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## DCN Dissertation Proposal: The impact of a pediatric interdisciplinary outpatient feeding clinic on preterm infant weight gain and caregiver compliance with feeding recommendations

Doretta Leung  
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The impact of a pediatric interdisciplinary outpatient feeding clinic on preterm  
infant weight gain and caregiver compliance with feeding recommendations

By: **Doretta Leung, MS, RD, LD/N, CLC**

DCN DISSERTATION PROPOSAL submitted in partial fulfillment of the requirements of the  
degree of Doctorate in Clinical Nutrition



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This team has been meeting monthly since October 2019. In March 2020, we began holding these meetings virtually to reduce the spread of COVID-19.

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## ABSTRACT

Early nutrition intervention along with interdisciplinary care is important for premature infants because malnutrition often leads to poor growth in this population.<sup>1,2</sup> Poor growth in preterm infants results in subsequent neurocognitive development as there is an association between deficient postnatal growth and poor neurologic outcome up to age 19.<sup>1,2</sup> It is important to focus on an infant's nutrition, feeding, and any gastroenterology concerns after hospital discharge to prevent poor growth. Most importantly, it is essential to have an interdisciplinary care monitoring infant care and outcomes in an outpatient setting; however, this service is lacking in Northeast Florida. The newly developed pediatric interdisciplinary feeding clinic (within Nemours Children's Health and Wolfson's Rehab) aims to provide prompt care to preterm infants. To determine the impact of the feeding clinic, the study plans to review preterm infants' nutritional status in the feeding clinic group (e.g., change in z-score of weight-for-length and change in z-score of weight-for-age) and compare to retrospective data of a similar study population, preterm infants who are in the current setting (multidisciplinary care) and not enrolled in the feeding clinic in six months period. In turn, it is hypothesized that infants enrolled in the newly developed pediatric interdisciplinary outpatient feeding clinic will have greater improvements in markers of nutritional status when compared to those infants not enrolled in the feeding clinic. This study will also evaluate the incidence of malnutrition within the study population by categorizing it into malnutrition and non-malnutrition groups. This study will utilize a retrospective-prospective before-after study design. In addition, this study will evaluate caregiver compliance with health care provider recommendations between the groups. Ultimately, this study aims to determine the benefits of a newly developed pediatric interdisciplinary outpatient feeding

clinic composed of a Gastroenterology Nurse Practitioner, Registered Dietitian, and Feeding Pathologist. The results from the study will hopefully provide a glimpse of the nutrition-related benefits of an infant feeding clinic, which may lead to potential funding for future expansion.

## CHAPTER 1 - LITERATURE REVIEW

### *Introduction on Infant Feeding*

Appropriate infant feeding is critical for the improvement of child survival worldwide.<sup>3</sup> In fact, the first 1000 days of life are considered the crucial window for childhood growth and development.<sup>3</sup> Inappropriate complementary feeding is one of the major causes of malnutrition in children under the age of 5 years.<sup>3</sup> Nutrition is a major factor contributing to healthy weight gain. The World Health Organization (WHO), American Academy of Pediatrics (AAP), and Academy of Nutrition and Dietetics (AND) recommend an exclusively human milk diet for healthy, term infants for the first 6 months of life.<sup>4,5</sup> Human milk offers specific advantages as it consists of various components, including a true solution, colloidal dispersions of casein molecules, emulsions of milk fat globules and milk fat globule membranes, and live cells, including stem cells.<sup>4</sup> When human milk is not available, iron-fortified cow milk-based infant formulas, labeled as “infant formula with iron” are preferred for feeding healthy term infants.<sup>4</sup> From birth to months of age, breast milk and/or infant formula is the main source of nutrition for infants.<sup>4</sup>

Infant growth is assessed using the WHO growth chart and rate of weight gain.<sup>4</sup> WHO growth standard charts report percentiles and z-scores on infants and children from 0 to 24 months of age.<sup>6</sup> The growth chart illustrates the distribution of selected body measurements in infants and children in a series of percentile curves.<sup>6</sup> There are three categories of growth charts: weight-for-age, length-for-age, and weight-for-length. The goal is to reach the 50<sup>th</sup> percentile for weight-for-length, as it demonstrates infant or child proportionality when evaluating height and weight. The 50<sup>th</sup> percentile within the weight-for-length chart suggests that the infant or child is in “perfect” proportion. Healthy infants are expected to double their birth weight at six months

and triple their birth weight at twelve months.<sup>5</sup> This pattern can be used as a quick technique to determine infants' nutritional status. Depending on the infant's rate of weight gain, the health professional will determine the appropriate weight (either using current weight or ideal body weight) to use to determine Estimated Energy Requirements (EER).<sup>5</sup> The EER is defined as the average dietary energy intake that is predicted to maintain energy balance in a healthy individual of a defined age, gender, weight, height, and level of physical activity.<sup>5</sup> However, medical conditions, such as prematurity, may affect an infant's ability to feed and may alter the feeding regimen to optimize infants' growth.

### **Prematurity**

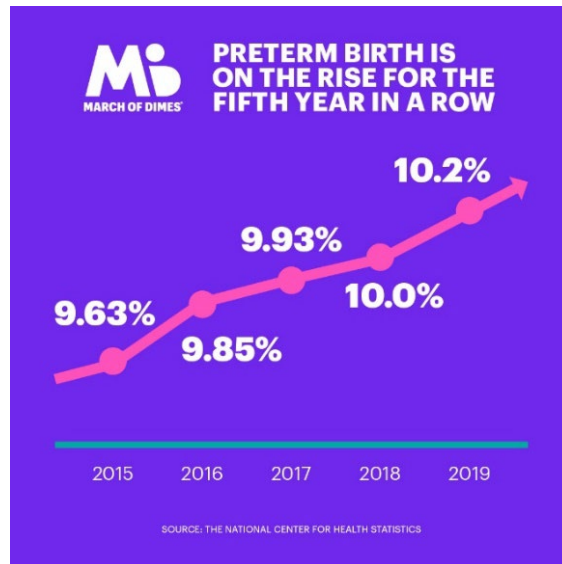
Prematurity is defined as babies born alive before 37 weeks of pregnancy.<sup>7</sup> There are three subcategories on preterm birth determined by gestational age: 1.) extremely preterm (less than 28 weeks), 2.) very preterm (28 to 32 weeks) and 3.) moderate to late preterm (32 to 37 weeks).<sup>8</sup> Most of the prematurity will be in the moderate-to-late preterm subcategories. Feeding support is recommended for preterm infants and is part of the guidelines developed by WHO as an intervention for the newborn baby to prevent future neurological impairments.<sup>8</sup>

Similar to a healthy infant's recommendation, AAP recommends human milk as the preferred source of enteral nutrition for the preterm infant due to the above-mentioned benefits.<sup>4</sup> However, premature infants may require additional nutritional supplementation to ensure adequate growth.<sup>4</sup> Poor growth in preterm infants results in subsequent neurocognitive development as there is an association between deficient postnatal growth and poor neurologic outcome up to age 19.<sup>1,2</sup> The degree of growth restriction combined with increased percent body fat and decreased percent lean body mass composition in preterm infants at term versus term

infants suggests that current practices do not align with promoting optimal growth and body composition in preterm infants.<sup>1</sup> WHO growth charts should be used for preterm infants who are corrected to term age.<sup>9</sup> Corrected age is defined as the child's age from the original due date.<sup>9</sup> Some experts even recommend correcting the age through the age of three.<sup>9</sup> The corrected age will need to be used for both weight-for-age and length-for-age growth charts. Since weight-for-length compares an infant's weight to his or her length, the goal is the same as term infants, which is to reach the 50<sup>th</sup> percentile.

Globally, it is estimated that about 15 million babies per year are born prematurely, which equates to an average of about 10.6% of all live births.<sup>8,10</sup> Over the past few decades, the frequency of premature live births has increased locally in the Northeast area of Florida, as well as worldwide. In 2020, preterm birth rates in Florida were 10.6%. Duval County, the largest county in Northeast Florida, had preterm birth rates of around 11.4%.<sup>11</sup>

**Figure 1.** *The rates of premature birth in Duval County.*



**Figure 1.** *The rates of premature birth in Duval County.<sup>11</sup> The rate of premature births continues to increase in Duval County. In 2020, the rate was 11.4 percent, the highest among the largest counties in Florida. Premature birth is a leading cause of infant mortality in Northeast Florida and across the country and can lead to life-long health issues for infants that survive.<sup>11</sup>*

**Table 1.** The total number of Preterm Births in Duval County between 2009 and 2019<sup>12</sup>

Preterm Births (<37 weeks gestation), Single Year Rates								
	Duval	Duval	Duval	Duval	Florida	Florida	Florida	Florida
Year	Count	Denom	Percent	MOV (+/-)	Count	Denom	Percent	MOV (+/-)
2019	1,499	13,032	11.5	0.5	23,345	220,010	10.6	0.1
2018	1,474	12,971	11.4	0.5	22,680	221,508	10.2	0.1
2017	1,533	13,180	11.6	0.5	22,836	223,579	10.2	0.1
2016	1,508	13,293	11.3	0.5	22,812	225,018	10.1	0.1
2015	1,497	13,041	11.5	0.5	22,396	224,273	10.0	0.1
2014	1,395	12,514	11.1	0.6	21,817	219,905	9.9	0.1
2013	1,342	12,555	10.7	0.5	21,565	215,194	10.0	0.1
2012	1,450	12,456	11.6	0.6	21,798	212,954	10.2	0.1
2011	1,361	12,402	11.0	0.6	22,002	213,237	10.3	0.1
2010	1,446	12,616	11.5	0.6	22,432	214,519	10.5	0.1
2009	1,569	13,176	11.9	0.6	23,337	221,391	10.5	0.1

**Table 1.** The total number of Preterm Births in Duval County between 2009 and 2019<sup>12</sup>  
*The total count and percent of preterm births in Duval County by year.<sup>12</sup> It provides the number of preterm infants and the total number of infants in Duval County in the last 10 years.<sup>12</sup> Data obtained from FLHealthCharts.com.*

- MOV - Measure of Variability: Probable range of values resulting from random fluctuations in the number of events. Not calculated when the numerator is below 5 or denominator is below 20, or the count or rate is suppressed. The MOV is useful for comparing rates to a goal or standard. For example, if the absolute difference between the county rate and the statewide rate is less than the MOV, the county rate is not significantly different from the statewide rate (alpha level = 0.05). When the absolute difference between the county rate and the statewide rate is greater than the MOV, the county rate is significantly different from the statewide rate. MOV should not be used to determine if the rates of two different counties, or the county rates for two different years, are statistically significantly different.<sup>12</sup>
- Denom - abbreviated for Denominator.<sup>12</sup>

### **Relationship Between Prematurity and Malnutrition**

Preterm and neonatal infants are more vulnerable to malnutrition at the beginning of life.<sup>1,13</sup> Factors that contribute to the increased malnutrition risk in this population include reduced nutrient stores, immature nutrient absorption, organ immaturity, delayed advancement in feeds, dependence on health care providers, and periods of rapid growth and development.<sup>13</sup> Ultimately, malnutrition results in poor growth.<sup>1</sup> Feeding problems also occur in 25-45% of non-premature (term) developing children, 70% in premature children, and 80% of those with developmental delays due to chronic medical conditions.<sup>14,15</sup> In addition to feeding complications, various medical conditions can lead to the placement of gastrostomy tubes. A retrospective study from 1997 to 2009 found that national trends have shown a 19% increase in surgical gastrostomy, with the highest increase among children under 1 year of age at 32%.<sup>16</sup> Furthermore, preterm infants are at a high risk of developing neurodevelopmental disability, especially those with malnutrition. The same study above found the prevalence of malnutrition was 20% among the preterm infants reviewed.<sup>17</sup> It is important to assess malnutrition status and provide early intervention as early childhood malnutrition contributed independently to depressive symptoms among youth who experienced significant malnutrition in the first year of life.<sup>18</sup>

Similar to a term infant's assessment, WHO growth standard charts are used to assess the nutritional status of preterm infants using the infant's adjusted gestational age in the weight-for-age and length-for-age growth charts. Weight-for-length is a strong indicator of pediatric malnutrition because it can catch early signs of wasting.<sup>19</sup> In a clinical setting, weight-for-length is the best measurement to determine the nutritional status of premature infants. The weight-for-length's z score is used to categorized malnutrition using the malnutrition guidelines.<sup>20</sup>



Defining, diagnosing, and coding for malnutrition may result in higher insurance reimbursement with the malnutrition coding using International Classification of Diseases (ICD) codes such as E44.1 (mild malnutrition), E44.0 (moderate malnutrition), and E43 (severe malnutrition). The availability of clinical practice guidelines used for coding malnutrition in the general population at institutions (in-patient) increased from 6.7% in 2012 to 100% in 2017.<sup>20</sup> The number of malnutrition patients who did not receive any intervention decreased from 70% in 2012 to 55.6% in 2017 after the appropriate malnutrition diagnosis are made.<sup>20</sup>

Calories and protein intake below age-recommended parameters are also indicators for pediatric malnutrition. Although poor growth may be due to medical complications of prematurity, malnutrition is often a cause.<sup>21</sup> It is important to review the impact of premature births on parents as this may positively alter their ability to improve compliance with recommendations given in a clinical setting.

### **Impact of Premature Births on Parents**

Parental guidance and encouragement are often necessary to ensure appropriate feeding and infant weight gain.<sup>22</sup> Prematurity remains a major public health concern because of its negative impact on infant and childhood morbidity and mortality. Preterm birth-related complications were the second leading cause of child death, after pneumonia, among children under the age of 5.<sup>10</sup> Parents and caregivers are also suffering from exhaustion and situational uncertainty, resulting in stress, sleep disorders, and relationship difficulties with the healthcare professionals.<sup>23</sup> Healthcare professionals often have less than 15 minutes with each patient, resulting in less time to provide the detailed information that parents may need.

The impact of premature births on parents is significant. Some of the parental stressors include separation from the infant, the sight of intravenous or feeding tubes, and the inability to hold their child.<sup>10</sup> On top of that, the parent is required to learn how to follow an individualized feeding regimen. If caregivers delay or miss their follow-up appointment after a hospital discharge, infants often receive the same concentration and volume that the hospital had given weeks or months later. However, this hospital regimen may be inappropriate for growth depending on the length of time between visits. Mothers of preterm newborns endure more severe levels of psychological distress than mothers of full-term babies.<sup>10</sup>

Secondary to health, nutritional, and developmental consequences, pediatric feeding disorders add stress to families. Areas of familial stress reported include social, emotional, and financial.<sup>24</sup> Many parents described the presence of a gastrostomy tube as difficult in that it increases the intensity of a child's care needs and that gastrostomy tube feedings did not have the same emotional component as oral feedings.<sup>24</sup> Feeding difficulties can impact family life and social interactions as parents are concerned about behaviors and the social stigmatism when feeding their child with non-traditional feeding means.<sup>24-26</sup> There are challenges in the relationship between parents of children with feeding disorders and the medical system.<sup>24</sup> While some parents reported positive experiences and good support, other parents described their increased dependence on the medical system as frustrating and filled with challenges, particularly regarding provider communication.<sup>24</sup>

Financial burdens are common due to the loss of ability for a caregiver to work due to limited availability to skilled caregivers, increased medical equipment costs, frequent medical appointments, and higher risk of ER visits and more frequent hospital readmissions.<sup>24,27</sup> Feeding Matters is a non-profit organization whose mission is to improve the system of care for children

with pediatric feeding disorders through advocacy, education, support, and research. In 2019, Feeding Matters published their Economic Impact Study, identifying the economic impact of pediatric feeding disorders on families. The nationwide survey indicated that 76% of respondents indicated that their child's feeding disorder was at least a moderate financial burden and that 79% of the respondents either quit their job or reduced their work responsibilities outside their home to care for their child with feeding disorders.<sup>28</sup>

Other expenses related to their child's feeding disorders included formulas and supplies, therapies and medical copays, and travel for medical appointments. Almost all private insurances do not cover formulas even with medical diagnoses and each insurance policy varies on formula approval. The need for more expensive specialized formulas (e.g., hydrolyzed or elemental formulas) can also cause additional financial stress. When searching on various websites, the cost of standard formula averaging around twenty-five dollars per can to the cost of specialized formula averaging around sixty dollars per can. Furthermore, the Feeding Matters Economic Impact Statement found that 97% of respondents felt stress regarding their child's health and family finances and this stress has resulted in health problems for 62% of caregivers respondents.<sup>28</sup>

Effective communication is integral to achieving quality healthcare.<sup>29</sup> Caregivers need a comprehensive interdisciplinary approach that a feeding clinic can provide to improve their child's health status. Patient-centered communication is defined as a mutual understanding of patients' health needs, values, and perspectives. Patient engagement and following through with care plans have been shown to lead to better health outcomes and higher patient satisfaction.<sup>29</sup> It has also been found that patients who experienced relatively better patient-centered communication with their practitioners resulted in a greater exchange of information.<sup>29</sup>

Effective communication between the health care team and caregivers is important. If caregivers understand the importance of following the recommendations given, weight gain most likely will be improved. Without appropriate weight gain, premature infants may experience lengthy hospitalizations, neurodevelopmental deficits, and hospital readmissions.<sup>30</sup> In turn, this may increase the financial burden on the health care system and their families. The appropriate rate of weight gain is also impacted by how well the infant is taking in the bottle and gastrointestinal symptoms that the infant may be experiencing, this is where the role of different health disciplines plays a part. In the next few sections, the role of gastroenterology medical professional, registered dietitian, and feeding therapist in premature infants will be reviewed.

### **Role of Gastroenterology (GI) Medical Professional in the Care of Premature Infants**

Premature infants frequently will have gastrointestinal problems such as diarrhea, nausea, and vomiting that cause physical distress, especially during and/or after feeding.<sup>31</sup> It is part of gastroenterologists' and gastroenterology nurse practitioners' assessment to diagnose and treat gastroesophageal reflux disease.<sup>32</sup> Additionally, the most frequent gastrointestinal injuries in the assessment during the first months of life in premature infants are colic and vomiting.<sup>33</sup> Then, it is followed by the diarrheal condition that maintained constant intensity throughout the first year.<sup>33</sup> However, the severity of gastrointestinal injuries tends to lessen closer to the infant's first year of life.<sup>33</sup> Necrotizing enterocolitis is a common devastating inflammatory gastrointestinal disease that frequently occurs in premature infants.<sup>34</sup> Gastrointestinal assessment is needed to determine if further testing is needed such as CT scan, upper GI endoscopy, and/or upper GI series.<sup>35</sup> GI professionals also perform abdominal and/or rectal examinations during the visit to complete the assessment.

### **Role of Registered Dietitian in the Care of Premature Infants**

Premature infants require appropriate nutrition to promote weight gain.<sup>31</sup> The nutrition assessment aims to provide support to the high-risk infant through the provision of optimal nutrition.<sup>36,37</sup> The benefits of nutrition assessment to the high-risk infant include accurate growth monitoring for optimal nutrition and growth.<sup>38</sup> The beginning of life is the most critical for premature infants as they remain vulnerable to poor growth and developmental disabilities. Registered dietitians play an important role in the nutritional care of premature infants in a neonatal intensive care unit (NICU), however, the interdisciplinary team approach is missing in an outpatient setting in the Northeast area of Florida.<sup>36</sup> Even though premature infants may achieve the desired rate of weight gain before discharge with intensive dietary management, catch-up growth does not occur until later, which would likely be managed in an outpatient setting.<sup>37</sup> The role of the registered dietitian in an outpatient setting is likely just as important, if not more, than the inpatient setting where around-the-clock assistance is available. Therefore, having the patient follow up with a registered dietitian in an outpatient setting is one of the keys to achieving optimal growth and development in premature infants.

A comprehensive nutrition assessment is performed at visits.<sup>39</sup> This nutrition assessment includes a review of food and nutrition-related history, anthropometric measurements, biochemical data, medical tests and procedures, nutrition-focused physical findings, and patient history.<sup>39</sup> The nutrition-focused physical findings are determined by the nutrition-focused physical exam (NFPE). A registered dietitian reviews the actual rate of weight gain compared to the recommended rate of weight gain. Patient nutritional needs are determined by using the nutrition care process (NCP), a standardized process to identify nutrition-related problems and provide appropriate nutrition intervention.<sup>40</sup> One of the evaluations should be if the current

feeding regimen is achieving the recommended rate of weight gain. Estimated Energy Expenditure (EER) for Infants Through Adolescents is used to calculate energy needs. The EER is defined as the average dietary energy intake that is predicted to maintain energy balance in a healthy individual of a defined age, gender, weight, height, and level of physical activity. Physical activity is not applicable for children under the age of 35 months.<sup>5</sup> For premature infants, a registered dietitian will pick the EER equation using the adjusted infant's gestational age. The below table is extracted from Pediatric Nutrition Reference Guide 12<sup>th</sup> Edition:<sup>5</sup>

**Table 2. Equations to Estimate Energy Expenditure for Infants Through Adolescents**

Age	Estimated Energy Requirement (EER) (kcal/d) = Total Energy Expenditure + Energy Deposition
0-3 mo	$EER = [89 \times \text{weight (kg)} - 100] + 175$
4-6 mo	$EER = [89 \times \text{weight (kg)} - 100] + 56$
7-12 mo	$EER = [89 \times \text{weight (kg)} - 100] + 22$
13-35 mo	$EER = [89 \times \text{weight (kg)} - 100] + 20$
3-8 y	Boys: $EER = 88.5 - 61.9 \times \text{age (y)} + PA \times [26.7 \times \text{weight (kg)} + 903 \times \text{height (m)}] + 20$ Girls: $EER = 135.3 - 30.8 \times \text{age (y)} + PA \times [10 \times \text{weight (kg)} + 934 \times \text{height (m)}] + 20$
9-18 y	Boys: $EER = 88.5 - 61.9 \times \text{age (y)} + PA \times [26.7 \times \text{weight (kg)} + 903 \times \text{height (m)}] + 25$ Girls: $EER = 135.3 - 30.8 \times \text{age (y)} + PA \times [10 \times \text{weight (kg)} + 934 \times \text{height (m)}] + 25$

Registered dietitians use their professional skills to determine if actual or ideal body weight is needed to determine the EER for infants according to the infant's adjusted gestational age and determine if other factors need to be included in the calculation. Many factors are considered in determining the appropriate weight to use. Factors such as trending of weight-for-age, trending of weight-for-length, rate of weight gain, etc.... Ultimately, the registered dietitian's involvement is extremely important to optimize the caloric intake of infants along with the speech pathologist and GI health professional.

### **Role of Feeding Therapist in the Care of Premature Infants**

Premature infants often require supplemental feeding due to a lack of coordination of the suck-swallow-breathe response.<sup>31</sup> Preterm infants exposed to a pacifier during enteral feedings and before bottle feedings are better bottle feeders as they have fewer fussy and awake states, require less time to establish nipple feeds, and settle more quickly after feedings.<sup>31</sup> A speech pathologist/feeding therapist will be able to observe immature suck, safety for oral feeding, and any other mechanical issue that may cause feeding difficulties.<sup>31</sup> A feeding therapist can also assess oral feeding skills related to the type of bottle use, nipple use, and holding angle.<sup>41</sup>

A feeding disorder is associated with unpleasant consequences, such as choking caused by incompetent suck-swallow-breathe responses, or diarrhea, nausea, and vomiting caused by gastrointestinal problems.<sup>31</sup> In fact, infants with feeding disorders often consume insufficient calories or nutrition, which may place them at risk for long-term behavior, health, and learning problems such as learning ability and regression of development physically such as crawling, sitting up, etc... Therefore, the involvement of GI, nutrition, and feeding is needed to provide a comprehensive assessment in premature infants.

### **Early Intervention and Prematurity**

In addition to a comprehensive assessment by different health disciplines, an interdisciplinary approach to effectively treat medical and feeding disorders and early nutrition intervention are also important components. In fact, the nutrition of preterm infants after discharge has assumed new importance due to the catch-up growth needed and is of growing concern.<sup>37</sup> Feeding is a developmental progression. Due to medical complications, these developmental steps are often altered, skipped, or occur with negative stimuli, resulting in

harmful consequences, such as tube dependency with the long-term use of feeding tubes.<sup>42</sup> Tube dependency has been defined as the active refusal to eat (or drink), the lack of motivation or inability to learn to eat by mouth, or showing no precursors of eating development and skills after long-term enteral feeding. Some risk factors for tube dependency include tube placement at a young age, tube feeding during the critical period for feeding skill development and interest in new foods, and the duration of tube feeding.

In a comprehensive review of 700 infants and young children with severe feeding difficulties, Rommell et al<sup>43</sup> found that an interdisciplinary team approach is essential for the assessment and management as combined medical and oral problems are the most frequent cause of pediatric feeding problems. Infants born preterm and/or with a birth weight below the tenth percentile for gestational age are at greater risk for developing feeding disorders.<sup>43</sup> Advocation for early intervention is important in regards to an infant's medical, nutritional, and therapeutic plan.

A study from Jadcherla et al<sup>44</sup> further supports early medical and therapeutic intervention for NICU babies. Regardless of gestational immaturity and respiratory morbidity, the presence of a gastrostomy tube and the inability to attain full-oral feeding milestones at discharge were associated with cognitive, motor, and communicative neurodevelopmental delays at 18-24 months.<sup>44</sup> The requirement of a gastrostomy tube at discharge appears to be an independent predictor of future neurodevelopmental delay after controlling for gestational age and common clinical risk factors.<sup>44</sup> Due to the complex interplay of neurologic and behavioral areas that control feeding and cognitive function, infants who present with delayed aerodigestive milestones are likely to have a greater neurodevelopmental delay.<sup>44</sup> The researchers recommend



timely initiation of oral-motor therapies and personalization of medical and nutritional strategies to provide opportunities for improved progression of feeding skills, as well as improvement in neurodevelopmental outcomes. Furthermore, Jadcerla et al<sup>44</sup> advocates for the development of a rehabilitation program to focus on dysphagia and upper aerodigestive adaption skills following gastrostomy tube insertion and the quality of oral feedings as opposed to quantity of feedings.<sup>44</sup> Future research should review and evaluate the weaning of the gastrostomy tube with the comprehensive interdisciplinary team approach.

Since preterm infants are at high risk of malnutrition, growth monitoring, and early intervention are essential to promote optimal feeding and growth. However, monitoring growth in preterm infants can be complex. Early growth failure may contribute to the burden of wasting, stunting, and being underweight in older children.<sup>45</sup> It is important to follow up with patients after discharge from the hospital to monitor their weight status. With regular nutrition-related follow-ups, patients will be closely monitored to optimize nutrition during this early stage of life. Early intervention needs to be considered when determining the timeframe of the study. Premature infants should be weighted biweekly to weekly for the first four to six weeks after hospital discharge, and then every two months thereafter.<sup>22</sup>

### **Successful Interventions Implementing an Interdisciplinary Approach**

Teamwork involving multiple disciplines is increasingly emphasized in all areas of health care, such as health research, services, education, and policy.<sup>46</sup> The terms multidisciplinary and interdisciplinary are increasingly used in the literature, but are ambiguously defined and interchangeably used.<sup>47</sup> The interdisciplinary approach involves team members from different disciplines working collaboratively, with common purposes, to set goals, implement decisions,

and share resources and responsibilities.<sup>47</sup> A team of clinicians from different disciplines develops a unique care plan considering the assessment, diagnosis, intervention, and patient-centered goals. The patient and/or family members/caregivers are involved in any discussions about the condition, prognosis, and care plan.<sup>47</sup>

In contrast, a multidisciplinary approach involves team members working independently to create discipline-specific care plans that are implemented simultaneously, but without explicit regard to their interaction.<sup>47</sup> A combination of both approaches may be used and the approach often depends on the targeted population.<sup>46</sup> By determining the benefit of an interdisciplinary approach, it will provide evidence of the effectiveness of teamwork.<sup>46</sup> Multidisciplinary approach is the current process offered at Nemours Children's Health in the gastroenterology department – different health disciplines may communicate with each other through email, in person, and/or phone after the visit is completed. The current process of discharged premature infants is family will first receive a referral to follow up with GI and nutrition upon discharge. Caregivers will receive a phone call from Nemours Children's Health to schedule a follow-up appointment. Then, depending on the next available appointments, the patient may be scheduled on different dates (current first new nutrition appointment availability as of October 2021 is January 2022 and first new gastroenterology appointment as of October 2021 is December 2021). Then, speech referral may be recommended upon discharge or after the initial appointment with GI and/or nutrition. Currently, the speech appointment's next available is about 3-4 months. The whole process of initiating a visit with all three health disciplines in an outpatient setting may take longer than 3 months.

To summarize the two approaches, the multidisciplinary approach draws on knowledge from different disciplines but stays within their boundaries. Interdisciplinary analyzes,

synthesize and harmonizes links between disciplines into a coordinated and coherent whole.<sup>46</sup>

The feeding clinic will focus on an interdisciplinary team approach when providing recommendations. Caregivers seem to have a high level of satisfaction (about 96%) with the interdisciplinary approach due to the team's ability to understand feeding concerns and to provide feasible recommendations for treatment options.<sup>48</sup>

Below list the strengths and weaknesses of the interdisciplinary approach:

*Strengths:*

- Allow creation of working networks across the disciplines.<sup>49</sup>
- Take collaborative teamwork toward one goal.<sup>49</sup>
- Health disciplines can provide a recommendation at the same point in time, instead of several, individual appointments at different intervals and the need for separate communications between each of the individual providers for treatment planning.<sup>48</sup> If the separate recommendation is provided at different times, caregivers may be confused on which, when, and how to implement recommendations given.

*Weaknesses:*

- May cause arguments between health disciplines.<sup>49</sup> One voice may be louder than the other.
- May lengthen visit time, however, the time total should be less if compare with a separate visit with each health discipline.

There are some successful interdisciplinary interventions in the literature. O'Neal et al<sup>50</sup> evaluated outcomes related to a multi-interventional nutrition program for newborns after

undergoing surgery for congenital heart disease following a standardized preoperative and postoperative nutrition program.<sup>50</sup> The nutrition program included an assessment of oral motor skills and aspiration risk by speech pathologists, cardiologists, neonatologists, dietitians, surgeons, gastroenterologists, otolaryngologists, and nurse practitioners in an inpatient setting.<sup>50</sup> The multi-interventional nutrition program was associated with improved weight gain, fewer gastrostomy tubes at hospital discharge, and increased pre-operative enteral feeding without increases in necrotizing enterocolitis, hospital stay, or mortality.<sup>50</sup>

Another successful intervention in the literature is family-centered care. Family-centered care is designed to increase family involvement, foster an optimistic attitude and effective stress coping techniques, and reduce uncertainty and negative emotions.<sup>23</sup> This intervention was designed for intensive clinical settings, however, for an outpatient setting – this type of intervention is lacking. This family-centered intervention has also been used successfully in some pediatric oncology settings.<sup>51</sup> Family-centered interventions are particularly appealing given the emphasis on the collective group rather than the individual.<sup>51</sup> The interdisciplinary medical team can help parents comprehend medical information to optimize the infant's feeding skills and feeding regimen, as well as address any gastrointestinal concerns.

### **Benefits of an Interdisciplinary Feeding Clinic**

Some of the benefits of an interdisciplinary feeding clinic were discussed in the above session when compare with the multidisciplinary approach. Other benefits of receiving an interdisciplinary evaluation include coordinated care, improved communication between the medical team and families, and referrals to appropriate services provided for follow-up. Coordinated care provides families with a coordinated plan including medical follow-up and/or

management, provider recommended advancement of oral skills/sensory feeding techniques/behavior modifications and reduced stress on families. Focusing on value-based care for children's health can fundamentally shift the way healthcare is delivered and financed. Value-based care's goals and metrics implicate the need for patient-centered and goal-based metrics, the need to include measures of overall health status, and the need to aim for improved and preserved health status.<sup>52</sup> The president and CEO of Nemours Children's Health System, Dr. Larry Moss, MD, states that "Children's health is the most powerful lever we have to influence the health of the next generation, and, ultimately, to influence the economy of this country."<sup>53</sup>

Pediatric Feeding Disorders (PFD) are multifaceted and involve multiple physiological systems. Due to the interplay between medical, nutritional, psychosocial, and feeding skill systems, treating each in isolation is found to be less effective. This multidisciplinary care model is the current system established. Disruption in one system negatively impacts function in another system. In January 2019, Goday et al<sup>54</sup> proposed a new and unifying diagnostic definition of Pediatric Feeding Disorders. The authors used the framework of the WHO's International Classification of Functioning, Disability, and Health (ICF) as it provides a holistic model of function and disability integrating a medical model with a social one.<sup>54,55</sup> By integrating the medical and social model, the ICF reviews the human being as interacting with society.<sup>55</sup> Pediatric Feeding Disorder was defined as "impaired oral intake that is not age-appropriate and is associated with medical, nutritional, feeding skill, and/or psychosocial dysfunction."<sup>54</sup>

Burklow et al<sup>56</sup> presented a classification system for the needs of ongoing oral-motor feeding intervention for complex pediatric feeding disorders and proposed that feeding problems

occur because of interactions between biological and behavioral factors.<sup>57</sup> When children are unable to meet their nutritional needs, they are at risk for failure to thrive and developmental delays.<sup>57</sup> The progression to food and food textures has important windows for exposure, development, and mastery, especially for those with an early need for respiratory support most likely due to prematurity. <sup>57</sup> Medical complications may interrupt this process and place children at risk of developmental delays, as well as prolonged reliance on a modified diet or non-oral means of nutrition.<sup>57</sup>

Based on research, medical and therapeutic best practice, and health trends, the feeding clinic members composed of a gastroenterology nurse practitioner, registered dietitian, and speech pathologist/feeding therapist strongly feel that this is a worthy investment to have an interdisciplinary feeding clinic as it is demonstrated to be the best way to provide quality and value-based service, to the patients with PFD.<sup>59</sup> This type of service has demonstrated effective outcomes in an inpatient setting, for example, this unified approach assists the care of the extremely premature infant in the first week of life resulted in a decrease in the length of hospitalization and improved patient outcomes.<sup>58</sup> Also, this investment demonstrates to yield significant and sometimes unexpected organizational and patient care rewards.<sup>59</sup> In turn, a collaborative recommendation can be made by the team versus the current model, which provides isolated care with three different disciplinary recommendations that often lead to confusion for the caregivers as mentioned previously. The proposed collaboration follows current and future healthcare trends in the area of Interprofessional Practice (IPP) as this provides a shared vision within an interprofessional framework and actively engages health professionals to accomplish organizational culture change.<sup>59</sup> This concept has been advocated for by the Institute of Medicine (IOM; Institute of Medicine of the National Academies in 2001)

and, more recently, by the Institute for Healthcare Improvement (IHI in 2008), the WHO (WHO in 2010), the Interprofessional Education Collaborative (IPEC in 2011), and other related professional organizations.<sup>45</sup>

The interdisciplinary feeding team intends to improve the current healthcare system of Northeast Florida and Southeast Georgia by providing a comprehensive program that will focus on improving outcomes and quality of care that is unique to these regions. Based on the rising rates of premature births, the target population for this study will be preterm infants. As mentioned above, 20% of premature infants are malnourished.<sup>17</sup> Children born preterm, low birth weight (LBW), or with other perinatal risk factors are at high risk for malnutrition.<sup>17</sup> Preterm infants require consistent monitoring, intervention, and follow-up care.<sup>36</sup> These are services that can be provided by the interdisciplinary feeding clinic. The role of each health professional on the interdisciplinary team is important to make the program successful. The feeding clinic will provide the continuation of interdisciplinary care that the infants received during inpatient. It is proposed that through the IPP model, we can improve collaboration among professionals in our health care systems with the goals of improving the patient/family experience, patient outcomes, safety, and cost efficiencies.<sup>60</sup>

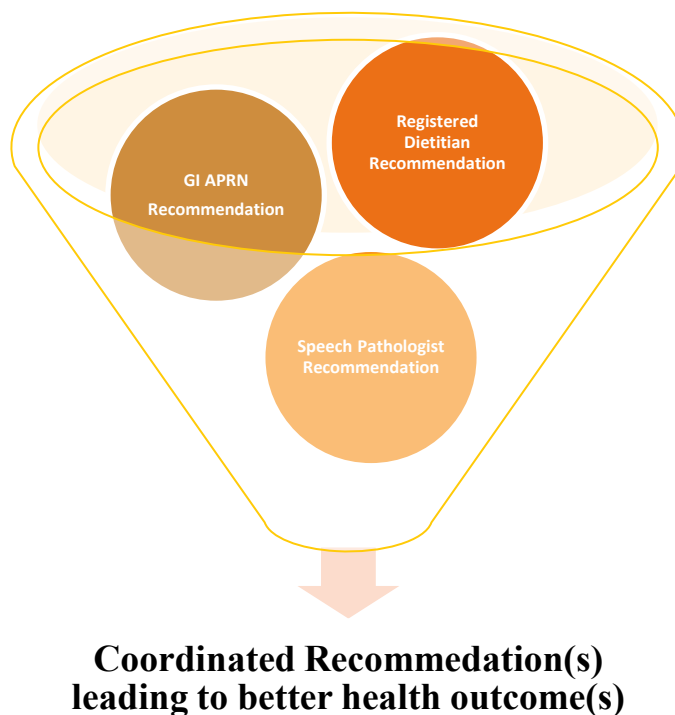
Malnutrition is more common among premature infants when compared to term infants. This disparity can be attributed to the fact that caregivers may have additional stress in caring for the infants due to issues associated with tube feeding guidance, constipation from hypotonia, feeding difficulties due to premature oral muscles, and pumping of breast milk instead of nursing due to NICU stay. A registered dietitian, gastroenterologist/nurse practitioner, and/or speech pathologist are often needed after hospital discharge as consistent monitoring, intervention, and follow-up care are required.<sup>36</sup> These services can be provided by the feeding clinic through an

interdisciplinary approach. The feeding clinic will provide the same interdisciplinary approach provided in the inpatient setting in the outpatient setting as well. High-quality complementary food and micronutrients, along with responsive and sensitive child care and feeding practices, are important for preventing malnutrition and achieving appropriate weight gain.<sup>61</sup>

An attractive point of the proposed feeding clinic is the reduced time spent at a collaborative appointment when compared with separate appointments. The family would come to one appointment to see a gastroenterology's advanced practiced nurse practitioner, registered dietitian, and feeding therapist/speech pathologist instead of two to three separate appointments and recommendations. The feeding clinic team will be able to provide the tools and resources necessary to encourage appropriate weight gain. As the family has fewer stressors, they may be more satisfied and have the appropriate mindset to provide for the infant, which may result in appropriate weight gain and developmental outcomes. This study will focus on the nutritional status of the preterm infant and caregiver's compliance to the recommendation, as these will both affect infant health outcomes.



*Figure 2. The intention of the Pediatric Interdisciplinary Outpatient Feeding Clinic*



**Gaps in the Literature Relating to the Feeding Clinic and Prematurity**

There are several gaps in the literature relating to interdisciplinary clinics. To begin, there is insufficient research that compares the outcomes of a feeding clinic versus a non-feeding clinic. In addition, there is a lack of research on the benefits of early intervention in preterm infants. There is limited literature regarding the perceptions of clients participating in feeding services, even though there is a surge in caregivers requesting this type of service.<sup>62</sup> In fact, some parents are even willing to relocate to receive these types of services. At Nemours Children’s Health, patients are traveling from Georgia and Tallahassee to receive services such as gastroenterology evaluation, nutrition services, and other specialty services.

Another gap in the current literature is relating to prematurity, failure to thrive (FTT), and malnutrition. Almost all FTT diagnoses mean that some degree of malnutrition is present.

Malnutrition incidence in preterm infants during the first 12 months of life is currently unknown.<sup>63</sup> The prevalence of malnutrition by severity (i.e., mild, moderate, and severe) and malnutrition status in an outpatient setting among preterm infants is limited in the literature. Malnutrition may be missed as providers may not be identifying and capturing the diagnosis of malnutrition and there is often variation in clinical criteria used by providers to diagnose malnutrition. For example, currently, there is a lack of standardized criteria for diagnosing and determining the severity of malnutrition (i.e., mild, moderate, or severe protein-calorie malnutrition) among providers. It is important to identify and categorize the degree of malnutrition among premature infants to determine the appropriate nutrition care plan. It is important to provide the necessary tools and guidance to caregivers to increase the survival rate of infants by optimizing nutrition status, maximizing oral intake, and minimizing gastrointestinal symptoms to maximize nutrient absorption.

In conclusion, survival and developmental outcomes of preterm babies are determined by environmental factors related to birth, quality of care services, and nurturing limitations as a result of the maternal psychosocial effect of preterm birth.<sup>17</sup> Quality of services that the pediatric interdisciplinary outpatient feeding clinic offer by Nemours Children's Health and Wolfson Rehab are unique and hope to improve the nutritional status of preterm infants enrolled in the feeding clinic in the six months period after NICU discharge. This study aims to improve growth rates and caregivers' adherence to provider recommendations and decrease malnutrition among preterm infants. This research study intends to provide a glimpse into the benefits of an interdisciplinary feeding clinic when compared with the traditional multidisciplinary model. This study is unique in that it focuses on the role of a feeding clinic specifically among premature infants.

## CHAPTER 2 - THEORETICAL FRAMEWORK

Feeding difficulties can impact family lives and social interactions as parents are concerned about behaviors and the social stigmatism when feeding their child with non-traditional feeding means.<sup>24-26</sup> The interdisciplinary medical team helps parents comprehend medical information to optimize feeding skills, regimen, and any gastrointestinal concerns. Current research has demonstrated that caregivers perceive the recommendations provided by health professionals as important to the care of preterm infants.<sup>24-26</sup> Adherence to the provider-recommended infant feeding regimen will directly affect infant health outcomes. If recommendations are followed, the appropriate rate of weight gain in infants will likely occur as it is a direct relationship. This research study will utilize the interprofessional learning continuum (IPLC) model as the foundation of the theoretical framework. An interdisciplinary team approach using IPP within the IPLC framework to actively engage health professionals to provide a shared vision will be used in the research study.<sup>59</sup> It is important to utilize the interdisciplinary team approach as it contributes to improved perceptions among parents which can lead to the maximization of nutrition and oral skills along with the minimization of GI symptoms to promote optimal weight gain for premature infants.

Interprofessional collaborative practice (IPCP) achieved significant momentum in 2015 with bipartisan Congressional support for the Medicare Access and CHIP Reauthorization Act. With the updated legislation, the Center of Medicare and Medicaid Services is transitioning from fee-for-service payments to value-based care, increasing incentives for higher quality care at lower costs.<sup>64</sup> The health systems will be reimbursed for the quality of their overall outcomes rather than for the number of services rendered.<sup>64</sup> These incentives require the health professions to move beyond traditional siloed practices to collaborating with the entire healthcare team.

Other than the insurance aspect of the use of IPCP, collaborative care may be more effective in improving nutritional and health status when compared to the traditional care model.<sup>65</sup> Research has shown that older adults receiving IPCP care had significant improvements in their nutritional status when compared to a control group.<sup>65</sup> IPCP had a strong correlation with nutritional status based on the correction analysis performed in this study.<sup>65</sup>

In a national effort report from IOM titled, *Educating for the Health Team*, there are growing concerns in health care, such as increased demand for services by newly insured Medicare and Medicaid populations, workforce shortages, and the need for comprehensive primary care, which has initiated the need for IPE.<sup>64</sup> Teamwork and collaborative practice have become the norm in specialties such as geriatrics, rehabilitation, renal care, cancer, and transplantation. However, the U.S. healthcare system did not historically revolve around a team-based, collaborative model, and this type of practice is still seen as an outlier.<sup>64</sup> It is important to establish team role models in practice to design, implement and evaluate team-based curricula across health professions.<sup>64</sup> Interprofessional learning continuum was deemed as the gold standard for the management of cancer patients and is promoted by leading organizations such as Action Against Cancer and the American Society of Clinical Oncology as essential for today's patient-centered healthcare environment to increase communication among healthcare providers to decrease patient errors and improve the delivery of clinical recommendations.<sup>66</sup> Given the multiple potential benefits and the goal of providing patients with comprehensive care, the interprofessional learning continuum model will be used as the foundation of this interdisciplinary team approach research study.

### *Interprofessional Learning Continuum (IPLC) Model*

Due to the increased focus on IPE in the healthcare system, in 2015, the IOM proposed the adoption of a comprehensive learning continuum model (Figure 3. IPLC model).<sup>64</sup> The interprofessional learning continuum (IPLC) model is a conceptual model evaluating interprofessional education (IPE) that could be adapted to specific healthcare settings.<sup>67</sup> The main focus is to guide the alignment of the interdependent healthcare and education systems as a comprehensive complex adaptive system.<sup>64</sup> The term interprofessional practice is used to describe when the use of the interdisciplinary team is put into practice. World Health Organization defines IPE as when two or more professions learn with, about, and from each other to enable effective collaboration and improve health outcomes and quality.<sup>66,68</sup> It is the current and future healthcare trends in the area of IPP. This concept has been advocated for by the IOM (IOM; Institute of Medicine of the National Academies in 2001) and, more recently, by the Institute for Healthcare Improvement (IHI in 2008), the World Health Organization (WHO in 2010), the Interprofessional Education Collaborative (IPEC in 2011), and related professional organizations.<sup>45</sup> The IPLC model was developed by a diverse committee of experts vetted for biases and conflicts of interest.<sup>67</sup> The committee members opened a one-day testimony from outside experts followed by three days of closed-door deliberation during which the committee members agreed upon its conclusions and recommendations.<sup>67</sup> Lastly, virtual meetings were conducted during which conclusions and recommendations presented were finalized.<sup>67</sup>

The IPLC model used Kirkpatrick's training evaluation model (developed in 1967 and revised in 1994) as the foundation of defining the learning outcomes.<sup>67</sup> Kirkpatrick's model proposed four levels of training evaluation criteria: reactions, learning, behavior, and results.<sup>69</sup> The four levels of learning outcomes were extracted from Kirkpatrick's model to describe

outcomes of learning in the IPLC model. These levels were then adapted for use in measuring outcomes of IPE. The overarching intent of the IPLC model is to create a framework that links IPE learning with patient health and systems-level outcomes.<sup>69</sup> The IPLC model was developed to guide future research to provide the foundation for IPE and IPCP outcomes research.<sup>66</sup>

The IPLC model is a theoretical tool to guide further research on the outcomes of interprofessional education and collaborative practice.<sup>66</sup> It concentrates on the combination of all professions to collectively care with and for patients.<sup>66</sup> The IPLC model demonstrates four interrelated components: a learning continuum, the outcomes of learning, health and system outcomes, and the major enabling and interfering factors that influence implementation and overall outcomes.<sup>67</sup> The learning continuum category demonstrates the impact of IPE across the professional continuum from a professional's initial training and throughout their professional career; therefore, this process starts early on when students are enrolled in the health profession.<sup>66</sup>

The IPLC model is designed to equip the interprofessional teams model with the skills to transform traditional primary care training environments into high functioning environments with active interprofessional learning. The learning continuum of the IPLC model as mentioned earlier is derived from Kirkpatrick's Expanded Outcomes Typology.<sup>13,66</sup> This includes learner's reaction, attitude/perception, knowledge/skill, behavior, and organizational change to benefit people and communities. Another factor in the IPLC model is the enabling or interfering factors defined by the committee as those influences that affect outcomes whether in an overt or covert manner.<sup>66</sup> These enabling or interfering factors include professional culture, institutional culture, workforce policy, and financing policy. Last but not least, the last component of the IPCL model is the individual and population health outcomes, system outcomes such as organizational

changes, system efficiencies, and cost-effectiveness which can be impacted by the other concepts mentioned earlier.<sup>66</sup>

One of the main strengths of the IPLC model is that it is adaptable to many healthcare settings and applies to all professions. This model can be used as a single professional practice toward improving IPE and IPCP outcomes in the clinical setting.<sup>66</sup> Another strength of this comprehensive conceptual model is its ability to greatly enhance the description and purpose of IPE interventions and their potential impact.<sup>67</sup> It also provides a consistent taxonomy and framework for strengthening the evidence base linking IPE with health and system outcomes.<sup>67</sup> Lastly, the model allows for mapping the specific characteristics of an IPE intervention, such as timing, setting, and approach to intermediate learning outcomes leading to specific types of health and system outcomes.<sup>67</sup>

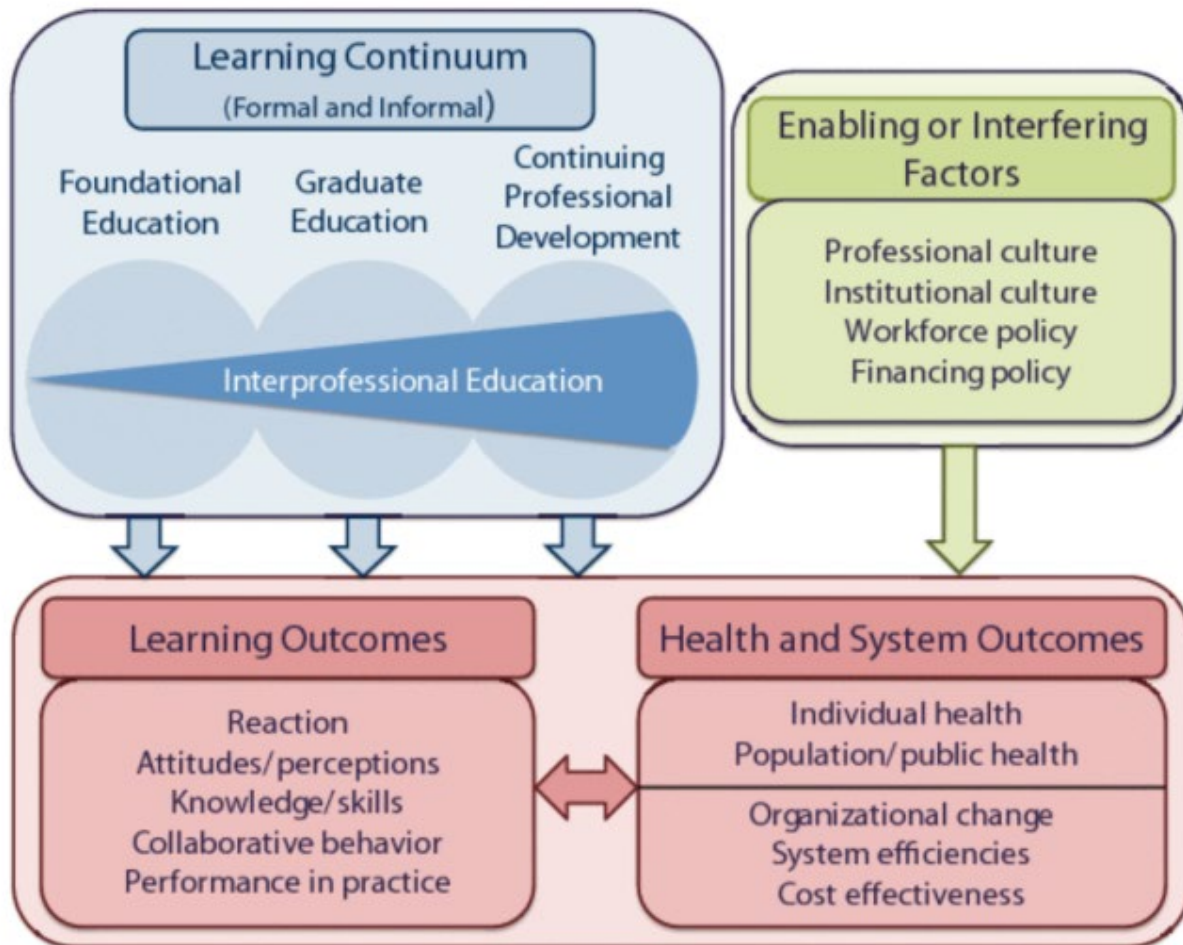
There are some weaknesses to the IPLC model. The figure of the IPLC model provides clarity on some of the written concepts, however, the graphic model lacks complete congruence with its more complex written depictions.<sup>66</sup> For example, a change from uni-directional arrows to dual-directional arrows between learning continuum and learning outcome would be more accurately indicate the knowledge learners bring to educational activities that can influence the learning.<sup>66</sup> Also, specific enabling and interfering factors may vary by setting and country.<sup>67</sup> Another weakness is that the environments in which IPE occurs are highly variable and complex, therefore, for research study design, the selection of meaningful control groups is problematic.<sup>67</sup> This finding may lead to well-designed IPE studies that may be cost-prohibitive.<sup>67</sup> Lastly, a major problem is the inconsistent vocabulary used to describe collaborative work and its association between learning activities and outcomes.<sup>67</sup> Sometimes, the development of a

research study is influenced by the funding agencies as grant seekers may want to match the words and phrasing from the funding organizations.

In summary, the significant environmental factors that have hindered the full development of both IPE and IPCP have changed over the last 10-15 years.<sup>64</sup> As in the '70s, there were environmental factors that produced barriers that hindering the full-scale adoption and mainstreaming of IPCP in the United State health care.<sup>64</sup> These include fee-for-service reimbursement favoring physicians over other professionals and teams, the rise of specialization, little early interest in the processes of health care, and the lack of evidence of team effectiveness.<sup>64</sup> Then, the transformation in the process of care in the '80s began with the emphasis on controlling access and reducing the use of resources and variances in care for cost containment.<sup>64</sup> In the early 2000s, the emphasis on high-performing teams by adopting teamwork skills as core competencies along with the insurance reimbursement trends continues.<sup>64</sup> This is the appropriate timing to access this model in current health care. The learning systems in the IPLC model will provide linkage between IPE to health system redesign to implement IPE within the healthcare system to improve the quality of services provided along with better health and system outcomes.<sup>64</sup> The IPLC model provides a foundation for future research to develop IPE in the curriculum and practices.<sup>70</sup>

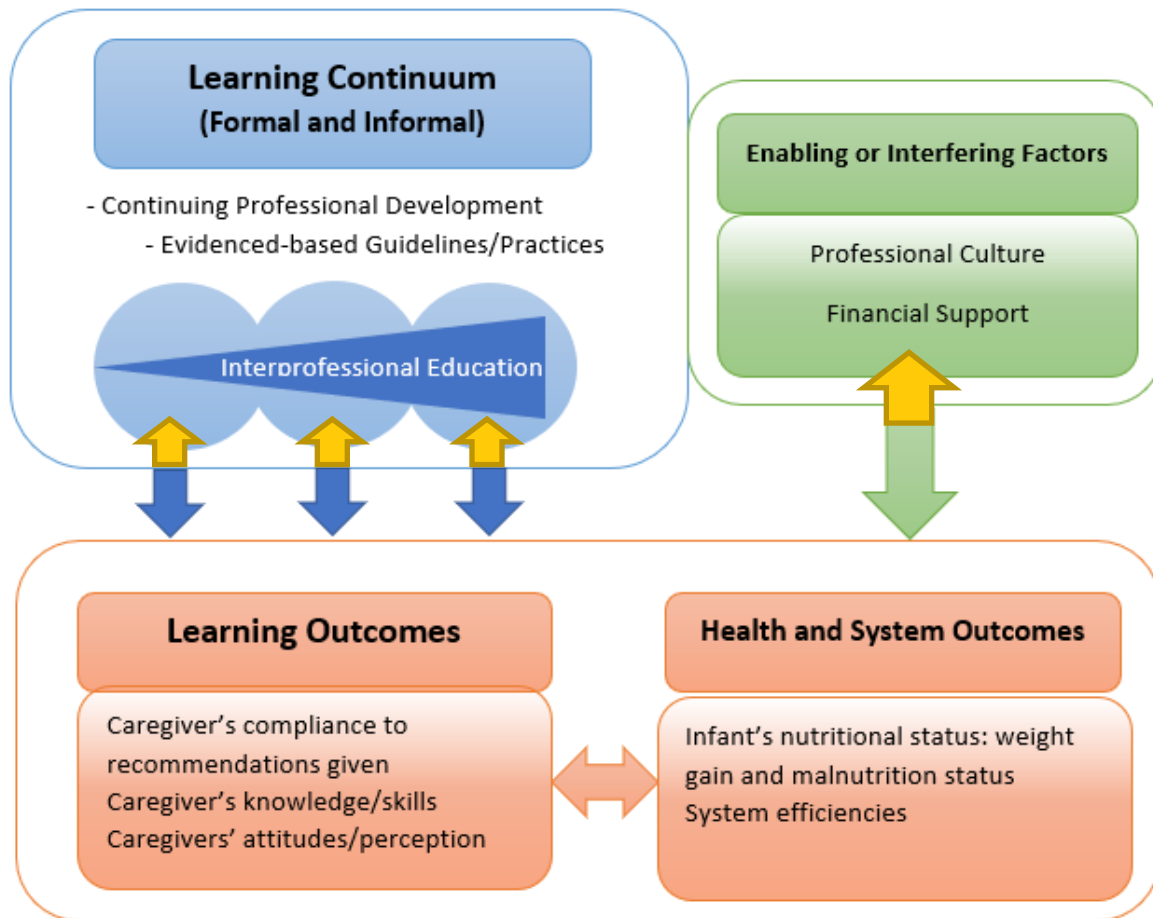


Figure 3. IPLC model<sup>67</sup>



**Figure 3.** IPLC model. The model is intended to be adopted by professional organizations with a stake in promoting, overseeing, and evaluating IPE.<sup>67</sup> IPLC model encompasses four interrelated components: a learning continuum, learning outcomes, individual and population health, and system outcomes. These system outcomes include organizational changes, system efficiencies, and cost-effectiveness, as well as the major enabling and interfering factors that influence implementation and overall outcomes.<sup>67</sup> The successful application of this model depends on how well the independent education and health care systems are aligned.<sup>67</sup>

*Figure 4. Proposed feeding clinic research study using IPLC model as the theoretical foundation.*



**Figure 4.** Proposed feeding clinic research study using IPLC model as the theoretical foundation.<sup>67</sup> The above model depicts an interprofessional learning continuum across foundational education, graduate education, and continuing professional development.<sup>67</sup> There are four broad domains: learning continuum, learning outcomes, enabling and interfering factors, and health and system outcomes.<sup>67</sup> For this research study, the first domain, which is the continuum of IPE, contains both formal and informal learning experiences that are linked to learning outcomes.<sup>67</sup> It uses the evidenced-based guidelines/practices across health disciplines as part of the experiences. Then, it leads to learning outcomes due to the collaborative behavior (interdisciplinary team care) that the feeding clinic can provide. This collaborative approach may affect caregivers’ compliance to recommendations given the increase in knowledge/skills of caregivers may changes in their attitudes and perceptions in making the changes. Lastly, this model may result in better health and system outcomes, such as the nutritional status of infants if there is greater adherence to recommendations among caregivers with the interdisciplinary model. Dual-directional arrows were incorporated in this research study model between learning continuum and learning outcomes as the knowledge learners bring to educational activities that can influence the learning.<sup>66</sup> Also, dual-directional arrows were adding to support the interchange relationship between health and system outcomes, and enabling/interfering factors as positive and/or negative health outcomes may also affect the professional culture.

*Chart 1. Relationship between the theories/models and proposed feeding clinic research study*

<b><i>Theory/Model</i></b>	<b><i>Use of Construct</i></b>	<b><i>Targeted IPLC Model Learning Outcomes<sup>70</sup></i></b>	<b><i>Relationship to the study</i></b>
<b><i>IPLC Model</i></b>	<ul style="list-style-type: none"> <li>▪ IPE learning continuum leading to change in learning outcomes and health/system outcomes.</li> </ul>	Knowledge/skills, Collaborative behavior	IPE leading to an interdisciplinary team approach may alter learning outcomes of caregiver’s perception, knowledge, and compliance to recommendations given by the feeding clinic. In turn, it will lead to better nutritional, GI, and feeding status in preterm infants.

## CHAPTER 3 – METHODS

### **Purpose Statement:**

The purpose of this study is to determine the impact of a pediatric interdisciplinary outpatient feeding clinic on premature infant weight gain and caregivers' adherence to recommendations in the pediatric interdisciplinary outpatient feeding clinic as compared to the traditional multidisciplinary care. The findings will be used to evaluate the effectiveness of interdisciplinary care in the feeding clinic.

### **Study design:**

A Retrospective-Prospective Before-After Study Design will be utilized. This study will be conducted in an interdisciplinary feeding clinic consisting of a gastroenterology nurse practitioner, registered dietitian, and feeding therapist/speech pathologist. The pre-implementation is also being referred to as the current setting/traditional multidisciplinary care, where patients are being seen after a referral is placed at hospital discharge after birth. In this setting, patients may be referred to all three health disciplines at discharge. It is also a possibility that patients are referred to one or two health disciplines and later on be referred to the second or third health discipline. Communication between groups mainly is through email or an internal messaging system. However, due to the uncoordinated visit along with different waiting times, patients are being seen at three separate appointments at different times and places. Time in-between visits may vary between days or months from each other.

While the current setting/traditional model will continue to exist, some premature infants will be in that setting vs. in the feeding clinic's setting. This is due to lack of resources, benefits

of interdisciplinary care, and budget. Therefore, the feeding clinic plans to be open about two times a month in the initiation of the clinic. Post-implementation is defined as the feeding clinic setting, which is also known as the interdisciplinary care in this research. In the post-implementation setting, the patient will receive care from all three health disciplines at the same time in the same room and coordinated recommendations will be given at the visit and follow-up visits. The feeding clinic is intended to initiate between Fall 2021 to Spring 2022.

### **Study Participant Setting**

Preterm infants discharged from Wolfson's Children Hospital downtown and surrounding area hospitals (e.g., Wolfson Children's Hospital South, UF Health, St. Vincent's) will be recruited for this study. To ensure adequate recruitment occurs, registered dietitians at Nemours Children's Health (outpatient) will communicate with Wolfson's RDs (Wolfson's Pediatric Hospital - inpatient) through pre-established routine weekly meetings.

Each infant subject who meets the study inclusion criteria and none of the exclusion criteria will be enrolled into the study with parent consent and will be identified using a medical record number (MRN). The caregiver's assessment checklist will use the infant's MRN as an identifier for both groups. For infants that meet the criteria in the pre-implementation setting, the researcher will review eligible participants and contact the caregiver to receive consent for infants to be in the pre-implementation group of the study, and at the same time, the caregiver will be invited to participate in the evaluation of caregiver adherence with feeding recommendations given during this period. For infants that meet the criteria in the post-implementation setting, the researcher will receive consent to enroll the infant in the prospective

part of the study and at the same time, the caregiver will be invited to participate in the evaluation of caregiver adherence with feeding recommendations given while in the study.

### **Inclusion Criteria**

Subjects must meet all of the inclusion criteria below:

- 1.) Infants must be categorized as preterm (<37 weeks of gestational age).
- 2.) Infants, male or female, aged 0-9 months (adjusted).
- 3.) A family member or a caregiver must sign a consent form for the study.
- 4.) The caregiver of the infant receiving the services must willing and able to attend visits in the outpatient feeding clinic.

### **Exclusion Criteria**

- 1.) Infants classified as extreme prematurity (Infant below 28 weeks completed gestation.)<sup>71</sup>
- 2.) Infants that are older than 9 months old (adjusted).
- 3.) Infants with only one data point of weight. Infants with one attendance to the feeding clinic and inability to locate a 6-month weight.
- 4.) Participants who were not seeking services from the feeding clinic.
- 5.) Inability to comprehend and complete the survey instrument.
- 6.) Infants with known or suspected complex gastrointestinal anomalies or dysfunction, inherited metabolic disorders, congenital neurological insults, suspected or diagnosed conditions associated with malabsorption (e.g. cystic fibrosis).
- 7.) Infants with known or suspected systemic or congenital infections (e.g. HBV, HCV, human immunodeficiency virus).

- 8.) Infants with known or suspected genetic conditions and/or metabolic conditions known to interfere with growth or body dysmorphism that can interfere with obtaining standard anthropometric measurements except for infants diagnosed with Down syndrome.

**Research Questions:**

- 1.) Does the pediatric interdisciplinary outpatient feeding clinic improve infants' weight and malnutrition status when compared to the traditional, multidisciplinary model?
- 2.) Does the pediatric interdisciplinary outpatient feeding clinic increase caregiver compliance with feeding recommendations when compared to the traditional, multidisciplinary model?
- 3.) Is there a correlation between caregiver compliance and infant's weight gain in both traditional, multidisciplinary model and interdisciplinary model?

**Study Aims:**

- 1.) To evaluate the impact of the pediatric interdisciplinary outpatient feeding clinic on preterm infant's weight gain when compared between traditional multidisciplinary care and interdisciplinary care from discharge anthropometrics to 6-months post-discharge anthropometrics.
- 2.) To evaluate the malnutrition status (non-malnutrition or malnutrition) of preterm infants in both traditional multidisciplinary care and interdisciplinary care from discharge anthropometrics to 6-months post-discharge anthropometrics.
- 3.) To evaluate the impact of the pediatric interdisciplinary outpatient feeding clinic on the percentage of caregiver compliance with feeding recommendations given at the

appointment before the 6-months post-discharge appointment and compared between traditional multidisciplinary care and interdisciplinary care.

- 4.) To evaluate if caregiver adherence is correlated with infant's weight gain in both traditional multidisciplinary care and interdisciplinary care.

### **Hypothesis:**

- Participating in the pediatric interdisciplinary feeding clinic will significantly improve weight and malnutrition status by 6 months after discharge.
- Parents participating in the pediatric interdisciplinary outpatient feeding clinic will be significantly more compliant with the recommendations given than in the current setting.
- Those parents that followed the feeding recommendations in both groups will have greater positive outcomes with infant weight outcomes.

### **Data Collection**

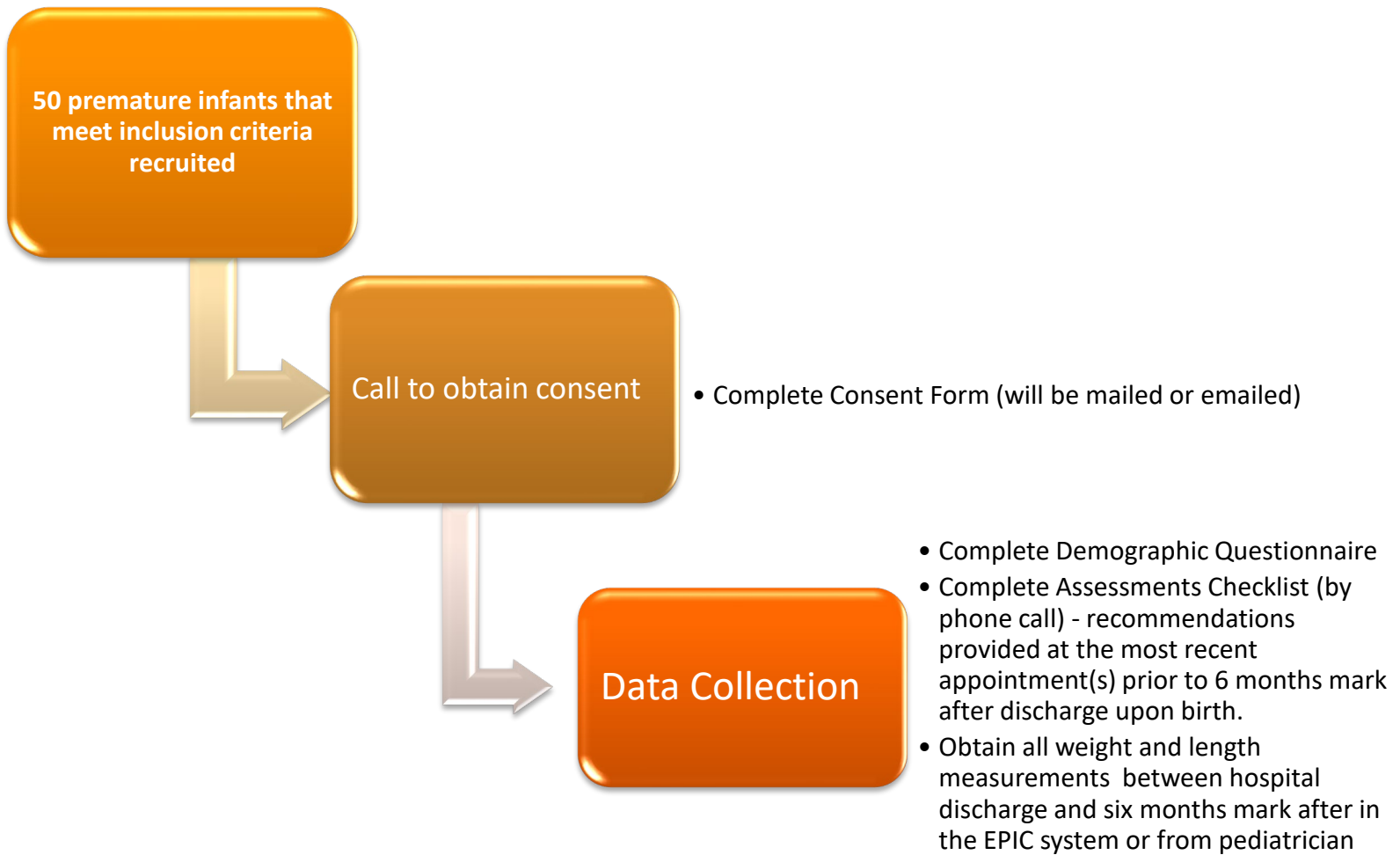
*Pre-implementation-traditional multidisciplinary care:* The study will collect historical data on at least 50 premature infants. Medical records will be reviewed of premature infants with diagnosis codes of either/or P07.02 or P07.30 (Prematurity codes) before September 2021, having been seen by a gastroenterologist or APRN, a Registered Dietitian, and a speech pathologist after discharge. Weight and length from hospital discharge to around the six months mark after discharge will be collected. The premature infants' gestational age will also be extracted as part of the demographic information. All anthropometrics between hospital discharge and 6-months post-discharge will also be collected, when available. If anthropometrics cannot be obtained around six months after discharge upon birth, the researcher will obtain information from pediatricians' offices since pediatricians usually obtain



anthropometrics at 2-3 month intervals.<sup>72</sup> Pediatrician contact information is shared in the EPIC medical record system used by Nemours. (To find this information, in a patient's chart in EPIC, under snapshot, click on Care Team and Communications.) This PCP information includes name, phone, and fax number. The researcher will add this to the consent form to give permission to obtain the data if needed.

Demographic information will be obtained via a questionnaire (demographic questionnaire can be found under Appendix I). This will be used for informational purposes initially, however, data collected through demographic assessment (refer to Appendix I) from this research may be used to identify findings in the future if applicable. Consistent with previous feeding clinic studies from literature reviews: gender, ethnicity, gestational age, caregiver information (parent, grandparent, or other), age, pediatrician information, and g-tube presence will be obtained.<sup>73</sup> A phone call will be conducted by the study coordinator or trained intern to complete the pediatric interdisciplinary outpatient feeding clinic assessment checklist. The checklist is used to determine if recommendations are being followed at the most recent appointment before the six months mark after hospital discharge upon birth. Consent forms will be signed by the caregivers before any data collection. Prior to the phone call to gather if recommendations are being followed, the researcher will review the medical record and/or discuss with other health disciplines involved to determine and verify recommendations provided at the appointment closest to the 6 months mark after hospital discharge.

*Diagram 1. Data Collection in the Pre-Implementation-Traditional Multidisciplinary Care*



**Diagram 1. Data Collection in the Pre-Implementation-Traditional Multidisciplinary Care.**

*All weight and length measurements are recorded during the duration of the study.*

***Post-Implementation-interdisciplinary care:*** The proposed pediatric interdisciplinary outpatient feeding clinic will follow up with preterm infants that received gastroenterology, nutrition, and/or speech consults during their hospital stay. Pediatric interdisciplinary outpatient feeding clinic plans to initiate first outpatient visit around two weeks after hospital discharge. Patients will be referred to the feeding clinic upon hospital discharge after birth. The feeding team will consist of a gastroenterology nurse practitioner, a dietitian, and a speech pathologist along with oversight of a medically complex clinic nurse practitioner and gastroenterology medical doctor. Eligible participants will be asked to participate in the study during the initial visit to the feeding clinic. There will be one consent form for all study aims. At the initial visit to the feeding clinic, gastroenterology's advanced practice nurse practitioner, registered dietitian, and feeding therapist plan to provide a coordinated visit by being in the same room together to provide one assessment and combined recommendations. Follow-up will be determined accordingly. This is the "interdisciplinary" approach mentioned in Chapter 1. The feeding clinic's strong points in comparison to the previous system include one appointment, one coordinated recommendation from all health disciplines, and early establishment after discharge.

The length of study participation per infant and caregiver will be six months – from the hospital discharge date to the 6 months mark after discharge. As discussed in the literature review, the importance of early intervention is needed after hospital discharge as infant rate of weight gain changes simultaneously with calorie intake. Therefore, it is the goal of the pediatric interdisciplinary outpatient feeding clinic to initiate the first visit around two weeks after discharge. The goal of enrollment of fifty premature infants should be met within three to four months from the start of the implementation of the new feeding clinic based on the project projection from Chart 2. Projection on the number of preterm infants in feeding clinic. The

feeding clinic is projected to initiate between Fall 2021 and Spring 2022. Fifty premature infants with either P07.02 or P07.30 (Prematurity codes) and that meet the inclusion and exclusion criteria will be consent to enroll in the pediatric interdisciplinary outpatient feeding clinic.

*Chart 2. Projection on the number of preterm infants in feeding clinic.*

Schedule:													
2021		Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
# patients		16	16	16	16	24	24	32	32	32	32	34	274
2022	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
# patients	34	34	34	34	34	34	34	34	34	34	34	34	408

Team members will gather anthropometric data over a six-month period from hospital discharge data (baseline) until six months post-discharge. The feeding clinic may follow up with infants in 2-3 months intervals depending on the severity of conditions. All weights and lengths will be obtained between the hospital discharge and six months mark post-discharge. All infants will be followed up at six months mark from the initial feeding clinic visit. The researcher will ensure that staff had completed the yearly training on weight and length measurements as this is a requirement in the current setting as it is also being referred to as the traditional multidisciplinary care model as well. Appendix II provides more information on how to obtain accurate anthropometrics.

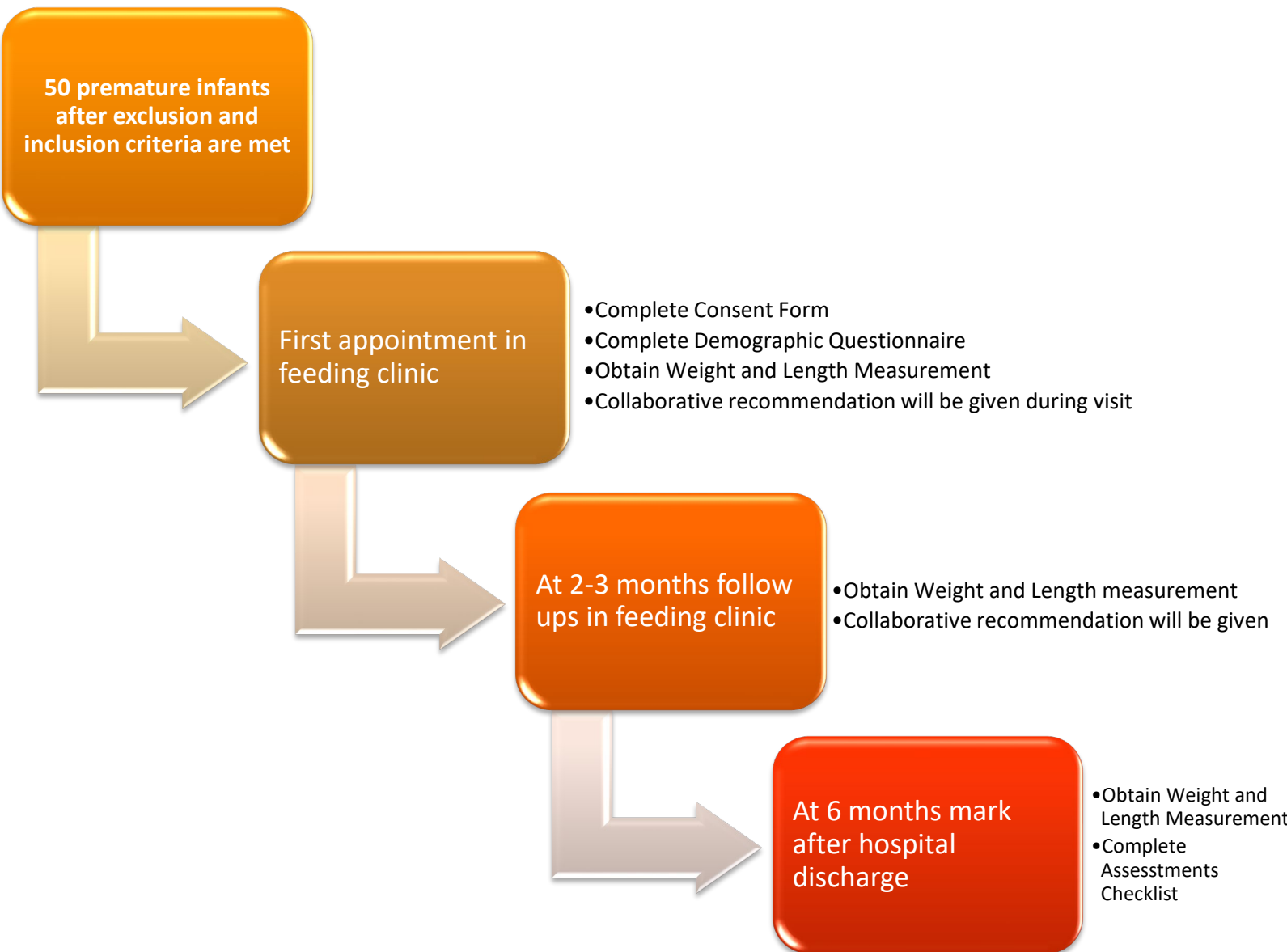
A pediatric interdisciplinary outpatient feeding clinic assessments checklist will be completed at the six months mark to determine if the feeding clinic recommendations provided at the appointment prior to the six-month mark are being followed.

Demographic information will be obtained via a questionnaire (demographic questionnaire can be found under Appendix I). It is completed at the initial visit by the health

professional. This will be used for informational purposes initially, however, data collected through demographic assessment (refer to Appendix I) from this research may be used to identify findings in the future if applicable. Gender, ethnicity, gestational age, caregiver information (parent, grandparent, or other), age, pediatrician information, and g-tube presence will be obtained consistent with pre-implementation collection<sup>73</sup>

*Diagram 2. Data Collection in the Post-Implementation-Interdisciplinary Care* demonstrates the study flowchart for the intervention group (see below). The feeding plan will be formulated by the coordinated team at each visit and discussed with the family to ensure appropriate comprehension and agreement.

**Diagram 3.** Data Collection in the Post-Implementation-Interdisciplinary Care



**Diagram 2.** Data Collection in the Post-Implementation-Interdisciplinary Care. *Weight and length measurements will be collected at all visits after feeding clinic enrollment.*

## Pediatric Interdisciplinary Outpatient Feeding Clinic Assessments Checklist

### *Oral/Sensory/Behavioral Feeding Skills Assessments*

Topic	Last visit recommendation?	Recommendation Follow? <small>Please check only if 50% or more of recommendations are followed for each topic.</small>
Attendance of feeding therapy with a speech-language pathologist	<input type="checkbox"/>	<input type="checkbox"/>
Feeding tool recommendation: bottle system and nipple flow rate, cup or straw	<input type="checkbox"/>	<input type="checkbox"/>
Oral feeding techniques	<input type="checkbox"/>	<input type="checkbox"/>
Advancement of diet: purees, or solid foods, new foods to the diet	<input type="checkbox"/>	<input type="checkbox"/>
If other recommendation, please specify below: _____	<input type="checkbox"/>	<input type="checkbox"/>

### *Medical Management of Gastroenterology Assessment*

Topic	Last visit recommendation?	Recommendation Follow? <small>Please check only if 50% or more of recommendations are followed for each topic.</small>
Constipation: recommendations and/or titrating of medication dose	<input type="checkbox"/>	<input type="checkbox"/>
Reflux: precautions or medications	<input type="checkbox"/>	<input type="checkbox"/>
Labs/imaging/stool studies order	<input type="checkbox"/>	<input type="checkbox"/>
If other recommendation, please specify below: _____	<input type="checkbox"/>	<input type="checkbox"/>



**Nutritional Assessment**

Topic	Last visit recommendation?	Recommendation Follow? <small>Please check only if 50% or more of recommendations are followed for each topic.</small>
Concentration of Formula and/or Breastmilk (e.g. add 1 teaspoon of baby cereal per oz of formula or breast milk, increase the concentration of formula to 24 kcal/oz)	<input type="checkbox"/>	<input type="checkbox"/>
Formula Change (e.g. change to a new formula, add formula to breastfeeding regimen (offer 2 oz of formula after nursing))	<input type="checkbox"/>	<input type="checkbox"/>
Total Volume/Intake Changes (e.g. offer 3 oz of formula per feeding instead of 2 oz, aim for 24 oz of formula per day, wake up infants at night for feeding)	<input type="checkbox"/>	<input type="checkbox"/>
Tube Adjustment (NG, NG, G-tube, or GJ-tube) (e.g. increase rate by 10 ml per hour at night, add a feeding through g-tube)	<input type="checkbox"/>	<input type="checkbox"/>
If other recommendation, please specify below: <hr/>	<input type="checkbox"/>	<input type="checkbox"/>

Were the recommendations given by health disciplines from GI, speech and nutrition overall easy to follow?

- Yes
- No

If “No”, can you explain why?

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**Additional Comments:**

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## **Statistical Analysis**

All analysis will be done under the advice of Dr. Julie Crook, Ph.D. (Biostatistician/Assistant Professor) from Mayo Clinic in the Department of Quantitative Health Sciences. Descriptive summaries of infants in the two groups will be provided within tables. This will allow an overall appreciation of the characteristics of the infants included in the study population, as well as confirmation, or otherwise, that the infants in the two groups are comparable. Any differences will be taken into account when interpreting the primary results. Tabular and graphical summaries will be created to present all the results to facilitate appropriate interpretation.

The EPIC system, Nemours's electronic medical record, will automatically adjust the z-score for weight based on gestational age. To determine the adjusted z-score, the system will use the infant's gestational age in weeks, then it will subtract the infant's gestational age in weeks from 40 weeks (gestational age of term infant) to indicate the adjustment for prematurity. Finally, gestational adjusted age is determined by subtracting the adjustment for prematurity in weeks from the child's post-natal age in weeks.<sup>74</sup>

**Primary analysis (Study Aim 1):** For the primary aim, weight-for-length z-scores at 6 months post-hospital discharge of infants in post-implementation of the study will be compared with those in pre-implementation. This relationship will be analyzed using a linear regression analysis adjusting for weight-for-length z-score at baseline (hospital discharge). From this model, we will obtain an estimate of the mean difference in weight-for-length z-scores in the infants in the post-implementation group compared to those in the pre-implementation group along with a 95% confidence interval and the corresponding p-value of 0.05.

**Secondary analysis I (Study Aim 1):** The secondary analysis will correspond to the first aim and the secondary outcome of the weight-for-age z-score. Similar to the primary analysis, this will be analyzed via linear regression adjusting for the baseline value.

**Secondary analysis II (Study Aim 2):** This study will group all malnutrition diagnoses into one category to classify nutrition status as “non-malnutrition” or “malnutrition” at 6 months, and at any intermediate time points. Chi-squared test and Fisher’s exact test will be used to compare the proportion of infants with malnutrition at 6 months between pre-implementation and post-implementation groups. If the number of malnutrition (or non-malnutrition) events is large enough, a multivariable logistic regression model will be used to evaluate if the interdisciplinary outpatient feeding clinic is associated with reduced malnutrition risk as compared to the traditional multidisciplinary model when adjusting for baseline differences. From this model, we will obtain an estimate of the odds ratio of malnutrition of the post-implementation group compared to those in the pre-implementation group along with a 95% confidence interval and the corresponding p-value of 0.05.

**Table 3. Primary Indicators of Pediatric Malnutrition Guideline.**

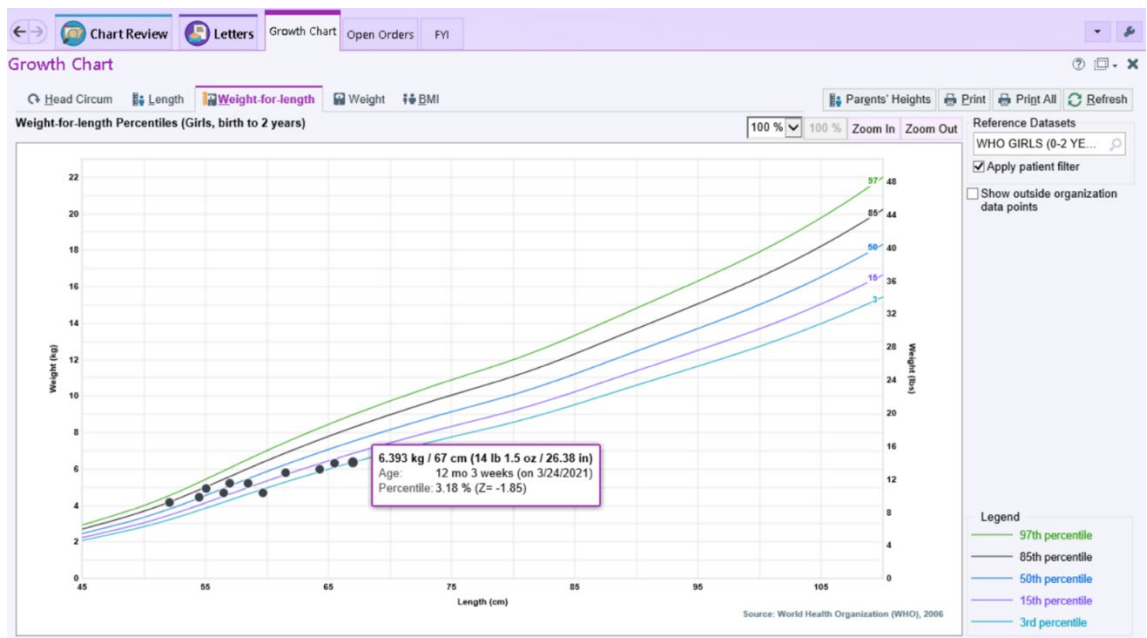
Indicator	Mild Malnutrition	Moderate Malnutrition	Severe Malnutrition
Weight-for-height z score	-1 to -1.9 z score	-2 to -2.9 z score	-3 z score or below
BMI-for-age z score	-1 to -1.9 z score	-2 to -2.9 z score	-3 z score or below
Length/height-for-age z score	No data	No data	-3 z score or below
Mid-upper arm circumference	-1 to -1.9 z score	-2 to -2.9 z score	-3 z score or below

BMI, body mass index. Adapted with permission from Becker PJ, Carney LN, Corkins MR, et al. Consensus statement of the Academy of Nutrition and Dietetics/American Society for Parenteral and Enteral Nutrition: indicators recommended for the identification and documentation of pediatric malnutrition (undernutrition). *Nutr Clin Pract.* 2015;30(1):147-161.

- Weight-for-length z-score can be obtained either through PediTools or through the EPIC system (Nemours's electronic medical record system). More information on the use of PediTools can be found under Appendix III of the study.

Using the EPIC system to obtain weight-for-length z score:

- 1.) Open patient charts in the EPIC system.
- 2.) Click on the growth chart tab on top.
- 3.) Make sure the reference dataset is under WHO Girls (0-2 years) or WHO Boys (0-2 years).
- 4.) Click on the weight-for-length tab on top.
- 5.) Place the arrow cursor on the date that participants attend the first feeding clinic appointment. A box will appear with the weight-for-length z-score. (Example below: weight-for-length z score is -1.85, categorized as mild malnutrition)



**Secondary analysis III (Study Aim 3):** This analysis will review the percentage of compliance with feeding recommendations in both pre-implementation and post-implementation groups. The percentage of compliance will be calculated as the total number of recommendations followed divided by the total number of recommendations given at the appointment before the six months mark after the hospital discharge upon birth. Two sample t-test or Wilcoxon rank-sum test will be used to compare the percentage of compliance between the two groups of infants. Linear regression will be performed to adjust for baseline differences, in the same way, the primary outcome is analyzed.

**Secondary analysis IV (Study Aim 4):** Pearson's correlation coefficient or Spearman's rank correlation coefficient will be used to estimate the association between the percentage of compliance and change of z scores of weight-for-length. A linear regression model will be used to evaluate the impact of compliance on weight gain, adjusting for baseline differences.

**Statistical power:**

The plan is to include a total of at least 100 infants, with at least 50 infants in each of the two study groups. This sample size was determined based on feasibility, as well as statistical considerations by Dr. Julie Crook, Ph.D. (Biostatistician/Assistant Professor) from Mayo Clinic in the Department of Quantitative Health Sciences. Weight-for-length z-scores in the general population of infants are constructed to have mean zero and standard deviation one. However, there is no existing information/data regarding the likely distribution of z-scores among preterm infants. It is expected that the means to be lower, as malnutrition will be more prevalent in premature infants, but the standard deviation is unknown. Estimates of the differences in z-

scores at 6 months will be provided to ensure adequate power (80% power, 5% significance level) under a variety of plausible assumptions for the standard deviation of the z-scores.

**Table 4.** *The difference in z-scores detectable with 80% power & 5% significance for different SD and sample sizes*

Standard deviation of z-scores	Difference in means detectable with:		
	n=25 per group	n=50 per group	n=100 per group
0.5	0.40	0.28	0.20
1.0	0.81	0.57	0.40
1.5	1.21	0.85	0.60

Regardless of statistical power, confidence intervals will be created for mean differences between the two groups, and these, along with all the informative summaries, will be of value in assessing the impact of the program, even if to a preliminary extent.

Research Question	Theoretical Construct	Data Collected	Statistical Test
<p>1.) Does the pediatric interdisciplinary outpatient feeding clinic improve infants' weight and malnutrition status when compared to the traditional, multidisciplinary model?</p>	<p>Health and system outcomes from IPLC model</p>	<p>Weight and length measurements at hospital discharge to six-month mark after discharge.</p>	<p><b>Primary analysis (Study Aim 1):</b> Weight-for-length z score – linear regression analysis.</p> <p><b>Secondary analysis I (Study Aim 1):</b> Weight-for-age z score – linear regression analysis with adjustment to the baseline value.</p> <p><b>Secondary analysis II (Study Aim 2):</b> Weight-for-length z score to categorize non-malnutrition and malnutrition status using Chi-squared test and Fisher's exact test.</p>
<p>2.) Does the pediatric interdisciplinary outpatient feeding clinic increase caregiver compliance with feeding recommendations when</p>	<p>Learning Outcomes from IPLC model</p>	<p>Pediatric interdisciplinary outpatient feeding clinic assessments checklist</p>	<p><b>Secondary analysis III (Study Aim 3):</b> Percentage of adherence to recommendations given – two-sample t-test or Wilcoxon rank-sum test.</p>

<p>compared to the traditional, multidisciplinary model?</p>			
<p>3.) Is there a correlation between caregiver compliance and infant's weight gain in both traditional, multidisciplinary model and interdisciplinary model?</p>	<p>Health and system outcomes from IPLC model</p>	<ul style="list-style-type: none"> <li>• Weight and length measurements at hospital discharge to six-month mark after discharge.</li> <li>• Pediatric interdisciplinary outpatient feeding clinic assessments checklist</li> </ul>	<p><b>Secondary analysis IV (Study Aim 4):</b> Weight per length and percentage of adherence to recommendations given - Pearson's or Spearman's correlation test.</p>

### **Anticipated Challenges:**

Gathering the data may be challenging as the study specifically looks at preterm infants, who need attentive care at all times. However, this specific group was chosen because this is a very vulnerable population. Participants will be recruited from all surrounding counties and facilities. The primary researcher's contact information will be sent out to pediatric hospitals and local pediatricians' offices for referrals. There is the risk of attrition at follow-up as patients may move to other states, have transportation issues, and/or other reasons for missed visits. However, this study provides the flexibility of what is built into the protocol and will gather more subjects if needed. The study population may not follow up at the exact six-month mark, however, the weight-for-length z-score will be reviewed. Capturing weight-for-length z-scores allows for the comparison of the infant's weight and length at the time of measurements which should minimize any errors.

Assessment checklist information will be gathered at the six-month visit or immediately after by phone. This may affect the result as the anthropometrics may not be around the six months post-discharge mark. Caregivers may have inadequate time during their visit to complete the checklist due to the variable length of the feeding clinic appointment. Based on the literature, feeding clinic time can be lengthy, often up to four hours.<sup>62</sup> Due to the length of the appointment, caregivers may be pressed for time, especially given the patient population. Caregivers may always need to be attentive to the infants (e.g., feeding the infants, oxygen care, changing diapers, etc.). Due to the COVID pandemic, some clinics only allow one caregiver at the visit; however, individual providers can lift this restriction. It will be encouraged for two caregivers to be present at appointments in the feeding clinic to assist in the data collection, as



well as anthropometric measurements. It is also a benefit to have both caregivers there to receive recommendations with the hope of increasing compliance.

The rate of weight gain is different depending on age. For example, a three-month-old infant's rate of weight gain is higher than an infant who is six months old; therefore, the distribution of the infant's age will need to be reviewed before a conclusion can be made. This discrepancy can be minimized if the study's population is around the same adjusted gestational age; however, this may be challenging due to the risk of bias due to age discrimination as the study cannot only gather premature infants that are born around the same time. The study will adjust for the infant's gestational age and review the age group in the study population.

### **Process of IRB at Nemours:**

The next step is to obtain IRB approval through Nemours for data collection. To submit for IRB approval, the researcher would need to complete training on basic (group 1), conflict of interest (COI), and Good Clinical Practices (GCP) through the CITI program at [www.citiprogram.org](http://www.citiprogram.org). After completion of the tutorial, the IRB account will be set up and ready for submission. The researcher had completed all training for Nemours IRB as of March 2021. The next step is to submit for FCOI disclosure.

Once IRB approves the study, the researcher will then start the recruitment process mentioned in the method session. Anonymity will be maintained by securing the informed consent form in a closed envelope which will be stored in a locked area to assure confidentiality.

**Study term and definition chart:**

<b>Term</b>	<b>Definition</b>
<b>Preterm Infants</b> <sup>2</sup>	According to WHO, born at younger than 37 weeks of gestation. <sup>2</sup>  (An infant born at 37 weeks or greater but who are less than 28 days old. <sup>13</sup> )
<b>Interdisciplinary Feeding Clinic</b>	The clinic involves with GI APRN, a Registered Dietitian, and a Feeding therapist/speech pathologist.
<b>Z-score</b>	The distance in standard deviation units from reference growth values adjusted for age and gender.
<b>Severe Malnutrition (using the Primary Indicators of Pediatric Malnutrition Guidelines)</b>	An infant with a z score between -3 z-score or below (will round up to the one decimal) <sup>19</sup>
<b>Moderate Malnutrition (using the Primary Indicators of Pediatric Malnutrition Guidelines)</b>	An infant with a z score between -2 to -2.9 z-score (will round up to the one decimal) <sup>19</sup>
<b>Mild Malnutrition (using the Primary Indicators of Pediatric Malnutrition Guidelines)</b>	An infant with a z score between -1 to -1.9 z-score (will round up to the one decimal) <sup>19</sup>
<b>Extreme Prematurity</b>	Infant below 28 weeks completed gestation. <sup>71</sup>
<b>FTT</b>	Weight-for-age, height-for-age, and/or head circumference-for-age under the 5th percentile. <sup>75</sup>
<b>Coding for malnutrition</b>	Malnutrition-unspecified type - E46  Mild protein-calorie malnutrition – E44.1

	Moderate protein-calorie malnutrition - E44.0 Severe protein-calorie malnutrition – E43
<b>Neonate</b>	An infant born at 37 weeks or greater but who are less than 28 days old. <sup>13</sup>

## APPENDIX I

MRN#:

### Demographic information (Fill by health professional)

1.) DOB \_\_\_\_\_

2.) Infant age \_\_\_\_\_

3.) Gestational age \_\_\_\_\_

4.) Gender

Female

Male

5.) Ethnicity (Please select one or more when applicable)<sup>76</sup>

White or Caucasian

Black or African American

Hispanic or Latino

Native American or Alaskan Native

Asian or Pacific Islander

Other

6.) G-tube present (Please select one from below)

Yes

No

7.) Breastfeeding (Please select one from below)

Yes

No

8.) Formula (Please select one from below)

Yes

No

9.) Is your child eligible for Women, infant, and children (WIC)?

Yes

No

**Data Collection:**

Hospital Discharged Date: \_\_\_\_\_

Six Month Mark Date (after hospital discharged): \_\_\_\_\_

	Date	Weight (kg)	Length (cm)	Weight per length z-score	Weight for age z-score
Hospital Discharged					
1 <sup>st</sup> outpatient visit					
2 <sup>nd</sup> outpatient visit					
3 <sup>rd</sup> outpatient visit					
4 <sup>th</sup> outpatient visit					

**Intervention group only:**

Malnutrition status at discharged: \_\_\_\_\_

Malnutrition status 6 months after discharged: \_\_\_\_\_

Malnutrition Guidelines \*Refer to table 8: none, mild malnutrition, moderate malnutrition, severe malnutrition



## **APPENDIX II**

### **Accurate Anthropometric Measurements**

#### **Procedure for Weighing infants using a digital infant scale:<sup>77</sup>**

- 1.) Cover scale with disposable paper.
- 2.) Activate the scale by turning it on, Zeroes will appear on the display panel. Make sure the scale is in kg instead of in pounds. \*If caregiver(s) is using the scale to take off the diaper, don't forget to zero the scale again and have the caregiver(s) hold the infant while you zero the scale.
- 3.) Ask the caregiver to place the infant on his or her back (without any clothes and diaper)
- 4.) Make sure the infant is not touching anything off the scale.
- 5.) The weight will appear on the display panel. Wait until the weight is paused
- 6.) Record the weight to the nearest two decimal points (e.g. 6.45 kg) on the data collection sheet. Check it for accuracy and legibility.

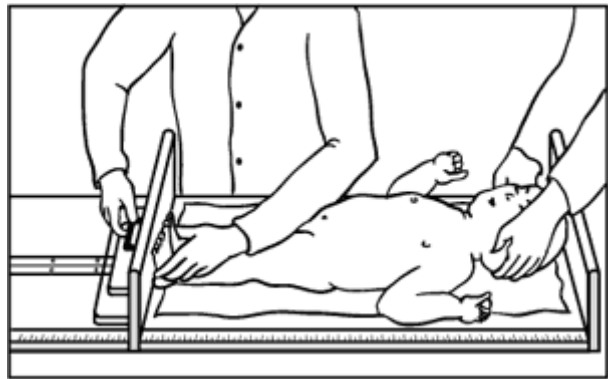
\*After the weight is measured, recommend advising caregiver(s) to place diaper back on baby and move to length board for measurement.

#### **Procedure for taking the recumbent length:<sup>77</sup>**

- Two people must be present to measure recumbent length.
  - 1.) Cover the board with disposable table paper.
  - 2.) The infant will need to be free of socks, shoes, headbands, and/or hair clips.
  - 3.) Place the sliding foot piece at the end of the measuring board and check to see that it is sliding freely.

- 4.) Ask the caregiver to stand directly behind the infant's head. Ask the caregiver to lay the infant down on his or her back on the measuring board.
- 5.) The second person, who is measuring the length, will need to position himself or herself on the right side of the infant so can hold the foot piece with the right hand.
  - Note: While the infant is on the measuring board, you must hold and control the infant so that he or she will not roll off or hit his or her head on the board.
- 6.) Ask the caregiver(s) to cup his or her hands over the infant's ears while the second person is holding down both infant's legs, will need to make sure that both legs are straight before recording. See picture 1 below.

**Picture 1. Appropriate length measurements.**



- 7.) Read the length measurement to the nearest 1/8".
- 8.) Record the measurement on the data collection sheet. Check to make sure it is accurate and legible.

## Common Errors in Measuring Recumbent Length<sup>78</sup>

1. Improper equipment used.
2. Hat, hair barrettes, or big hairdos not removed.
3. Shoes, sandals, socks are not removed.
4. The infant's head is in an incorrect position.
5. The infant's head is not against the headpiece.
6. Legs are not straightened or properly positioned.
7. Heels are not flat against the footboard.
8. Heels or legs are not flat against the recumbent board.
9. Only one leg is extended rather than both legs.
10. The infant is crying while the measurement is taken. Recommend repeating at a later time during the visit.

More information will be on the below websites:

[Pediatric measures for babies and children - MRC Epidemiology Unit \(cam.ac.uk\):](#)

<https://www.mrc-epid.cam.ac.uk/take-part/typical-visit/paediatric-measures>



## APPENDIX III

### The use of PediTools

The data will be entered into the Peditools website: [WHO Growth Standard for 0 to 24 months \(peditools.org\)](http://www.peditools.org).<sup>6</sup> This study will be using the WHO growth chart. Weight-for-length z-score will be calculated using WHO anthropometry software as a ‘gold standard’ to compare the two data points. WHO Growth Standard for 0-24 months. Using 2006 WHO growth standard charts to report percentiles and z-score on the infant from 0-24 months of age. Per the CDC, WHO growth standards are recommended for use in the US for infants and children 0 to 2 years of age. In 2006, the WHO released an international growth standard that describes the growth of children living in environments believed to support optimal growth.<sup>6</sup>

PediTools not only can provide the weight-for-age z score, but it will also provide an individualized infant’s rate of weight gain.

#### *Strengths*

- Provide an individualized rate of weight gain based on gestational age. The PediTools will provide the individual rate of weight gain for adjusted gestational age.<sup>6</sup>
- Provide calculation of exact z-scores and percentiles for 13 distinct growth charts.<sup>6</sup>

#### *Weaknesses*

- Web calculators on the PediTools website are only limited to analyze a single measurement and don’t reflect on how measurements change over time. This will need to be calculated separately.

- This is done on the server-side, therefore, in areas with limited internet availability, the tools are inaccessible. <sup>6</sup>

Hospital dietitians are using PediTools when determining growth velocity. Paper growth charts were commonly used in the past before electronic health records.<sup>6</sup> The device can be used to provide parameters for anthropometric measurements of interest related to a measurement at a given age to a precisely calculated z-score and percentile. The expected anthropometric measurement at a particular z-score and age can also be calculated. Postnatal growth failure is common in preterm infants and in the literature reviews, it was mentioned that it can be associated with long-term neurodevelopmental impairment.

This is the way to utilize the PediTools website, it is the plan to enter the date of birth, gender, gestational age at birth, and specific dates and measurements are entered. Then, the weight-for-age z-score and recommended rate of weight gain for this particular infant will be generated.

This is the website for PediTools: [PediTools Home](#)

### **Step-by-step instruction to using PediTools:**

Click on Growth calculator for preterm infants – this uses the 2013 Fenton growth charts to report percentile and z-score with integrated gestational age calculator and decision support. For data analysis, the following parameters need to be included: gender, gestational age, and growth metrics.

Below is an example of the information entered into the system.

## Growth: from 0 to 24 months

Male  Female

Age (months)

**OR** Date of birth

and Date of measure

Weight (kg)

Head circumference (cm)

Length (cm)

---

Optional: GA at birth

Once all information is entered, then press the submit button.

<b>6.18 months, female</b>						
	<b>Value</b>	<b>Imperial</b>	<b>%ile</b>	<b>Z-score</b>	<b>50%ile</b>	<b>Monthly*</b>
Weight (kg)	4.61	10 lb 2.6 oz	0%	-3.91	7.36	0.23
Head (cm)					42.3	
Length (cm)	57.5	22.64 in	0%	-3.74	66.0	1.36
Wt-for-Len (kg)			8%	-1.39	5.22	
*Expected monthly increase to maintain current percentile						

<b>3.7 months corrected, for birth at 29 0/7 weeks, female</b>						
	<b>Value</b>	<b>Imperial</b>	<b>%ile</b>	<b>Z-score</b>	<b>50%ile</b>	<b>Monthly*</b>
Weight (kg)	4.61	10 lb 2.6 oz	1%	-2.44	6.25	0.40
Head (cm)					40.3	
Length (cm)	57.5	22.64 in	3%	-1.82	61.4	1.94
Wt-for-Len (kg)			8%	-1.39	5.22	
*Expected monthly increase to maintain current percentile						

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