Neonatal/Maternal Child Health

A Low Cost Portable Device for Breastfeeding Diagnostic

The purpose of the Breastfeeding Diagnostic Device (BDD) is to allow accurate and convenient measurement of the sucking microstructure, a medical term defined in lactation literature that quantifies the infants’ efforts during breastfeeding. Breastfeeding is pivotal to optimal infant health in the newborn period and throughout the first year of life. Despite high rate of breastfeeding initiation after birth, sustained breastfeeding rapidly decreases overtime and by two weeks 30% of the mothers have started formula feeding on their infants. Therefore, there is a pressing need by mothers and healthcare providers for effective diagnosis of breastfeeding, which can benefit substantially from a quantitative assessment of infants’ effort during breastfeeding. To meet that need, we have developed a prototype of the BDD that allows direct measurement of infants’ intraoral pressure during breastfeeding with minimal disturbance, from which the sucking microstructure can be accurately derived. The Connecticut Bioscience Pipeline Grant will provide funding for recruitment of mother-infant breastfeeding dyads to test the BDD in the home settings for reliability, tolerance and acceptance during feeding. The BDD will be validated by comparing its sucking microstructure measurement across breastfeeding and bottle-feeding sessions to the well-accepted microstructure measurement using Neonur in bottle-feeding. New data from studies on mother-infant dyads will drive the essential revision of the BDD design to secure our U.S. and world patent applications. Also, a systematic value analysis of the BDD in the context of a hospital setting will be conducted to pave the way for commercialization. Completing the proposed study will make this project competitive for application to larger external funds like CBIF $500K and NIH SBIR.

Early Life experience imprints gut microbiome in preterm infants

This research project examines the new models of brain-gut-microbiota signaling mechanisms involved in early life stress and prediction of infant neurodevelopment using cutting-edge microbiological and immune-inflammatory biomarker prediction strategies. Three specific research aims are proposed in a prospective longitudinal study to examine: (1) preterm infants’ gut microbiome patterns and mucosal immune-inflammatory responses over the first 3 weeks of NICU stay; (2) the linkage of gut microbiome patterns and mucosal immune-inflammatory responses with early life stress; and (3) the linkage of gut microbiome and mucosal immune-inflammatory responses with autonomic nervous and neurobehavioral outcomes. Study results will provide the preliminary data for an R01 grant proposal and will further contribute to neonatal care in reducing negative consequences of stress in high-risk infants. A Patient-Oriented Career Development Award (K23) Funded by National Institute of Nursing Research, Xiaomei Cong, PI.

Early Life Physiological and Psychosocial Stress Imprints Gut Microbiome in Preterm Infants

Over the past decade, advances in neonatal care have led to substantial increases in survival among very preterm infants (≤ 32 weeks gestation). With these gains, recent concerns have focused on significant increases in neurodevelopment morbidity such as white matter damage in the developing brain and serious diseases such as necrotizing enterocolitis (NEC) linked to immature neuro-immune systems and early life stress. In the neonatal intensive care unit (NICU), premature infants are often exposed to a variety
of early life stressors, including repeated painful procedures, daily clustered care, infection, antibiotic treatment, and maternal separation during critical neurodevelopmental windows. Nearly 40% of NICU survivors have at least one neurodevelopmental deficit and the resultant costs exceed $26.2 billion per year plus the added burden for families and society. Yet, mechanisms of early life experiences that alter infants’ health outcomes remain largely unknown.

The brain-gut signaling system in conjunction with the composition of the gut microbiome has been found to be remarkably related to life-long stress and health. Recent evidence demonstrates that microbial species, ligands, or products within the developing intestine are crucial to early programming of the central nervous system and regulation of intestinal innate immunity. The central hypothesis driving this translational research is that premature infants subjected to stressful early life experiences develop an altered gut microbiome increasing risk for neurodevelopmental morbidity and gastrointestinal (GI) dysfunction relative to the development of NEC. Using state-of-the-art analytic and computational methods, our study will be the first study to investigate the linkage of early life stress with the brain-gut-microbiota mechanism in human preterm newborns. A prospective longitudinal design will be used to examine:

**Aim 1:** Preterm infants’ gut microbiome patterns over the first 3 weeks of NICU stay;

**Aim 2:** The linkage of gut microbiome patterns with early life stress;

**Aim 3:** The linkage of gut microbiome with autonomic nervous system responses, neurodevelopmental outcomes, and patterns of GI dysfunction related to the development of NEC.

During the 5-year study conducted in the CCMC NICU (Hartford and Farmington), 50 stable preterm infants (28 0/7 – 31 6/7 weeks gestation) will be recruited and followed for 3 weeks. The outcome measurements are gut microbiota (16S rRNA, metagenomic, and metatranscriptomic sequencing), early life stress (NICU Infant Stressor Scale), autonomic responses (spectral analysis of heart rate variability), neurodevelopmental outcomes (NICU Network Neurobehavioral Scale), and GI dysfunction (enteral feeding and NEC incidences). Data collection will begin on day one of life once consent is obtained from parents. Stool samples and autonomic responses will be collected on postnatal days 1 to 5, 7, 10, 14, 18, and 21 (10 data collection points), early life stressors will be measured daily, and neurodevelopmental outcomes will be examined at 36 weeks post-menstrual age prior to NICU discharge. GI dysfunction will be measured throughout the NICU stay. Exploratory data analysis will be conducted with a focus on the evolution in each variable’s distribution over time and linkages among variables. Funded by the Institute for Systems Genomics (ISG), Xiaomei Cong, PI.

**Factors Related to Prevalence of Sustained Breastfeeding**

**Background:** The late preterm infant (35-38 weeks gestation) exhibits physiologic risk for less than adequate nutritional intake when exclusively breastfeeding, and therefore may require supplemental feedings. There is little evidence to support the best practice to produce the long term outcome of sustained breastfeeding in this population.

**Purpose:** The purpose of the proposed pilot, exploratory, correlational study is to determine the prevalence of sustained breastfeeding in the late preterm infant at one and two months of age. In addition, exploring which factors may predict sustained breastfeeding in the late preterm infant will be examined.
Methods: Variables for the proposed study will be breastfeeding self-efficacy, in-hospital lactation consultations, use of supplemental feeding methods, maternal and infant demographic data, characteristics of the birth process, in-hospital feeding practices, and post discharge lactation support. After informed consent, subjects identified through purposive sampling will tabulate their Breastfeeding Self-Efficacy Scores and lactation support, supplemental feeding methods used, and demographic factors will be collected. At one and two months of age, telephone structured interviews will determine the current feeding status and assess post discharge lactation support.

Statistical Analysis: Descriptive statistical and bivariate logistic regression analysis will identify the prevalence of sustained breastfeeding in this population and articulate the predictive capacity of the data collected for sustained breastfeeding at one and two months of age. Impact on Nursing Practice: By determining the prevalence of and identifying what factors are related to sustained breastfeeding in late preterm infants, there will be evidence to support practice guidelines in this population. Funded by Sigma Theta Tau Mu Chapter, Joan Kuhnly, PI

Maternal Assessment of Infant Breastfeeding Pattern

Purpose: The purpose is to 1) to describe maternal perceptions of infant breastfeeding behaviors weekly from birth to 1 month of age and 2) to determine how infants’ breastfeeding behaviors and breastfeeding behavior type changes from birth until 1 month after discharge.

Background/Significance: Although the goal for mothers and infants is to exclusively breastfeed for six months, barely half of all mothers exclusively breastfeed their infants beyond two weeks of age. The most commonly reported maternal reasons for breastfeeding cessation, lack of infant satiation, milk insufficiency, and ongoing cracked and bleeding nipples, may actually be an outcome of an infant’s breastfeeding behaviors. Developing a maternal self-report instrument that describes different types of ineffective latch and inefficient breastfeeding patterns would assist mothers to seek professional assistance and clinicians to identify mothers and infants at risk for early breastfeeding cessation.

Methods: A prospective longitudinal study will be utilized to describe mothers’ perception of their infants’ breastfeeding behaviors and their selection of their infants’ breastfeeding behavior type during hospitalization, at 1-, 2-, 3- weeks and 1 month after hospital discharge.

Setting/Sample: Fifty mother-infant breastfeeding dyads will be recruited from the Birthing Center of Duke Hospital, a regional referral center with 3300 births per year. Infants > 34 weeks gestation will be recruited from the Well-Baby Nursery and Special Care Nursery

Procedures: Data will be collected via chart review, maternal self-report instrument, and audio taped semi-structured interview at enrollment in the hospital, and audio taped semi-structured interview telephone calls and maternal self-report instrument at 1-, 2-, 3- weeks, and 1 month after hospital discharge.

Analysis plan: Analysis of research questions will include simple number and percentages to describe infant breastfeeding behaviors and behavior types and a Generalized Linear Mixed-Effects Models applying Generalized Estimating Equations to examine infant breast feeding behaviors over time. In addition, a set of 2 x 2 Fisher’s Exact Tests will be performed to examine the association between the absence (0) and
presence (1) of each type of breastfeeding behavior at each assessment point based on maternal perceptions, and a set of bivariate logistic regression analyses will be performed to examine the influence of potential explanatory variables on breastfeeding cessation by 1-month, controlling for maternal and infant characteristics.

Nursing Relevance/Implications: Development of a reliable maternal self-report instrument of infant breastfeeding behavior types will facilitate early identification of mother-infant dyads at-risk for early breastfeeding cessation. The long term goal of this research is to validate the maternal self-report instrument with the physiological parameters of nutritive sucking using the number of sucks, number of sucks per burst to quantify ineffective and inefficient infant breastfeeding behaviors to identify infants at-risk for early cessation of breastfeeding and altered neurodevelopment. Funded by the American Nurses Foundation, Ruth Lucas, PI, Jacqueline McGrath, Co-Investigator.

Maternal Assessment of Infant Breastfeeding Behaviors

Breastfeeding is beneficial to mother and infant. However, in 2011, only half of all breastfeeding dyads are exclusively breastfeeding at two weeks. Research has extensively examined maternal factors contributing to successful breastfeeding initiation and duration. Little research has examined infant factors that contribute to breastfeeding success. Presently, an infant’s breastfeeding success is measured by infant satiation after feeding and normative growth. These two infant outcomes depend on an infant’s ability to create an effective latch, vacuum at the breast, and sustain an efficient latch, adequate milk transfer for satiation and growth. Infant factors that likely contribute to breastfeeding discontinuation are an ineffective infant latch and lack of an efficient pattern. During an infant’s hospital stay, professional tools and breastfeeding support is focused on the infant creating an effective latch. Evaluation of an efficient pattern during hospitalization is by the number of audible swallows and may be difficult to assess as maternal milk is being established. A maternal assessment of effective and efficient feeders would help mothers before and after their milk is established to identify if their infant is at risk for breastfeeding cessation. Currently, observation of breastfeeding behaviors is the gold standard to assess nutritive sucking parameters. The most robust parameters for effective latch is average maximum pressure, and for efficient patterns are visual observation of the number of sucks and the number of sucks per burst during a feeding. Measuring the average maximum pressure does not have readily available apparatus within the United States. However, an infant is not able to sustain an efficient pattern without an effective latch. A recent maternal assessment in a retrospective Japanese study had mothers describe their infant as one of five different categories of breast feeders: barracudas (vigorous), resters, gourmets, excited-inefficient, and procrastinators. Each category of breast feeders was described with different breastfeeding durations and different combinations of effective and efficient breastfeeding behaviors. The purpose of this pilot study is to determine the reliability of weekly maternal assessment of infant breastfeeding behaviors using the categories of breast feeders and to test the feasibility of comparing maternal assessment of categories of breast feeders to observed infant behaviors. My program of research trajectory is to further expand maternal assessment of infant breastfeeding behaviors to be used as a screening tool for atypical neurodevelopment and early identification of infants to refer to early intervention. Funded by the Association of Women’s Health Obstetrics and Neonatal Nurses, Ruth Lucas, PI, Jacqueline McGrath Co-Investigator.

Maternal Descriptions of Late Preterm Infant Breastfeeding Behavior Types
**Problem:** Although the goal for mothers and late preterm infants is to transition to breastfeeding exclusively, little is known about late preterm infant breastfeeding behaviors during the first month after discharge home. The purpose of this study is to examine maternal descriptions of their infant’s breastfeeding behavior and have mothers categorize their infant’s breastfeeding behavior using a maternal report instrument of infant breastfeeding behavior types. Mother-preterm infant dyads will be followed weekly from enrollment to 1 month after discharge.

**Method:** A prospective descriptive pilot study.

**Sample:** A convenience sample of 25 mother-preterm infant (34 – 36 6/7 weeks gestational age) breastfeeding dyads.

**Instruments:** A semi-structured interview of mothers describing their late preterm infant breastfeeding behaviors and a maternal report instrument of infant breastfeeding behavior types.

**Procedure:** Mother-preterm infant breastfeeding dyads will be recruited after delivery and before infant discharge for four weekly contacts. At weekly contact, mothers will be interviewed using a semi-structured interview and mothers will also be asked to complete a maternal report instrument categorizing their infant’s breastfeeding behavior type.

**Significance:** Information from this study will identify infant breastfeeding behaviors that may contribute to early breastfeeding cessation, partial at-breast feeding and exclusive at-breast feeding and thereby assist mothers to seek timely professional assistance. Funded by National Association of Neonatal Nurses, Ruth Lucas, PI, Jacqueline McGrath, Co-Investigator