors, or nutritive sucking.

Implications for Practice. OFS is one criterion for hospital discharge. 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, to facilitate OFS, clinicians should focus on modifiable factors, such as providing appropriate and timely assessment and interventions to introduce and advance oral feeding.

Implications for Research. The findings and innovative measure of OFS offer researchers a new approach to identify preterm infants who are at risk for delayed OFS. This research lays the ground work 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.

B. Background and Significance

Up to 150,000 infants are born very premature (< 32 weeks gestational age) each year in the United States.[3,10,11] These infants require admission to the Neonatal Intensive Care Unit (NICU) and extended tube feeding.[2,7,89,141,160,161] They are challenged to attain oral feeding success (OFS), defined as the infants' ability to consume 100% of the prescribed volume by mouth. OFS is considered one of the criteria for hospital discharge.[10] The transition from tube to oral feeding is characterized by a high degree of variability, is often based on clinical judgment, and a trial and error approach. This current transitional approach may not necessarily be aligned with current literature, which suggests that oral feeding should be offered when the infant exhibits signs of oral feeding readiness.[83,94,109,168-173] Thus, it may not be conducive to the achievement of oral feeding success.[163-167] Delayed achievement of oral feeding success can lead to oral feeding difficulty, prolonged hospitalization, less optimal mother-child interaction, later developmental delays, and increased health care costs.[6,8,23-27] In order to establish a standardized and effective transitional approach that facilitates OFS, a better understanding of the relationship between duration of tube feeding and OFS in preterm infants during their initial hospitalization is a key scientific and clinical priority.

While tube feeding is necessary to maintain adequate caloric intake for growth and development,[141-143] there can be negative effects. For example, feeding tube insertion induces unpleasant stimulation, such as pain, choking, and gagging, and may even contribute to oral stimulation hypersensitivity, leading to discomfort and rejection of a new oral stimulus.[31,89,144-148,150] Recently, researchers have suggested that non-nutritive sucking measures (i.e., number of sucks, number of bursts, burst organization score) decreased when infants was receiving their tube feeding when compared with the time before tube feeding.[160] Previous researchers have showed that preterm infants who had been tube fed during their initial hospitalization were at higher risk for impaired oro-motor function and coordination, oral sensitivity, facial defensiveness, oral feeding difficulties, and oral aversion after discharge.[141,143] Nonetheless, evidence is still limited regarding the relationship between the duration of tube feeding and oral feeding success in preterm infants during their initial hospitalization.

Furthermore, alert behavioral states, orally-directed behaviors, and nutritive sucking (involves milk ingestion) patterns have consistently been shown to be predictors of oral feeding success.[47,79,85,86,102,107] Alert behavioral states may be characterized by open eyes, focused attention, searching movements of the eyes, quiet inactivity or movement of the extremities, and strong muscle tone.[103,201] Orally-directed behaviors include mouthing, rooting, tonguing, empty sucking, wipe-at-mouth, hand-to-mouth, sucking-on-tongue, and sucking-on-hand.[106,107,116,117] A mature nutritive sucking pattern is demonstrated by an increase in the number of sucks, sucks per burst, sucking pressure, and shorter inter-burst width (length of time between sucking bursts).[43,45,202] These predictors of oral feeding success are often demonstrated by preterm infants who are actively engaged during an oral feeding episode[83,93] Infants often demonstrate alert behavioral states and orally-directed behaviors prior to feeding.[79] Infants may need to maintain intra-feeding alert behavioral states and perform mature nutritive sucking.[79] This active oral feeding process is learned and refined with oral feeding experience (oral feeding attempts offered), allowing the infant to achieve OFS.[79]

While oral feeding is an active process, tube feeding is a passive process.[83,93] Preterm infants are tube fed according to a schedule, with a prescribed volume.[83,93] When the infant begins 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. The current recommendation for the NICUs is to implement an infant-directed feeding allowing preterm infants to feed orally, as early and as often as they exhibit signs of oral feeding readiness.[83,94,109,168-173] However, an infant-directed feeding approach is often not implemented or implemented incorrectly in many NICUs. Currently, the common oral feeding practice in NICUs is scheduled feeding with a prescribed volume. In this case, previous research has shown that during the transition from tube to oral feeding, some preterm infants received tube feeding instead of oral feedings due to reasons that were unrelated to the infants' readiness or ability to oral feed, including "time management reasons" or "other reasons."[164,167] Thus, the opportunity to learn and refine the active oral feeding process may be delayed.[141,146-148] However, the relationships between duration of tube feeding and alert behaviors states, orally-directed behaviors, and nutritive sucking during initial hospitalization are not well understood.

The primary purpose 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 purpose was to identify the potential relationships between duration of tube feeding and (a) alert behavioral states, (b) orally-directed behaviors, and (c) 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.

C. Method

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.[203] NMI ranges from 1 to 5, with 1 describing infants without serious medical problems and 5 describing infants with the most serious complications.[203]

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 3). 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 3). There are different approaches and units of measurement to evaluate OFS as mentioned in chapter 2.[24,70,71,83,85,91,99,120,177] 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.[84] This definition eliminates early brief oral attempts that were followed by long stretches of tube feeding only.[84] 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.[84] 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 4 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.[107,114,117,201,204] 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.[86,107,114,117,201,204] This system exhibits valid individual differences and an accurate profile of the behavioral states of preterm infants during the neonatal period.[86,107,117,205,206] 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.[117]

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.[106,107,116,117,207] Any occurrence of mouthing, rooting, tonguing, yawning, sucking-on-tongue, empty-sucking, swipe-at-mouth, hand-to-mouth, and suck-on-hand was recorded.[106,107,116,117,207] The reported ICCs from previous research were good to excellent and ranged from 0.87 to 0.93.[117]

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.[208] 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.[209] 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.[209]

Nutritive sucking

Nutritive sucking was evaluated using the Neonur (Figure 5).[135] 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.[43,45,46,82,202] 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.[25,48] 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.[25,48]

4. Procedure

The study timeline is portrayed in Figure 3. 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 5). 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.[210,211] 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.[212-215] Suggested benchmarks for small, medium, and large effect sizes ω^2 are 0.01, 0.06, and 0.14, respectively.[212-215] A small effect size indicates a trivial effect, whereas a large effect size indicates substantial effect and practical significance.[212-215] 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.

D. Results

1. Descriptive Statistics for Sample Characteristics

The statistical analysis was completed with 28 infants (80% of the original study sample). Sample characteristics are portrayed in Table IV. 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).

2. Descriptive Statistics for Outcome Variables

Descriptive statistics for the outcome variables are presented in Table V. 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.

3. Bivariate Analyses

We observed significant differences in the mean *total* duration of tube feeding and duration of *exclusive* tube feeding between infants with different Neonatal Medical Index classifications (Table VI). The 5th NMI classification (indicating major health complications) 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 VII). Significant negative correlations between *total* duration of tube feeding and GA and birthweight were identified (Table VIII). Significant negative correlations between duration of *exclusive* tube feeding and GA and birthweight were also identified (Table VIII).

4. 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 ($\beta = -1.21$, $P = 0.002$, $R^2 = 0.35$) 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 ($\beta = -1.10$, $P = 0.000$, $R^2 = 0.41$) and OFS was observed (Figure 6 and Table IX).

After adjusting for *total* duration of tube feeding, correlation between birthweight and OFS was significant (β = −.98, P = 0.001, $\mathcal{CP}^2$ = 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 (β = −.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.

E. Discussion

In this study, we found that infants who had a longer *total* duration of tube feeding during the initial hospitalization also had lower OFS during the transition from first to full oral feeding; however, OFS was not associated with duration of *exclusive* tube feeding. Additionally, duration of tube feeding (*total* or *exclusive*), was not associated with pre-feeding orally-directed behaviors, alert behavioral states, or nutritive sucking. This is the first quantitative report to support clinical observations that infants who struggle to achieve OFS have a longer duration of tube feeding. A previous investigator reported that preterm infants who had an extended duration of tube feeding were at higher risk for impaired oro-motor function and coordination, oral sensitivity, facial defensiveness, oral feeding difficulties, and oral aversion after discharge.[141] Using a novel way to assess OFS, our findings provide beginning evidence regarding longer duration of tube feeding and risk for delayed OFS. However, it is important to note that the duration of tube feeding is dependent on medical needs, maturation, and oral feeding ability. These factors cannot be easily manipulated.[141] Our initial evidence offers a new strategy to identify infants who are at risk for delayed OFS, facilitating the assessment of at-risk infants prior to the introduction of oral feeding and during the transition to OFS.[141]

The duration of *exclusive* tube feeding did not correlate with OFS during the transition from first to full oral feeding. This finding could reflect that infants with a younger GA require the need for *exclusive* tube feeding. The current trial and error approach of early oral feeding introduction,[83,94,168-170] as early as 31 weeks GA,[190] may aim to minimize the duration of tube feeding. This approach may result in oral feeding intolerance, and regression back to *exclusive* tube feeding.[83,94,168-170] Our finding may challenge this approach, as our data are suggestive that the duration of *exclusive* tube feeding (prior to the initiation of oral feeding) might not interfere with later OFS. An accurate assessment prior to the initiation of oral feeding is crucial to avoid the trial and error approach and ensure infants' ability to oral feed safely and efficiently.

At our one-time oral feeding evaluation, there was no correlation between duration of tube feeding (either *total* or *exclusive*), orally-directed behaviors (pre-feeding), alert behavioral states (pre- and intra-feeding), or nutritive sucking. Our finding was reassuring in that the duration of tube feeding may not be correlated with the infants' ability to demonstrate these behaviors after tube feedings were discontinued.

This finding is limited by the one-time assessment of oral feeding within 48 hours after the removal of tube feedings. Our finding provides the observations after the feeding tube is discontinued while previous research showed that the presence of a feeding tube during oral feeding was associated with lower minute ventilation, tidal volume, pulse rate, oxygenation, nutritive sucking pressure, oral intake,[158,159] and immature non-nutritive sucking patterns.[160]

In this analysis, it was not surprising that the mean duration of tube feeding (*total* and *exclusive*) significantly varied between infants with different NMI classifications. The duration of tube feeding is dependent on the infant's health status.[89,141] Additionally, various infant characteristics have been previously associated with duration of tube feedings, OFS, behavioral states, orally-directed behaviors, and nutritive sucking.[84,131,175] In the literature, younger gestational age (GA) and post-menstrual age (PMA) correlate with a lower proportion of time spent in alert behavioral states, immature sucking patterns, lower rate of transfer, and smaller bolus size.[84,131,175] Prolonged feeding transition in preterm infants is predicted by younger GA, lower birthweight, younger PMA at first oral feeding, and higher morbidity score.[84] Thus, it was expected that younger GA and lower birthweight would be significantly correlated with longer duration of tube feeding. Interestingly, birthweight was the only significant covariate in the relationship between duration of tube feeding and OFS, after controlling for duration of tube feeding. The finding indicated that the smaller infants in our study had higher OFS. In our sample, 14.29% of the infants were diagnosed with IUGR. While their birthweight was low, the GA may have been higher, influencing maturity and improved OFS. Furthermore, we speculated that the smaller infants were anticipated by staff to be at risk for oral feeding difficulty. Thus, the smaller infants (when compared with larger infants) may have received more comprehensive assessments and interventions, playing a crucial role in facilitating their OFS. The roles of infant characteristics in the relationship between duration of tube feeding and OFS warrant further investigation.

F. Limitations

This study has several limitations. The generalizability of the findings is limited by the small sample size and the use of one study site. The findings are further limited to clinically-stable infants born between 28 to 32 weeks GA, primarily of African American and Latino ethnicity, who had at least one week of tube feeding. The small sample size may also reduce the power to detect a small effect, thus it may limit our ability to identify significant correlations between duration of tube feeding with other outcomes in our hypotheses as well as the significance of other covariates. Independent and dependent variables were measured simultaneously, and therefore we cannot make any conclusions about a causal effect or its direction. Additionally, there were numerous extraneous factors that were not collected (e.g., nurse/patient ratio, nurses' feeding techniques, activities/unit flow around feeding, number of oral feeding attempts, type of milk, or oral/sensory stimulation). These extraneous factors may play an important role in OFS and should be carefully considered in future studies.

The data used to test our secondary hypotheses were limited by the cross-sectional design. The data were obtained at a one-time observation and may be more reflective of the infants' oral feeding readiness and skills upon the achievement of OFS. In order to explore the relationship between duration of tube feeding and its potential effect on oral feeding readiness and skills during the transition from tube to oral feeding, a longitudinal design with repeated measures is necessary.

G. Implications for 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.[85,115,163-167] 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.[48,92,105,106,117,179,191-200] 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,[83,94,109,168-173] should be considered to facilitate an individualized feeding plan and support infants during the transition from tube to oral feeding.

H. Implications for 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 [126] and the Neonatal Oral-Motor Assessment Scale (NOMAS).[127] Particularly, the NOMAS was originally designed for full-term infants, so its validity, when applied in preterm infants, has been questioned.[128-130] There are quantitative measures of non-nutritive and nutritive sucking patterns that objectively assess the infants' oral feeding skills.[23,52,134-138] 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.[139,140] 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.

Table IV

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 V

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 VI

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 VII

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 VIII

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 IX

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 3. Study Timeline

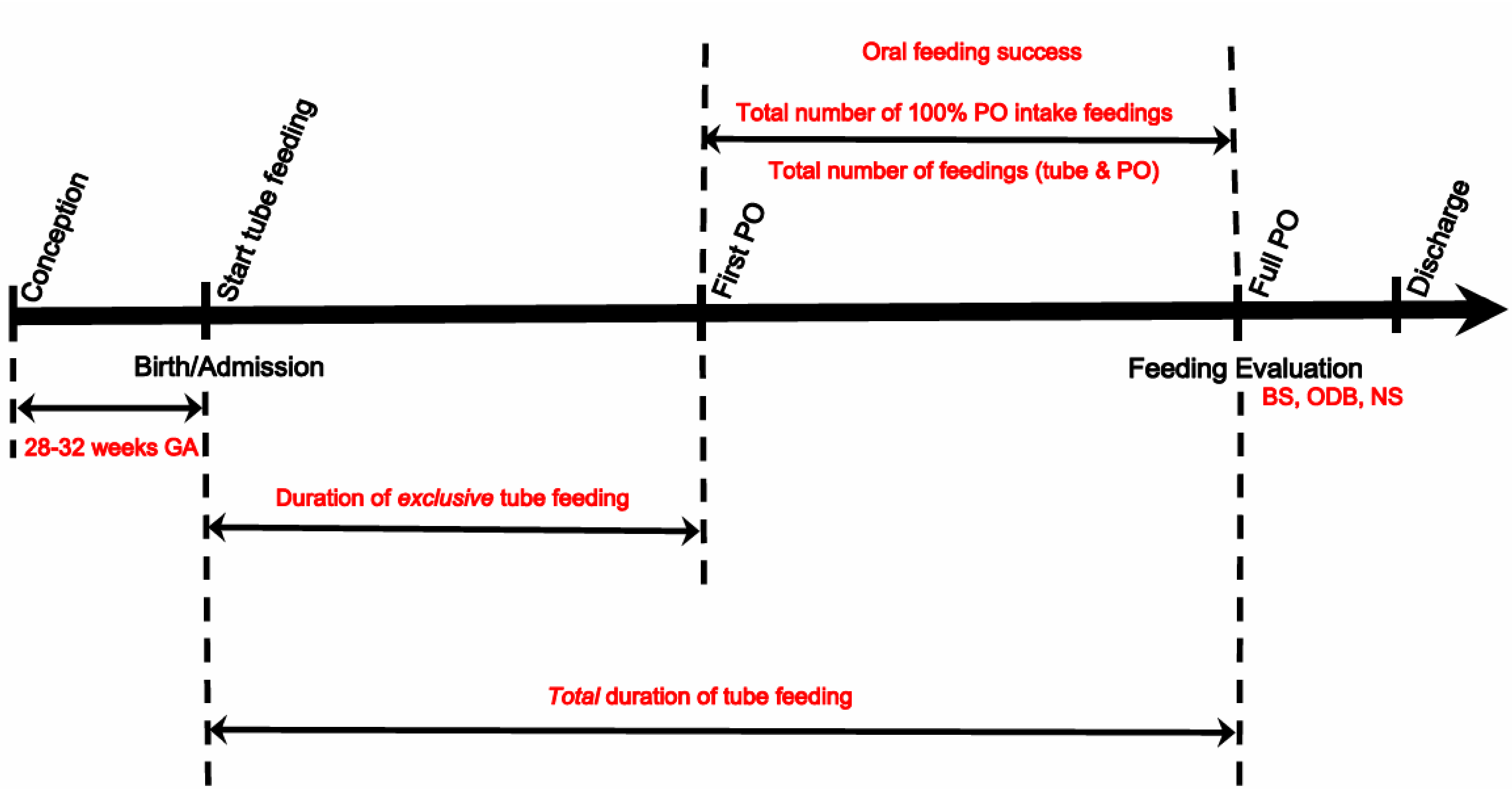
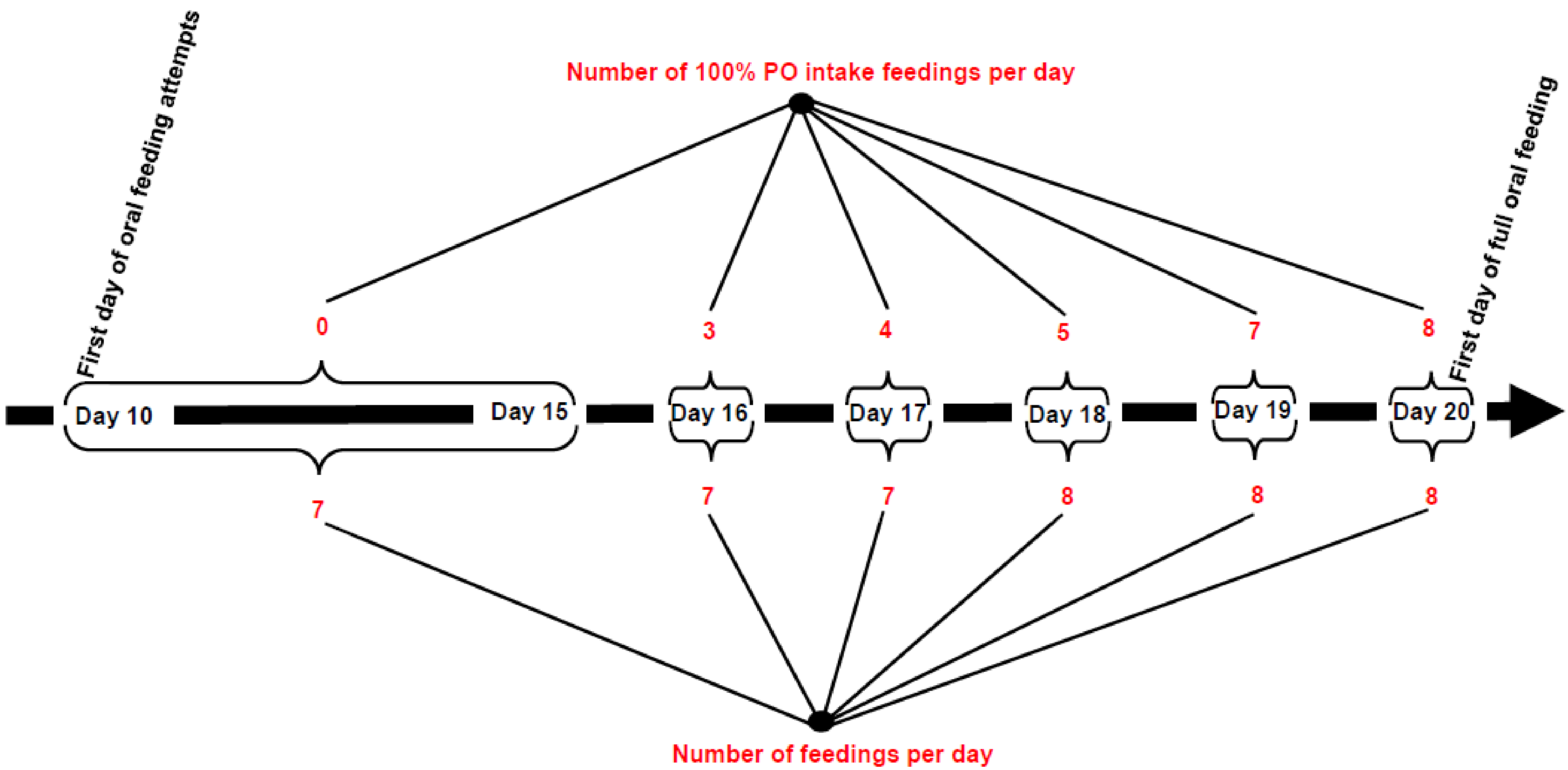


Figure 4. Example Calculation of Oral Feeding Success for a Preterm Infant



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

Figure 5. Neonur Feeding System

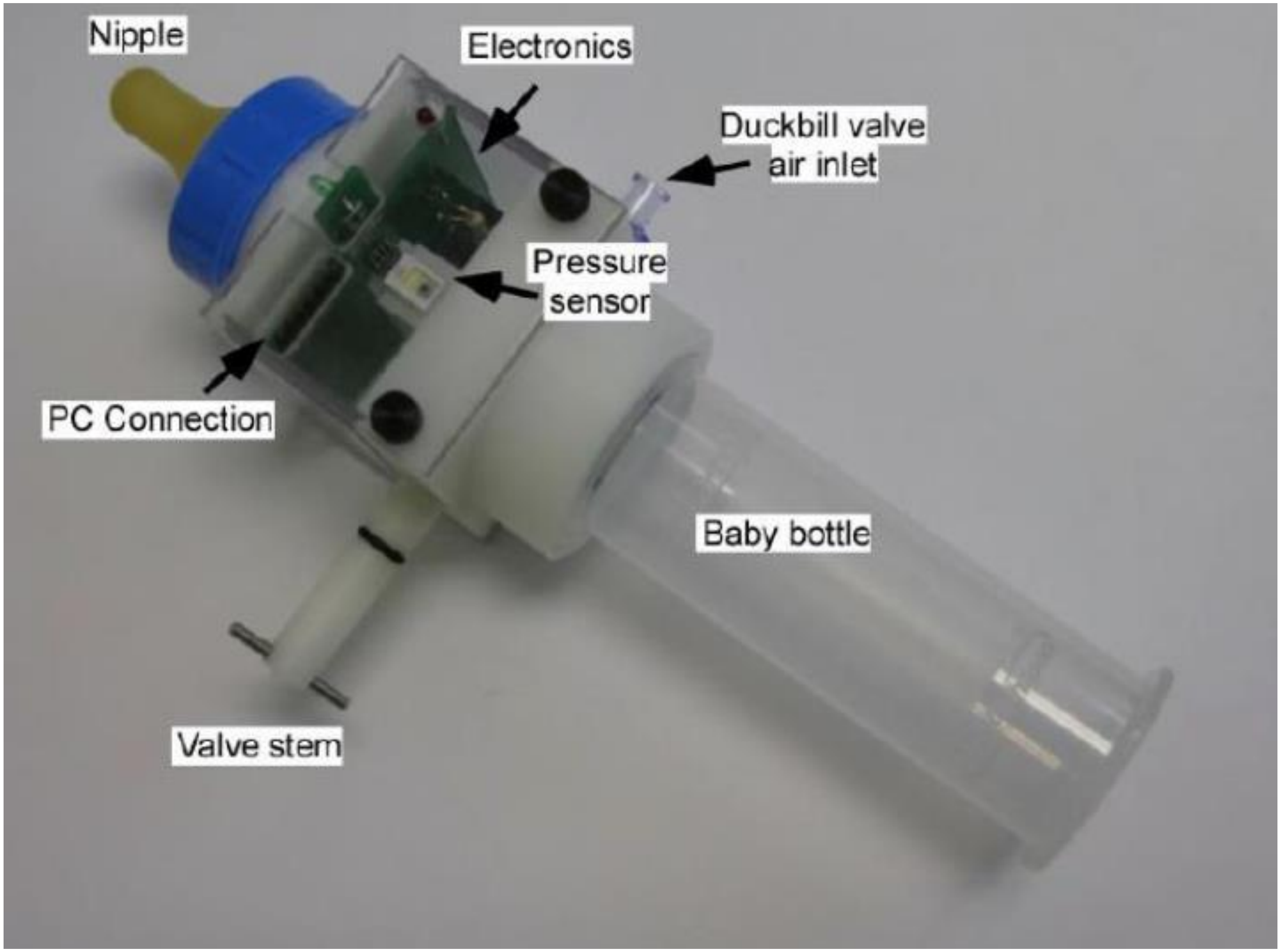
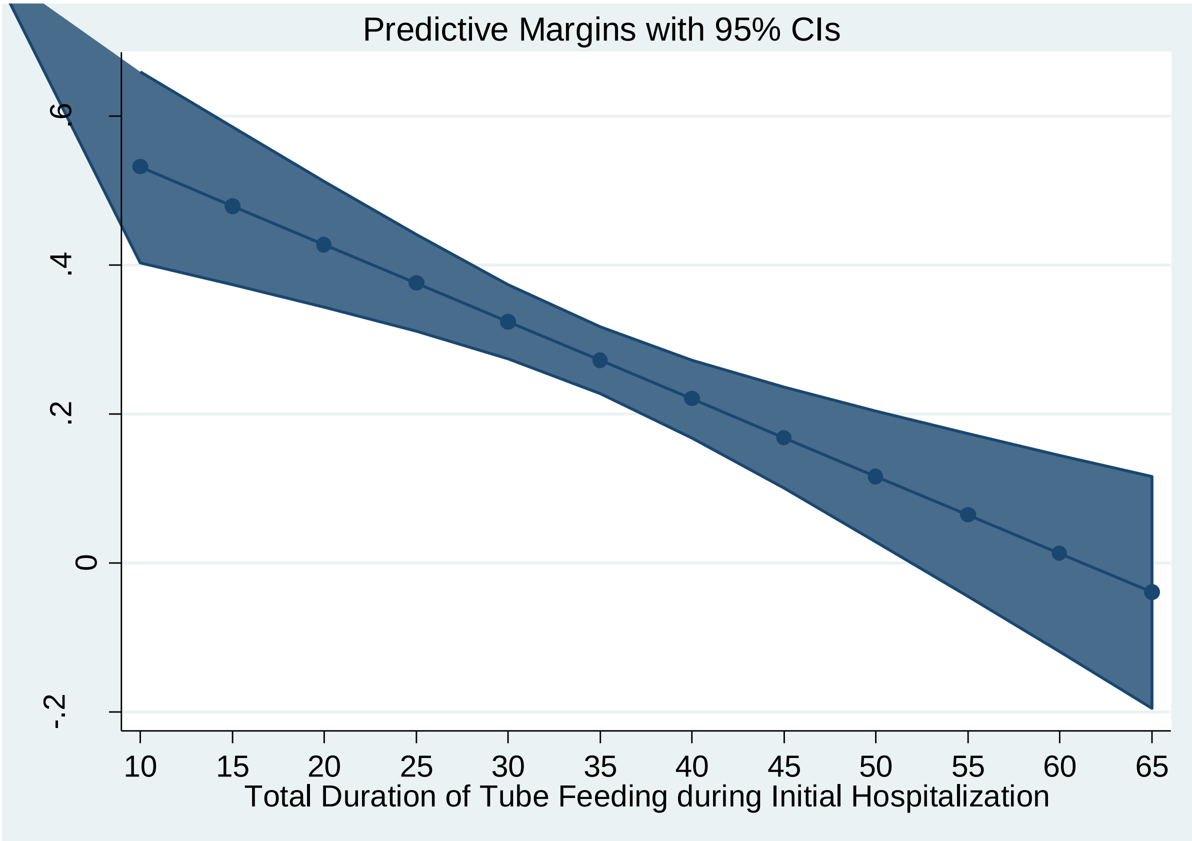


Figure 6. The Relationship between *Total* Duration of Tube Feeding and Oral Feeding Success in Preterm Infants



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APPENDICES

Appendix A. IRB Approval

UNIVERSITY OF ILLINOIS
AT CHICAGO

Office for the Protection of Research Subjects (OPRS)
Office of the Vice Chancellor for Research (MC 672)
203 Administrative Office Building
1737 West Polk Street
Chicago, Illinois 60612-7227

Approval Notice
Initial Review (Response to Modifications)

March 18, 2016

Thao Griffith, BSN
Women, Child, & Family Health Science
7647 W Balmoral Ave
Chicago, IL 60656
Phone: (773) 617-3473

RE: Protocol # 2016-0116
"The Relationship between Duration of Tube Feedings and Quality of Oral Feeding in Preterm Infants"

Dear Ms. Griffith:

Your Initial Review (Response to Modifications) was reviewed and approved by the Expedited review process on March 18, 2016. You may now begin your research.

Please note the following information about your approved research protocol:

Protocol Approval Period:	March 18, 2016 - March 18, 2017
Approved Subject Enrollment #:	40
Performance Sites:	UIC
Sponsor:	a) UIC College of Nursing PhD Student Research Award; b) Alpha Lambda Chapter Research Award; c) Sigma Theta Tau International; d) Midwest Nursing Research Society; e) National Association of Neonatal Nurses
PAF#:	a) Not Applicable; b) Not Applicable; c) 2015-05421; d) 2015-02761; e) 2015-07094
Grant/Contract No:	a) Not Applicable; b) Not Applicable; c) Not Applicable; d) Not Applicable; e) Pending

Grant/Contract Title: a) Not Applicable; b) Not Applicable; c) Sigma Theta Tau International Small Grants; d) Midwest Nursing Research Society Dissertation Grant; e) NANN Research Based Small Grant

Appendix A. IRB Approval (Continued)

Research Protocol:

a) The Relationship between Duration of Tube Feedings and Quality of Oral Feeding in Preterm Infants; Version 2, 02/29/2016

Recruitment Material:

a) Brochure: The Infant Feeding Quality Research; Version 2, 02/29/2016

Informed Consent:

a) Waiver of Documentation of Consent granted for incidental participation of NICU Nurses [45 CFR 46.117(c)]. Nurses will be videotaped while feeding infants, whose feedings are observed for research purposes; no data will be collected for NICU nurses. The videotaping process will be explained to the nurses prior to the feeding observation period.
b) Alteration of Informed Consent granted for incidental participation of NICU Nurses [45 CFR 46.116(d)]. Nurses will be videotaped while feeding infants, whose feedings are observed for research purposes; no data will be collected for NICU nurses. The videotaping process will be explained to the nurses prior to the feeding observation period.

Parental Permission:

a) Consent/Parental Permission form: The Relationship between Duration of Tube Feedings and Quality of Oral Feeding in Preterm Infants; Version 2, 02/29/2016
b) Waiver of Informed Consent/Parental Permission granted [45 CFR 46.116(d)] for the identification of potential subjects in the recruitment phase of the research.

HIPAA Authorization:

a) HIPAA Authorization form: The Relationship between Duration of Tube Feedings and Quality of Oral Feeding in Preterm Infants; Version 1, 01/18/2016
b) Review Preparatory to Research acknowledged [45 CFR 164.512(i)(1)(ii)]

Additional Determinations for Research Involving Minors:

The Board determined that this research satisfies 45 CFR 46.404, research not involving greater than minimal risk. Therefore, in accordance with 45 CFR 46.408, the IRB determined that only one parent's/legal guardian's permission/signature is needed. Wards of the State may not be enrolled unless the IRB grants specific approval and assures inclusion of additional protections in the research required under 45 CFR 46.409. If you wish to enroll Wards of the State contact OPRS and refer to the tip sheet. In addition, a waiver of parental permission has been granted under 45 CFR 46.116(d) for review of medical records for the purpose of identifying potential subjects.

Your research meets the criteria for expedited review as defined in 45 CFR 46.110(b)(1) under the following specific categories:

(4) Collection of data through noninvasive procedures (not involving general anesthesia or sedation) routinely employed in clinical practice, excluding procedures involving X-rays or microwaves. Where medical devices are employed, they must be cleared/approved for marketing. (Studies intended to evaluate the safety and effectiveness of the medical device are not generally eligible for expedited review, including studies of cleared medical devices for new indications.)

(5) Research involving materials (data, documents, records, or specimens) that have been collected, or will be collected solely for nonresearch purposes (such as medical treatment or diagnosis).

(6) Collection of data from voice, video, digital, or image recordings made for research purposes.

Appendix A. IRB Approval (Continued)

(7) Research on individual or group characteristics or behavior (including but not limited to research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

Please note the Review History of this submission:

Receipt Date	Submission Type	Review Process	Review Date	Review Action
02/03/2016	Initial Review	Expedited	02/25/2016	Modifications Required
03/02/2016	Response To Modifications	Expedited	03/18/2016	Approved

Please remember to:

→ Use your **research protocol number** (#2016-0116) on any documents or correspondence with the IRB concerning your research protocol.

→ Review and comply with all requirements on the guidance,
"UIC Investigator Responsibilities, Protection of Human Research Subjects"
(http://tigger.uic.edu/depts/ovcr/research/protocolreview/irb/policies/0924.pdf)

Please note that the UIC IRB has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

Please be aware that if the scope of work in the grant/project changes, the protocol must be amended and approved by the UIC IRB before the initiation of the change.

We wish you the best as you conduct your research. If you have any questions or need further help, please contact OPRS at (312) 996-1711 or me at (312) 413-3202. Please send any correspondence about this protocol to OPRS at 203 AOB, M/C 672.

Sincerely,

Teresa D. Johnston, B.S., C.I.P.
Assistant Director
Office for the Protection of Research
Subjects

Appendix A. IRB Approval (Continued)

Enclosures:

(Please note that stamped and approved .pdfs of all recruitment and consent documents will be forwarded as an attachment to a separate email. OPRS/IRB no longer issues paper letters and stamped/approved documents, so it will be necessary to retain the emailed documents for your files for auditing purposes.)

1. **Parental Permission:**
   a) Consent/Parental Permission form: The Relationship between Duration of Tube Feedings and Quality of Oral Feeding in Preterm Infants; Version 2, 02/29/2016
2. **HIPAA Authorization:**
   a) HIPAA Authorization form: The Relationship between Duration of Tube Feedings and Quality of Oral Feeding in Preterm Infants; Version 1, 01/18/2016
3. **Recruiting Material:**
   a) Brochure: The Infant Feeding Quality Research; Version 2, 02/29/2016

cc: Barbara McFarlin; Women, Children, & Family Health Science; M/C 802
Aleeca Bell, Faculty Sponsor; Women, Children & Family Health Science; M/C 802
OVCR Administration, M/C 672

Appendix B. Research Site's Letter of Support

UIC COLLEGE OF MEDICINE
UNIVERSITY OF ILLINOIS AT CHICAGO

UNIVERSITY OF ILLINOIS
Hospital & Health Sciences System
Changing medicine. For good.

January 19, 2016

Dear IRB at UIC:

I support the work of the nursing doctoral student, Thao Griffith. We look forward to having her conduct this research in the NICU here at CHUI.

The dissertation study is primarily focus on examining the relationship between the duration of tube feedings and the quality of oral feeding. She is interested in testing the hypothesis of whether longer duration of tube feedings is associated with lower quality of oral feeding. The findings may yield critical insights regarding the tube feeding practices as well as the transition from tube to full oral feeding in the NICU.

Sincerely,

Arvind Shukla,MD, FRCPC

Associate Professor Clinical Pediatrics
Interim Chief Division of Neonatology
Children's Hospital of University of Illinois
840 S Wood St
M/C 856
Chicago, IL 60612
Phone: 312-996-4185
Fax: 312-355-5548

Appendix C. Grant Award Letters

Thao Pham
University of Illinois at Chicago
4607 N Sheridan Road Apt 406
Chicago, Illinois 60640

Dear Thao Pham,

On behalf of the MNRS Grant Review Committee and Board of Directors, I am pleased to inform you that you have been selected to receive the 2015 MNRS Dissertation Grant for your submission entitled Tube Feedings and Oral Feeding Success in Preterm Infants. The committee was impressed with your application and program of research. MNRS is proud to count you as one of our own.

You will be recognized at our upcoming Annual Conference in Indianapolis, Indiana, during the MNRS Business Meeting & Awards Presentation. The presentation is scheduled to begin at 5:00pm on Saturday, April 18, 2015. Please plan to attend and be recognized by your colleagues. Note that expenses related to conference attendance are your responsibility. If you do not plan to attend, please advise Sherry Dzurko, MNRS's Assistant Executive Director, via email at sdzurko@mnrs.org as soon as possible. You may ask someone from your university to accept your award for you. If you decide to do that, please let Sherry know who will be attending in your place.

Attached is a reminder of the Grant requirements. Please provide Sherry Dzurko with a copy of your IRB Approval and your College/Universities W9 by Wednesday, February 25, 2015 in order to receive the $2500 funds for your grant at the Conference. If you do not have IRB approval yet, funds will not be released until MNRS has received confirmation of approval.

Lastly, in order to help us publicize your receipt of this grant, please forward Sherry your Biosketch (the NIH form can be used), a short bio (100-200 words) and a photograph by the above noted date. The photo should be a head and shoulder shot, in black and white or color, and high resolution. The photo may be used for publicity purposes at the MNRS Awards Ceremony, in the final program brochure, in the electronic newsletter "Matters," and on our web site post-conference.

Congratulations on this impressive honor!

Sincerely,

Linda M. Herrick

Linda M. Herrick, PhD, RN, FAAN
President, Midwest Nursing Research Society (MNRS)

Appendix C. Grant Award Letters (Continued)

National Association of Neonatal Nurses

April 30, 2015

Thao Pham
University of Illinois at Chicago
College of Nursing
845 S Damen Avenue
Chicago, IL 60612

Dear Thao:

On behalf of the National Association of Neonatal Nurses (NANN), thank you for submitting your application, ***The Effects of Tube Feedings on Preterm Infant Nutritive Feeding Organization,*** for the 2015 Small Grants Award Program. Your application was chosen to receive one of the $5,000 grants. Congratulations! Included are comments regarding your grant submission; please use these constructively as you move forward in conducting your research. Note any revisions that the review committee has requested for your project and if specifically requested, respond back to the NANN office with confirmation that you intend to make these changes **by Thursday, May 14, 2015**.

Each application was reviewed by active neonatal researchers and clinicians. The reviewers noted the high quality of applications submitted and the many strong candidates for research and evidence based practice project funding. Your passion for neonatal nursing is evident as well as your commitment to advancing nursing research.

Requirements in receiving this Small Grants Award include:

1) Attendance at the 2015 NANN Annual Educational Conference in Dallas, TX on October 22-25, 2015 to personally accept your funding award. NANN is indebted to our corporate sponsors who have generously provided funds to make the NANN Small Grants program a reality. Your personal acceptance of the award allows NANN to publicly acknowledge the generous support of our corporate sponsors, and to encourage other NANN members to apply for future Small Grants. Registration and housing will be open on May 4 and you can save $100 by registering early. Please go to www.nannconference.org to register and secure your hotel reservations.

2) Dedicating at least one hour at the Research Institute Steering Council booth at 2015 NANN Annual Educational Conference to help promote the Small Grants program. A member of the Small Grants Committee will be in contact with you regarding a designated time.

3) Submission of periodic progress reports and updates to a member of the Small Grants Committee who will be assigned to you.

4) Submission of an abstract of findings from your Research or Evidence Based Project for the 2017 NANN Annual Educational Conference. Your submission will automatically be accepted, but does need to be entered into the abstract portal. The Call for Abstracts will open in early July 2016.

Appendix C. Grant Award Letters (Continued)

5) Attendance and presentation of the findings from your Research or Evidence Based Project at the 2017 NANN Annual Educational Conference.

6) Return of any unused/unneeded funds that remain after December 31, 2017.

If you are unable to meet any of the above requirements your funding may be rescinded.

For funds to be distributed to you at the 2015 NANN Annual Educational Conference in September, we must have proof of IRB review. We expect that you should have IRB approval no later than August 1, 2015. Please submit IRB documentation to the NANN offices as soon as possible [Attention: Stephanie Wimmerstedt, swimmerstedt@nann.org]. While the Small Grants Committee appreciates that IRB delays are possible and often out of the investigator's control, if you are unable to provide documentation of IRB approval by March 1, 2016 your funding award can be rescinded.

Your award will be announced during a certificate presentation at the Opening General Session on Friday, October 23 at 8:00 AM. Please be seated by 7:45 AM in the front of the general session room so that you can easily make your way to the stage to receive your certificate.

Please email Stephanie Wimmerstedt, swimmerstedt@nann.org to confirm your acceptance of this grant **by Thursday, May 14, 2015**, along with a photo of yourself to include in the Conference Program Book. At that point, you will have someone 'assigned' to you from the NANN Small Grants Committee as a point of contact for you and your mentor.

Sincerely,

Elizabeth A. Damato

Elizabeth Damato, PhD RN CPNP
Chair, Small Grants Committee

Appendix C. Grant Award Letters (Continued)

Sigma Theta Tau International
Honor Society of Nursing

550 West North Street
Indianapolis, Indiana 46202
stti@stti.iupui.edu
www.nursingsociety.org

Phone	317.634.8171
Fax	317.634.8188
U.S./Canada	888.634.7575
International	+800.634.7575.1

Tuesday, 19 January 2016

Congratulations, Thao Pham, BSN:

On behalf of Sigma Theta Tau International, I am pleased to inform you that your proposal, "The Effects of Tube Feedings on Preterm Infant Nutritrive Feeding Organization", has been selected to receive the 2014 Sigma Theta Tau International Small Grants in the amount of $5000.

Your grant funding period begins on Monday, 1 June 2015 and ends on Tuesday, 31 May 2016. Please note that funding is not retroactive. Expenditures made before Monday, 1 June 2015 will not be covered by this grant. Final reports are due to honor society headquarters 90 days after the end of the funding period. The funding period ends Tuesday, 31 May 2016. Once your final report is received, the remaining $500 of your grant will be sent. Guidelines for completing the final report can be found on the society's Web site at:

http://www.nursingsociety.org/advance-elevate/research/research-grants/guidelines-for-preparing-the-grant-final-report-for-the-honor-society-of-nursing-sigma-theta-tau-international

Along with sending your final report, we would like for you to include a short testimonial on how receiving the grant has helped you with your research. This information can be in the form of an email, or as a word attachment and sent to tonna@stti.org.

Grant recipients must submit a full report (i.e., grey literature: the working paper, progress report, etc.) of their investigation/research results to the Virginia Henderson Global Nursing e-Repository. Grant recipients retain full copyright to all works submitted to the repository and may choose to distill/refine the information contained in the working paper and submit an article/book manuscript to the journal/publisher of their choice for tenure and/or promotion purposes. Most publishers do not consider the public dissemination of grey literature to be "prior publishing." If the grant recipient is working with a publisher and has concerns about submitting the full report to the repository, an embargo period may be requested to avoid perceived interference with the journal/book publication process. Embargo periods will be considered on a case-by-case basis and will not extend beyond industry standards. The repository will display general item information during the embargo period, but the full-text attached file will not be accessible to the public for a set period of time. To submit a full report or for additional information, visit www.nursingrepository.org and select the "Get Started" tab. If you have additional questions, contact Kimberly Thompson, repository manager, by phone at 888.634.7575 888.634.7575 FREE (U.S./Canada toll-free) or via email at repository@stti.org.

Appendix C. Grant Award Letters (Continued)

In order to process your grant funds, you **must** complete the grant acceptance information found by linking to the following site:

http://stti.grant.confex.com/stti_grant/december1415/speakerscorner.cgi

If you are awarded additional funding for the same budget items covered in your Sigma Theta Tau International Small Grants, contact Tonna Thomas at the honor society (research@stti.iupui.edu). All funding agencies to which you have submitted your proposal need to be notified of the receipt of this grant.

The reviewers' comments about your proposal are available by going to:

http://stti.grant.confex.com/stti_grant/december1415/app/papers/reviewercomments.cgi?recordid=10462&password=139707

We wish you success in your study and look forward to the contribution your work will make to the discipline of nursing and to health care.

If your grant funding check will be issued to you as an individual and you in North America, please contact Tonna M. Thomas at tonna@stti.iupui.edu to request a W9 form. Checks will **not** be issued without this information. Please check with your tax advisor for clarification regarding research grants and personal gross income.

Kind Regards,

Tonna M. Thomas
Grants Coordinator

Appendix C. Grant Award Letters (Continued)

UIC COLLEGE OF NURSING
UNIVERSITY OF ILLINOIS AT CHICAGO

University of Illinois at Chicago | College of Nursing
845 S. Damen Ave. (M/C 802)
Chicago, IL 60612

February 20, 2015

Dear Ms. Pham;

Congratulations! You have been awarded the **College of Nursing PhD Student Research Award** in the amount of $750. Please plan to attend the Awards Presentation portion of our Nursing Research Day on Friday March 6th at the Student Center West (2nd floor) at 11:40 AM. Of course, you are welcome to attend all morning!

The **College of Nursing PhD Student Research Fund** supports doctoral students by providing financial assistance with the direct costs of their dissertation research. As a condition to receive this support, you must write a letter of appreciation to **CON PhD Student Research Donors.** This letter will allow you to demonstrate your appreciation of the research award and share some information about yourself, such as a discussion of the degree you are pursing, your career goals and aspirations, why you have chosen nursing and how the research award will or has been utilized. **Please forward this letter to *Susan Littau, Office of Research Facilitation*** via email attachment: slittau@uic.edu **no later than Monday, March 23rd** Please copy Sara Almassian (salmas1@uic.edu) as well.

Each year, the College publicizes lists the scholarship and research award. We would greatly appreciate if you could send a digital photo of yourself to include in our publicity; **please send your high resolution photo to Sara Almassian at salmas1@uic.edu.**

Your scholarship may only be used to cover your cost of attendance (tuition and fees, living expenses, books/supplies, housing) as determined by the Office of Financial Aid and may not be used to supplant any other gift aid (i.e. grants, other scholarships) that you may be receiving. If you are receiving financial aid, federal regulations require that you report your scholarship award to the Office of Financial Aid as this will be taken into account when determining your financial aid eligibility. Students with no remaining financial need, or who have been awarded grants only may be ineligible to receive the scholarship funds. Once the Office of Student Financial Aid (OSFA) has determined a student's eligibility for the scholarship, they will make the necessary adjustments to the student's financial aid prior to disbursement of the scholarship. These adjustments may preclude the scholarship from being refunded to the student. Students are encouraged to view their E-award, which is their electronic financial award letter, and their billing statement periodically throughout the semester.

Your scholarship award will be processed through the Financial Aid Office in late March/early April. If you have a balance on your account, the scholarship award will first be applied to those charges.

I wish you much success in your studies for this semester at the UIC College of Nursing and in your future career as a nurse leader. As a future alumna, hopefully you will consider supporting College of Nursing students – as friends of the College are helping you to achieve your personal and professional goals through this award.

Congratulations again on your award!

Sincerely,

Holli DeVon

Holli DeVon, PhD, RN
Associate Professor
Chair, Research Committee

www.uic.edu/nursing

Appendix C. Grant Award Letters (Continued)

Dear Thao,

On behalf of the STTI Board I am happy to inform you that you have been awarded $1,500 for your research project.

We will be presenting the checks at our Nurse's Week Celebration on Thursday, May 14th. Please let me know if you can attend. If not, we will make other arrangements to get the check to you that week.

Dr. Lauren Vacek

Dear Aleeca,

I am pleased to inform you that your advisee, Thao Pham, is receiving one of three monetary awards for 2015 from the Alpha Lambda Chapter of STTI. Thao is receiving a check for $1,500.

We will be presenting the checks to our awardees on Wed. May 5th at 12 noon at UIH hospital. This is an annual lunch sponsored by Alpha Lambda in honor of Nurse's Week.

On behalf of the Alpha Lambda Board I would like to invite you to attend if you are available.

Best,
Lauren Vacek
President-elect, UIC CON Alpha Lambda Chapter of STTI

VITA

Thao Griffith, PhD (Candidate), BSN, RN

Curriculum Vitae
7647 W. Balmoral Avenue
Chicago, Illinois 60656
773-617-3473
thaogriffith@gmail.com

ACADEMIC BACKGROUND

2017 (anticipated)	Ph.D. University of Illinois at Chicago, College of Nursing, Chicago, IL GPA: 3.8/4.0
2012	B.S.N. University of Illinois at Chicago, College of Nursing, Chicago, IL GPA: 3.9/4.0

PROFESSIONAL EXPERIENCE

2015-Present	Research Assistant Children's Hospital of Wisconsin, Milwaukee, WI Early Behavioral Predictors of Oral Feeding for Infants Who Received Non-Oral Feedings PI- Rosemary White-Traut
2016	Graduate Research Assistant University of Illinois at Chicago, College of Nursing, Chicago, IL Infant Massage Study to Improve Mother-Baby Synchrony PI- Aleeca Bell
2012-2015	Graduate Research Assistant University of Illinois at Chicago, College of Nursing, Chicago, IL Hospital to Home: Optimizing the Infant's Environment (R01) PI- Rosemary White-Traut
2012-2013	Registered Nurse Pediatric Health Associates, Naperville, IL
2011-2012	Undergraduate Research Assistant University of Illinois at Chicago, College of Nursing, Chicago, IL Hospital to Home: Optimizing the Infant's Environment (R01) PI- Rosemary White-Traut
2011	Student Nurse Intern Shriners Hospital for Children, Chicago, IL
2008-2010	Rehabilitation Care Assistant Marianjoy Rehabilitation Hospital, Wheaton, IL

TEACHING EXPERIENCE

2017-Present	Teaching Assistant, Pharmacology, UIC College of Nursing Graduate Entry MS students
2016	Teaching Assistant, Skills Laboratory and Theory for Introduction to Clinical Concepts and Processes, UIC College of Nursing BSN students
2016	Guest lecture, Stress, Coping, & Spirituality for Introduction to Clinical Concepts and Processes, UIC College of Nursing BSN students

RESEARCH FUNDING

2015-Present

The Relationship between Duration of Tube Feedings and Quality of Oral Feeding in Preterm Infants (**PI-Thao Griffith**)
National Association of Neonatal Nurses Research Based Small Grant ($5000)
Sigma Theta Tau International Small Grants ($5000)
Midwest Nursing Research Society Dissertation Grant ($2500)
University of Illinois College of Nursing Research Award ($750)
Sigma Theta Tau International Alpha Lambda Chapter Research Award ($1500)

PUBLICATIONS

Articles: (*Peer-reviewed data-based)

*White-Traut, R., Li, L., Norr, K., Rankin, K., Campbell, S.K., **Griffith**, T., Vasa, R., Geraldo, V. (2017). Do orally directed behaviors mediate the relationship between behavioral states and nutritive sucking in preterm infants? *Early Human Development,* 109, 26-31.

***Griffith**, T., Rankin, K., White-Traut, R. (2016). The Relationship between Behavioral States and Oral Feeding Efficiency in Preterm Infants. *Advances in Neonatal Care, 17*(1), E12-E19*.*

*White-Traut, R., **Pham**, T., Shapiro, N., Liu, L., & Rankin, K. (2014). Preterm infants' orally directed behaviors and behavioral state responses to the integrated H-HOPE intervention. *Infant Behavior and Development, 37*(4), 583-596.

*White-Traut, R, **Pham**, T., Rankin, K., Norr, K., Shapiro, N., & Yoder, J. (2013). Exploring factors related to oral feeding progression in premature infants. *Advances in Neonatal Care, 13*(4), 288-294.

Oral presentations: (Presenting author underlined)

***Griffith**, T., Rankin, K., White-Traut, R. (2016). *The Relationship between behavioral states and oral feeding efficiency in preterm infants.* Paper symposium, Midwest Nursing Research Society Conference, Milwaukee, WI.

Research posters presented

*White-Traut, R., Simpson, P., PhD; Delaney, A., Mussatto, K., Silverman, A., Uhing, M., Gralton, K., **Griffith**, T. (2015). *Early behavioral predictors of oral feeding for infants who received non-oral feedings*. Poster presentation, Midwest Nursing Research Society Conference, Milwaukee, WI.

***Pham**, T., White-Traut, R., Rankin, K., Norr, K., & Shapiro, N. (2012). *Exploring factors related to oral feeding progression in premature infants*. Poster presentation, Midwest Nursing Research Society Conference, Dearborn, MI.

HONORS & AWARDS

2012	Bachelor of Science in Nursing distinction of Magna Cum Laude
2012	Honor College Graduate
2012	Sigma Theta Tau International Evidence-based Research Poster Award
2010-Present	College of DuPage Student Spotlight
2009	Honorable Bonnie M. Wheaton Scholarship

PROFESSIONAL MEMBERSHIPS

2015-Present	National Association of Neonatal Nurses (NANN), Member
2012-Present	Sigma Theta Tau International (STTI), Alpha Lambda Chapter Member
2012-Present	Midwest Nursing Research Society (MNRS), Member

PROFESSIONAL LICENSURES & CERTIFICATIONS

2012-Present	Illinois Registered Nurse
2015-Present	Wisconsin Registered Nurse
2009-Present	American Heart Association Basic Life Support

PROFESSIONAL & COMMUNITITY SERVICE ACTIVITIES

2014-2015	Graduate Student Nurses Organization Research Committee Representative University of Illinois at Chicago, College of Nursing, Chicago, IL
2014-2015	Sigma Theta Tau International Alpha Lambda Chapter Student Liaison University of Illinois at Chicago, College of Nursing, Chicago, IL
2012	Volunteer Y-Me National Breast Cancer Organization, Chicago, IL
2012	Volunteer Family Health Fair Screening at Faith Monument Church, Hosted by University of Illinois Hospital and Health Sciences System, Chicago, IL
2011	Volunteer Back to School Health Fair at UIC Student Center West, Hosted by University of Illinois Hospital and Health Sciences System, Chicago, IL