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Impact of a NICU Bedside Reading Initiative on Self-Reported Maternal Stress and Mother-Infant Attachment

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IMPACT OF A NICU BEDSIDE READING INTIIATIVE ON SELF-REPORTED MATERNAL STRESS AND MOTHER-INFANT ATTACHMENT

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By

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ABSTRACT

IMPACT OF A NICU BEDSIDE READING INITIATIVE ON SELF-REPORTED MATERNAL STRESS AND MOTHER-INFANT ATTACHMENT

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Dissertation supervised by Ara J. Schmitt, Ph.D.

Premature birth and a corresponding hospitalization in the Neonatal Intensive Care Unit (NICU) presents infants and their families with an array of medical and psychosocial stressors that have the potential to impact neurodevelopment and social-emotional functioning in both the long-and short-term. Research has demonstrated the importance of family-integrated, developmental care interventions and a need for supportive environmental and sensory stimulation for the infant to optimize developmental, social, and emotional outcomes. Engaging parents in bedside care that fosters sensory development, supports cognitive and language skills, and lays a strong foundation for bonding and attachment can be monumental for the dyad. Implementation of a NICU-based mother-infant bedside reading intervention has a variety of potential benefits for both the mother and the infant, specifically in relation to supporting the growing maternal-infant attachment relationship and alleviating some degree of maternal stress from the NICU environment.

DEDICATION

I dedicate this text to my family, and especially my beautiful children, Rowen and Calla.

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Chapter I

Introduction

Premature birth, or a birth occurring prior to 37 weeks gestation, affects about 1 of every 10 infants born in the United States. Although preterm birth rates in the U.S. decreased from 2007 to 2014, rates rose for the second straight year in 2016 (Centers for Disease Control and Prevention, 2017). Medical management of premature infants has advanced greatly in recent decades, and infants of increasingly lower gestational ages have a chance at survival. Advancements in medical technology and the corresponding decreased rates of mortality aside, morbidity rates for premature infants remain high. For those neonates that survive, significant short-term and long-term physiological and psychological implications exist for both the premature infants and their families (Als et al., 2004).

Premature infants often spend their first days, weeks, or even months in a neonatal intensive care unit (NICU). The NICU environment offers medical care and support for prematurity-related complications in infants, including respiratory problems, temperature instability, cardiovascular problems, blood or metabolic issues, infection, gastrointestinal issues, and neurological complications (Altmier & Phillips, 2014). The NICU also provides advanced medical care for this vulnerable population, but the environment of the NICU itself is also associated with increased levels of stress, which impact the infant's neurodevelopment and the developing parent-child relationship. For parents, stressors associated with the NICU may interfere with their developing relationship with their child and create difficulties in other familial relationships as well. Specific aspects of the NICU environment that have the potential to be highly stressful for parents may include the physical environment in a new and unfamiliar ICU setting, the infant's physical appearance and behavior, staff and parent interactions, and

alterations in the parent role (Miles, 1989). Parents of premature infants are at greater risk for mental health concerns including postpartum depression, anxiety, post-traumatic stress disorder, and other stress-related conditions (Ishizaki, 2013).

The effects of prematurity and the NICU are both biological and environmental in nature, and may have lasting neurodevelopmental implications that can persist through young adulthood (Als, et al., 1994). Prematurity is associated with learning, motor, visual, and hearing impairments, contributing to approximately half of disabilities in childhood (Saigal & Doyle, 2008; Glass, Costarino, Stayer, Brett, Cladis, & Davis, 2015). In order to possibly avoid the occurrence of disability, interventions in the NICU to promote developmentally-supportive care practices and appropriate developmental stimulation are widely advocated (O'Brien et al., 2013; Ortenstrand et al., 2010). Developmental care practices aim to provide supportive, individualized interventions to decrease stress and optimize neurodevelopmental outcomes as the infant receives intensive medical care in the NICU. These strategies, and other family-centered interventions to lower parental stress and improve bonding, may benefit both the infant and the parent-child dyad.

Significance of the Problem

A vast literature base exists in which investigators explore the impact of developmental care strategies and the positive outcomes for infants and their families, both physiological and psychological. These strategies have been associated with decreased rates of parental stress and improved parent-infant attachment relationships (Vandenberg, 2007). Individualized developmental care interventions have also demonstrated ranging effects in enhancing neurodevelopmental outcomes in domains such as cognitive, motor, and language skills (Symington & Pinelli, 2006). These may include interventions such as infant massage, positive

touch, optimizing the NICU environment, and/or parental reading at bedside. In consideration of appropriate interventions that can most significantly impact all parties involved in both the short- and long-term, we must consider the domains of functioning at highest risk, time and cost of intervention strategies, and the known benefits for both the infant and their family.

Although the World Health Organization (WHO) defines prematurity as any birth occurring prior to 37 weeks gestation, the WHO further categorizes prematurity based on gestational age including extremely preterm (<28 weeks), very preterm (28 – <32 weeks), and moderate or late preterm (32– <37 completed weeks of gestation) ("Preterm Birth", 2018). Children born in the very or extremely preterm categories are at higher risk levels for co-morbid medical disorders and long-term disability. Neurological insults, specifically intraventricular hemorrhage (IVH), are a major complication of prematurity and particularly for infants born very or extremely preterm (<32 weeks gestation (Whitelaw, 2001). Intraventricular hemorrhage may arise due to a host of factors considering the fragility of the germinal matrix vasculature and the possibility of disturbance in the cerebral blood flow in the premature infant. Presence of IVH reduces the survival and enhances the risk of a number of additional neurological implications, including post-hemorrhagic hydrocephalus, cerebral palsy, developmental disability or intellectual disability. Of infants with moderate to severe IVH, approximately 45–85% develop major cognitive deficits and approximately 75% of these infants require special education in the academic setting (Ballabh, 2010).

One specific functional domain of concern for infants born prematurely and experiencing IVH is language development. Studies have found cerebellar hemorrhagic injury in preterm infants to be associated with a higher prevalence of long-term pervasive neurodevelopment disabilities, including receptive and expressive language deficits (Limperopoulos et al., 2007).

Deficits in language and communication have both short and longer-term implications and are likely to affect a student's school success and longer-term developmental progress (Foster-Cohen, Champion, & Woodward, 2010).

Given increased rates of delay and disability in the domain of language development in this population, an intervention targeting not only these concerns for language development in the neonate, but also the mental health of the parent and the parent-child relationship, is optimal. NICU-based parent-infant reading initiatives or interventions have the potential to benefit both the child and parent by providing the infant with appropriate auditory stimulation while in the NICU environment, exposing the infant to speech and language to support future expressive and receptive communication development, and cultivating the early parent-child relationship through a positive bedside activity in a NICU setting were parenting opportunities may be limited.

Positive implications of a NICU based parent-infant reading initiative to educate parents on the positive effects of reading to their infant in a NICU environment and encouraging and supporting regular engagement in this activity may include decreasing parental stress and supporting parent-infant attachment, yet these specific outcomes have not yet been explored in the literature. In addition to levels of parental stress and the attachment relationship, for infants, the increased exposure to parental speech facilitates auditory development and later language skills. A NICU based parent-infant reading initiative is a low-cost strategy that may assist the parent in positively engaging with his or her premature infant, while supporting the parental role at the child's bedside in the NICU.

Theoretical Basis

Theories such as the Biopsychosocial Model, Stress Theory, and the Theory of Synactive Development, focusing on experience dependent learning, all contribute to this topic of interest. The Biopsychosocial Model emphasizes the importance of understanding human health and illness (Engel, 1977; Placencia & McCullough, 2012). Through this model, we understand that infants born prematurely are at greater risk of medical instability and following discharge, they often require more frequent medical visits, hospital admissions, and in-home care services. Parents and caregivers experience greater care demands, both inpatient and outpatient, which may pose stress and strain on the child's caregivers and, consequentially, on the family unit as a whole. Stress Theory also contributes to this domain of study as it describes stressors as physical or psychosocial elements of a situation that impose demands on an individual and lead to a stress response (Magnussen, 1982). In the NICU environment, there are physical, interpersonal, and psychosocial transactions and elements that affect the family and parent. Finally, the Synactive Theory of Development by Als (1982), describes that a child must negotiate the early and emerging developmental process within the context of their environment. When this environment is within the NICU setting, early experiences and subsequent learning is impacted.

As we understand the impacts of early experiences on neurodevelopment and learning, we can more specifically focus in the domain of reading. Reading aloud to children at a young age has proven instrumental for experience-dependent learning and for the development of early language and reading skills (Larivviere & Rennick, 2011). Hart & Risley (1995) demonstrated this in their study that examined linguistic and academic progress among children from different socioeconomic backgrounds. For 2.5 years, infants in 42 families were observed for one hour per week from 7 months until 3 years of age. Authors found that parent talkativeness to their infants

accounted for a correlation between SES and the children's later linguistic and academic development. The study demonstrated that children benefited from a conversational communication style with parents and found that the size of a child's vocabulary could be experience dependent and not necessarily attributed to an inherent language learning difficulty (Hart & Risley, 1995).

Long-term benefits of shared reading, even in infancy, include higher vocabulary comprehension and production, cognition, and socioemotional competence (O'Farrelly, Doyle, Victory, & Palamaro-Munsell, 2018). The development of the auditory system during the critical neonatal period occurs based on the quality of sounds infants experience, and language in books provides positive input through exposure to speech and parent voice. In addition to benefiting speech and language development, reading in the NICU environment may support the growing attachment between the parent and child. Zauche, Darcy Mahoney, Thul, Zauche, Weldon, and Stapel-Wax (2017) found that by teaching parents the benefits of treating their young child as a conversational partner and by modeling such interactions, pediatric health care providers can help parents support their child's literacy, educational success, and health. In the NICU environment where there are barriers to positive reciprocal parent-infant interactions, reading is an opportunity for parental engagement and fostering of the early parent-child relationship. Literature on reading advocacy programs has shown that NICU parents identified reading with their infant as an important behavior both during NICU hospitalization and after discharge, and reported more frequent shared reading, on a weekly basis, even after discharge (Janasek, 2015).

Relevant Literature

Parents of infants hospitalized in the NICU are subject to increased levels of parental stress, and many elements of the NICU environment and their child's hospitalization can have

negative implications for the burgeoning maternal-infant attachment relationship. Providing support to parents, specifically mothers, during this critical time may assist in ameliorating some degree of stress and support the burgeoning parent-child relationship. Use of a NICU-based mother-premature infant bedside reading initiative can provide a way for the mother and infant to connect, thus decreasing some degree of stress associated with the difficulties parenting a premature infant. Additionally, it may support the growing mother-infant relationship and provide appropriate sensory stimulation to the premature infant, who relies on this positive input for neurodevelopmental growth. There is extensive empirical literature to support this process.

Recent literature supports the idea that parental reading to infants in the NICU can connect a parent and child and offer a way to positively engage parents in caregiving (Walker, 2013). Lariviere and Rennick (2011) examined the specific effects of a NICU-based parent book reading intervention on parent and child interaction and its impact on the frequency of reading to infants following discharge. Parents reported increased feelings of control, intimacy, and normalcy when engaging in this practice in the NICU setting. Additionally, twice as many parents, compared to a matched control group, reported reading three or more times a week to their child once home from the hospital following this intervention.

Research has not explored the impacts of a NICU-based parent-infant reading initiative to reduce negative effects of parental stress and to support the growing parent-infant attachment relationship. For the purpose of this study, a brief, targeted initiative aiming to educate parents on the benefits of reading to their baby in the NICU will be developed and implemented in the Children's Hospital of Pittsburgh of UPMC Neonatal Intensive Care Unit (NICU). Measurement of parental stress through the Parental Stressor Scale: Neonatal Intensive Care Unit (PSS: NICU) and the maternal-child attachment relationship via the Maternal Attachment Inventory (MAI)

prior to and following this intervention program will be completed. Accordingly, I am posing the following research questions:

Research Question 1: Does a NICU-based, mother-premature infant bedside reading initiative impact levels of parental stress during the premature infant's hospitalization in a NICU? Hypothesis 1: Compared to mothers in a no-treatment control group, maternal stress levels as measured by the Parental Stress Scale: Neonatal Intensive Care Unit (PSS:NICU) will significantly decrease after implementation of the bedside mother-premature infant reading initiative.

Research Question 2: How does a NICU-based, mother-premature infant bedside reading initiative impact the mothers' report of the maternal-infant attachment relationship during their premature infant's hospitalization in the NICU? Hypothesis 2: Following the implementation of the NICU-based bedside mother-premature infant reading initiative, mothers will report enhanced mother-infant attachment relationships as measured by the Maternal Attachment Inventory (MAI) when compared to a no-treatment control group.

Research Question 3: How do the degree of prematurity and level of IVH relate to parental stress and maternal-infant attachment, and do the effects of a NICU-based mother-premature infant bedside reading initiative differ in their impact maternal-infant attachment and parental stress during a premature infant's hospitalization in the NICU based on level of prematurity and degree of IVH? Hypothesis 3: Severity of prematurity and IVH will predict higher levels of parental stress as measured by the PSS:NICU, in both intervention and control groups, but stress will be reduced more significantly in treatment groups compared to no-treatment controls. Hypothesis 4: Maternal-infant attachment as measured by the MAI will be more impaired in infants with more significant levels of prematurity or severity of

intraventricular hemorrhage but will improve more significantly across the course of the infant's hospitalization in the treatment group, compared with the no-treatment control group.

Chapter II

Literature Review

According to the Centers for Disease Control and Prevention, nearly half a million or 12.3% of infants are born prematurely in the United States each year (Chronic Disease Prevention and Health Promotion | CDC, 2017). Preterm birth is also a global obstetric challenge. About 13 million preterm deliveries occur per year worldwide, an overall incidence rate of about 9% of all births (Altmier & Phillips, 2014). These infants are subject to increased mortality rates, but also a range of short and long-term morbidities, including pulmonary, cardiac, neurological, and renal problems (Altmier & Phillips, 2014). Dependent on morbidity factors as well as their gestational age, infants may experience extensive hospitalizations in a neonatal intensive care unit (NICU) following birth. Medical advances have led to dramatic survival increases of very low birth weight infants, yet risk for lasting medical issues and developmental delay or disability remains a concern.

Premature birth has great impacts on the child, but there are many psychosocial implications for the family, as well. Premature birth impacts the parents' expectations of a normal pregnancy, birth, and healthy child, and may cause increased situational, personal, and environmental stress (Als et al., 1994). The risk of impaired parent-child interaction and attachment problems is also increased with a NICU admission. Caregivers must acquire specialized caregiving skills, comprehend and discern complex information regarding the infant's illness and medical condition, and communicate with various staff in the NICU environment. Parents have fewer opportunities to engage in normal newborn caregiving practices, which has implications for the early parent-child interactions and relationships (Bialoskurski, Cox, & Hayes, 1999). Early positive, and secure attachment relationships are

associated with more positive outcomes in early childhood, school age, and even into adolescence and adulthood. Research suggests that family factors and environmental influences are even more predictive of future academic performance of children born prematurely than were perinatal complications (Gross, Mettleman, Dye, & Slagle, 2001). Gross and colleagues (2001) described that in general, neonatal medical risk factors become less critical over time as environmental influences begin to play a more dominant role in cognitive outcome. They found that preterm children having ongoing and consistent contact with both biological parents, even if they lived in separate households, were 3 times more likely to be at appropriate grade level, and children reared in stable family units were significantly more likely to have optimal school outcome (Gross et. al., 2001). Their findings suggest an interactive relationship between environmental and biological risk factors, specifically for preterm children, who may be more vulnerable to environmental influences, specifically non-optimal ones (Gross et. al., 2001).

Medical Implications of Prematurity

A premature infant is one born early, prior to 37 weeks gestation. As a result of premature birth, infants are subject to an array of health problems and may experience extended hospitalizations in their early life, most likely beginning in a NICU. Dependent on when during the gestational period the baby is born, neonates are categorized into stages of prematurity. Late preterm infants are born between 34 and 36 weeks of pregnancy, moderately preterm infants are born between 32 and 34 weeks of pregnancy, very preterm infants are born at less than 32 weeks of pregnancy, and extremely preterm infants are born at or before 25 weeks of pregnancy (Sponge et al., 2011). Generally, the earlier the infant is born, the more likely he or she will experience health problems and spend time in a NICU. Infants born late preterm are at less risk than infants born before 34 weeks, but are more likely to have long-term neurodevelopmental

problems or experience infant death than those born at term (Ellman et al., 2007). Additionally, infants born between 34 and 37 weeks account for the highest rate of admissions to the NICU and for a large proportion of health care costs in the United States (Sponge et al., 2011).

Causes of Prematurity and Resulting Health Problems

Various pregnancy-related problems may increase the risk of preterm birth. Some of these risk factors include a weakened cervix, birth defects of the uterus, history of preterm birth, infection, poor maternal nutrition, preeclampsia, or premature rupture of membranes. Beyond these possible causes, in many circumstances the causes of premature birth are unknown.

Infants may experience a wide variety of health problems as a result of prematurity impacting various organ systems. Babies born prior to 34 weeks gestation commonly experience respiratory distress syndrome (RDS), as they do not produce sufficient surfactant necessary to expand the small air sacs within the lungs (World Health Organization, 2018). From a respiratory perspective, more significantly preterm infants are also at risk for chronic lung disease (CLD) or bronchopulmonary dysplasia (BPD), often requiring prolonged respiratory supports. From an ophthalmologic perspective, they may experience Retinopathy of Prematurity (ROP), which arises when blood vessel growth in the eyes occurs abnormally. Untreated, this can lead to vision loss and blindness. Preterm infants receive regular ophthalmologic screenings to monitor the presence or progress of ROP and treatments for more severe cases may include laser surgery (World Health Organization, 2018).

Hyperbilirubinemia is another common diagnosis for a premature infant. Almost all preterm infants less than 35 weeks gestational age (GA) have elevated total serum or plasma bilirubin (TB) levels, which results in neonatal jaundice, the yellowish discoloration of the skin caused by bilirubin. The major complication of hyperbilirubinemia is bilirubin-induced

neurologic dysfunction (BIND), which occurs when bilirubin crosses the blood-brain barrier and binds to brain tissue. Kernicterus is the chronic and permanent neurologic outcome of BIND and can have significant lasting neurological impacts. Hyperbilirubinemia is treated with phototherapy or exchange transfusions (World Health Organization, 2018). Infants born prematurely are also at risk for a Patent Ductus Arteriosis (PDA), a heart issue that arises when the ductus arteriosus which connects the two major blood vessels of the heart does not close properly after birth, which can lead to respiratory problems and heart failure if untreated.

A condition called necrotizing enterocolitis (NEC) is also prominent in this population. Necrotizing enterocolitis is a disorder involving the intestines, which can arise several weeks following birth and may lead to feeds being halted during treatment, and in more severe cases, bowel resections. From a neurological perspective, infants born prematurely are at higher risk for intraventricular hemorrhage (IVH), which in more severe forms can have lasting significant neurological and developmental impacts on the child, and must be closely monitored (World Health Organization, 2018).

Intraventricular Hemorrhage

Intraventricular hemorrhage (IVH) refers to bleeding inside or around the spaces in the brain containing the cerebral spinal fluid (i.e., the ventricles). Intraventricular hemorrhage is a major complication of prematurity and remains a major problem both in the short and long term for the premature infant in a NICU setting. Approximately 12,000 premature infants experience IVH each year in the United States (Ballabh, 2010). The incidence of IVH in infants under 1500 grams, considered very low me (VLBW) infants, has decreased from 40-50% in the early 1980s, to 20% in the late 1980s. However, since this time, the incidence has remained stable at nearly 20%. In extremely low birth weight (ELBW) infants, weighing between 500-750 grams, the

occurrence rate of IVH is higher, near 45% (Wilson-Costello, Friedman, Minich, Fanaroff, & Hack, 2005).

Intraventricular hemorrhage generally begins in the germinal matrix of the neonate, which is a highly vascularized collection of neuronal-glial precursor cells. This may generate due to a variety of factors, but most commonly is attributed to disturbances in cerebral blood flow in the fragile germinal matrix vasculature. When hemorrhage in the germinal matrix occurs, the ependyma breaks, and the ventricles fill with blood (Ballabh, 2010). Smaller and more premature the babies and those with respiratory problems are more likely to experience IVH. Neonates are at greatest risk of IVH within the first 48 hours of life, and nearly all IVH occurs within the first four days of life.

An IVH is often undetectable outside of screening head ultrasounds, but may be detected by subtle changes in level of consciousness, movement, tone, respiration, or eye movement. Less commonly, more significant deterioration of physiological status may occur with symptoms including coma, posturing, generalized tonic seizures, or quadriparesis (Whitelaw, 2001; Ballabh, 2010).

Outcomes of Intraventricular Hemorrhage

The survival rate of premature infants is greatly impacted by the presence of IVH, which increases the risk for a number of neurologic issues and deficits. Additionally, a higher mortality rate is observed in premature infants with severe IVH (Whitelaw, 2001). Outcomes are impacted by the severity or grade of the IVH. Premature infants with moderate to severe IVH, Grades three or four, are at higher risk for post-hemorrhagic hydrocephalus, cerebral palsy, and intellectual disability (Ballabh, 2010). Infants with mild IVH, Grades one and two, also remain

at risk for a range of developmental disabilities (Bolisetty, Dhawan, Abdel-Latif, Bajuk, Stack, Lui, 2014).

Approximately 45–85% of premature infants with moderate to severe IVH develop major cognitive deficits, with nearly 75% of these infants later requiring special education in schools (Roze et al., 2009). Although thought to be less severe, Grade one and two IVH is still associated with adverse neurodevelopmental outcomes in extremely premature infants. In a regional cohort study by Bolisetty and colleagues (2014) of preterm infants born between 23 and 28 weeks gestation, isolated grade one and two IVH was independently associated with neurosensory impairment, higher rates of developmental delay, cerebral palsy, deafness, and blindness (Bolisetty et al., 2014).

In a study by Roze et al. (2009), motor, cognitive, and behavioral outcomes at school age in preterm children with periventricular hemorrhagic infarction were examined. A prospective cohort study was completed with all preterm infants less than 37 weeks gestation with periventricular hemorrhagic infarction from the years 1995 through 2003. Ultrasound scans were reviewed, and at four to 12 years of age, motor, neurologic, behavior, and intelligence outcomes were evaluated. Surviving preterm children with periventricular hemorrhagic infarction were at greater risk for diagnoses of cerebral palsy, although functional impairments at school age were limited. Roze and colleagues (2009) reported that for 60-80% of preterm infants in the cohort, intelligence was within one standard deviation of the norm. Verbal memory, behavior, and executive function problems occurred slightly more than for preterm infants without lesions, yet functional outcomes at school age were found to be more positive than previous literature indicated (Roze et al., 2009).

Sensory Development in Premature Infants

In terms of sensory development of the fetus and infant, basic physical structures such as the eyes, ears, mouth develop early in gestation, but in the last 16 to 20 weeks the primary neurosensory development occurs. Neurosensory development of the fetus is known to follow a sequential pattern throughout the gestational period, beginning with sensations to skin (touch), followed by kinesthetic (movement), chemosensory, auditory, and lastly visual development (Graven, 2000). Development of the sensory systems typically occurs during the gestational period in the in-utero environment. However, when an infant is born prematurely, these sensory systems are forced to mature in a much different environment. Physical, chemical, sensory, and social-emotional exposure within the NICU environment are known to influence the development of these systems (Graven, 2000). Sensory stimulation and exposure may occur at the wrong time in the developmental trajectory or at a level of intensity that is not appropriate. This can have various neurodevelopmental consequences and emphasizes the importance of adapting the NICU environment to support healthy brain development (Graven & Browne, 2008).

Auditory development. Auditory development includes both the structural development of the parts of the ears in the first 20 weeks of gestation, and the development of the neurosensory part of the auditory system primarily after 20 weeks gestational age. Following these time periods, the auditory system becomes functional at around 25 weeks gestation and it enters a critical period from then until 5 to 6 months of age when it must receive appropriate stimulation to develop in a typical fashion (Graven, 2000). Elements of the auditory system include the cochlea of the middle ear and the auditory cortex in the temporal lobe. Sounds stimulate the inner ear through a mechanism of bone conduction. Signals of varying intensity

and frequency through speech, music, and sounds of our environment activate the hair cells of the cochlea, axons of the auditory nerve, and neurons of the temporal lobe auditory cortex. The frequencies at which this occurs in the womb parallels the frequency development in the cochlea, as tissue and fluid filter high-frequency sounds protecting the cochlea and supporting auditory maturation (McMahon, Wintermark, & Lahav, 2012). As the NICU often generates intense and continuously loud background noise, frequency discrimination and ultimately the development of the auditory system, is impacted. Controlling this outside noise and, at appropriate points in the developmental course, providing exposure to meaningful speech sounds and music are critical steps for auditory system development (Graven & Browne, 2008).

The auditory system of the preterm infant is adequately mature between 30 and 32 weeks gestation to permit auditory learning. Auditory learning has been demonstrated as early as 35-36 weeks gestation, and is affirmed by studies demonstrating newborns selectively responding to maternal speech (Krueger, 2010). In a NICU setting, exposure to speech is critical, and care practices must be instilled to reduce ambient noise to permit the infant to hear and respond to family speech and language (Graven, 2000). In an effort to address this noise and the sound levels in a NICU environment, the American Academy of Pediatrics Committee on Environmental Health developed guidelines for safe sound levels within the NICU. These included hourly L_{eq} of 50 dB, hourly L_{10} of 55 dB, and 1-second duration $L_{max} < 70$ dB (Graven, 2000). These noise criteria assist in lowering ambient noise, but still allow for speech intelligibility.

Impact of the NICU on Families

Premature birth and hospitalization in the NICU setting is a significant and stressful life event not just for infants, but also for their families. Financial, social-emotional, and physical

burdens are often placed on families during this time. Families may live a distance from the hospital, have limited transportation, have additional children in the home to care for, or may need to return to work so they can be present when their child is discharged from the hospital. All of these factors may limit a parent's presence in the NICU during their child's hospitalization. Parents of premature infants may lack support and have fewer opportunities to engage with their newborn than if their baby did not experience a hospitalization in the NICU. This can lead to misperceptions of the baby's behavioral cues, and labeling of their babies as 'difficult,' leading to lasting attachment-related issues (Craig et al., 2015). Parents of premature infants are also at increased risk for mental health issues, including postpartum depression, anxiety, post-traumatic stress disorder, and other stress-related conditions (Ishizaki, 2013).

Preparation for discharge and the transition home is an extensive process for families with premature and sick infants following their stay in the NICU. Limiting factors for integrating parents into care are unfortunately present in the NICU setting, including the medical complexity of the child, physical barriers such as equipment or an isolette, and poor communication between families and medical staff. These factors may impede the parents' understanding of their child's cues and medical needs, impacting their readiness for their discharge to home. Studies by O'Brien et al. (2013) and Ortenstrand et al. (2010) worked to integrate families into the NICU team and asked parents to be active participants in all aspects of their baby's care. In both studies, significant benefits for both parents and infants were noted, including lower levels of stress and increased confidence in caregiving for parents, and for babies, better weight gain, shorter hospitalizations, and higher rates of breastfeeding.

Parental Stress in the NICU

Beyond impaired attachment, the NICU presents various sources of stress for families. Environmental stressors include the appearance of critically ill infants with various tubes and lines, and surrounded by medical equipment. In the NICU, infants often experience painful, invasive, or stressful procedures. The sights and sounds of the ICU, including the large number of ill infants also hospitalized within the unit, are also impactful on the parent in terms of additional stress. Changes in the expected parent role and staff communication and behavior are also common stressors cited by parents in the NICU environment (Zeanah & Jones, 1982). A study by Carter, Mulder, and Darlow (2007) noted that the altered parental role was the highest source of stress for both parents. Parents of infants born prematurely have been shown to suffer higher rates of anxiety and depression, and reportedly deal with increased financial, relational, and familial stressors (Carter, Mulder, and Darlow, 2007). With greater knowledge of the factors that contribute to parent stress, health professionals can facilitate parent coping, that may promote more optimal parent–infant relationships and subsequently promote infant development (Carter, Mulder, & Darlow, 2007).

Parental Stress and Parent-Infant Attachment

Various studies have worked to examine the relationship between parental stress and parent-infant attachment. In a study by Vaughn, Egeland, Sroufe, and Watters (1979), infant-mother attachment was evaluated between in the early years of life in families under stress. In a group of economically-disadvantaged families, the strange situation paradigm developed by Ainsworth (1978) was conducted with mothers and infants aged 12-18 months. Significantly more infants were found to have differing attachment classifications over time when compared to a population of middle-class families. Anxious-attachment relationships were found to be

associated with less stable caretaking environments. Changes from secure to anxious attachment were associated with higher rates of stressful events when compared to infants classified as having consistently secure attachments with their caregivers (Vaughn et al., 1979).

Coyl, Roggman, and Newland (2002) evaluated factors contributing to infant attachment security, specifically stressful events. Their research found that maternal depression, negative interactions, and physical punishment all directly affected infant attachment security. Additionally, economic stress and relational stress directly affected maternal depression and frequency of physical punishment, thereby indirectly influencing infant attachment security (Coyl et al., 2002). A NICU hospitalization for a preterm infant has the capacity to generate high rates of economic and relational stressors for families, and mothers of preterm infants have reportedly higher rates of postpartum depression and anxiety than those born full term (Obeidat, Bond, & Callister, 2009). Given the relationship between increased rates of parental stress and impaired attachment relationships, interventions and supports for the parent and for the parent-infant dyad in the highly stressful NICU environment are critical.

Mother-Infant Attachment

There is substantial research on the typically-developing mother-infant relationship. Researchers pioneered methods of observing the interactions between a mother and her child, and measuring various forms of the interactions (Ainsworth, 1964; Ainsworth & Bell, 1970; Ainsworth, Bell, & Stayton, 1970; Ainsworth, Blehar, Waters, & Wall, 1978). John Bowlby (1969) believed that attachment was an all or nothing process; however, further research has indicated there may be individual differences in attachment quality, specifically based on the security of an individual's attachment to their primary caregiver (Ainsworth & Bell, 1970).

Ainsworth developed an experimental procedure to observe the behavior between a mother and child and determine the nature of the attachment relationship and style of attachment.

In the procedure, known as the 'Strange Situation', a mother, infant, and stranger interact in a series of events, while their interactions are monitored, examining their proximity and contacting seeking, contact maintaining, avoidance of proximity and contact, resistance to contact and comforting. From these studies, Ainsworth (1970) identified three main attachment styles: secure, insecure avoidant, and insecure ambivalent/resistant. These attachment styles were hypothesized to occur as a result of early interactions with the mother. In a secure attachment, a child feels confident the caregiver will meet his or her needs, he or she will utilize the caregiver as a safe base as he or she explores the environment, and will seek the caregiver in times of distress. A caregiver in a secure attachment relationship is sensitive to a child's signals and is able to consistently meet needs as they arise. In an insecure-avoidant attachment relationship, the child does not consistently orient to an attachment figure as he or she explores the environment and he or she is observed to be more independent, both emotionally and physically. His or her caregiver may be insensitive or reject his or her needs, as the caregiver may withdraw from helping and be unavailable when the child exhibits distress. In an insecure-ambivalent attachment style, the child may display clingy or dependent behavior and also ambivalence or rejection toward caregiver due to a lack of feelings of security within the relationship. The child may have difficulty exploring the environment away from his or her caregiver, and when in distress, may be difficult to soothe as his or her needs have historically not been consistently met by the caregiver (Ainsworth, 1970). In the NICU, the child and caregiver are separated, and parents are not able to take on the primary caregiver role in their child's early weeks and months of life. The NICU may prevent parents from providing

consistent responsiveness to their child's needs, as well as providing comfort in the presence of distress and pain.

Attachment and the Premature Infant

Parents of infants hospitalized in the NICU experience one of the most stressful times of their lives. This stress has definite short-term consequences, specifically on the establishment of the parent-child relationship. Expectant mothers develop an attachment with their baby during pregnancy, and this attachment increases following the birth of the child (Obeidat, Bond, & Callister, 2009). When a child is born prematurely and requires specialized care, parenthood begins in an unfamiliar and stressful environment. This may contribute to delayed or impaired maternal attachment (Obeidat, Bond, & Callister, 2009). In addition to these potential long-term repercussions for the parent-child relationship, the child's development may also be impacted. Considering their already increased risk for neurodevelopmental disability and delay, modulating the stress experienced by parents in the ICU setting is critical.

Evaluation of the attachment relationships of premature infants in the first years of life has been explored in various studies. In a study by Plunkett, Meisels, Stiefel, Pasick, and Roloff (1986), 33 high-risk premature infants, all with hospitalizations of more than one month at birth, were compared to attachment patterns of healthy, premature infants initially hospitalized for less than one month. Infants with more complex medical diagnoses and moderate to lengthy hospitalizations displayed more anxious-avoidant attachment patterns than that of infants in the healthy, premature group (Plunkett et al., 1986).

In a more recent study by Meijssen and colleagues (2011), maternal attachment representations at 18 months after very preterm birth were studied. A post-discharge assessment, the Infant Behavioral Assessment and Intervention Program (IBAIP), was designed to assist

parents to support and enhance their infant's regulatory competence and development. This intervention was delivered via six to eight home visits during the first eight months after birth. Maternal attachment representations were assessed with the Working Model of the Child Interview (WMCI), which classified the attachment relationships into balanced or non-balanced. The exact relationship between balanced and non-balanced and the attachment categories established by Ainsworth were not fully described; however, balanced could be most closely associated with a secure attachment style. No difference between the control and experimental groups were found; however, 30% of the mothers of preterm infants had non-balanced attachment representations. Negative feelings when first seeing their baby and negative or ambivalent feelings in the first weeks at home with their baby were seen to be related to non-balanced attachment representations (Meijssen et al., 2011).

Korja, Latva, and Lehtonen (2012) completed a systematic analysis of the literature on preterm infant attachment relationships. In a review of studies of mother–preterm infant interactions, differences between preterm and full-term maternal and infant interaction behaviors in mother-infant dyads were most evident during the infant's first six months of life. Five of 18 studies showed equal or even higher quality mother–infant interaction in preterm infant groups compared to those born full-term. Overall, studies of maternal and infant attachment indicated that preterm infants and their mothers are not at higher risk of insecure attachment. However, the mother-infant relationship when the infant is born prematurely is complex, and differing elements of the dyad's relational patterns may lead to greater psychological risk than others (Korja et al., 2012).

Theoretical Background

Various theories lend to the development of a NICU-based maternal-premature infant intervention, that is cost effective, time efficient, and has lasting implications for the parent and infant in both the short- and long-term. The biological implications to the infant when born prematurely, and the psychological and social implications to the parents in regard to increasing situational stressors and barriers faced in the critical period for early mother-infant bonding lend to the biopsychosocial model as a clear theoretical contributor (Engel & Romano, 1977). Stress Theory also lends important information to this area of study (Magnussen, 1982). Within Stress Theory, stressors exist as physical and psychosocial elements of a situation that may lead to a stress response. In the case of the hospitalized premature infant and their family, both physical and psychosocial factors are extremely present: the physical include aspects of the child's medical care and the hospital ICU environment, and the psychosocial stressors include the engagement with various medical care providers, and deceased ability to parent and engage with their newly born infant. Additionally, treatment in a NICU environment has the ability to impact social and biological factors for the infant through their ongoing development. For this reason, the Synactive Theory of Development is also critical to consider (Als, 1982). This theory explains that the infant must negotiate early and emerging developmental processes within the context of their environment, and when critical periods of development are occurring while the infant is hospitalized in the NICU, this may have implications on various aspects of functioning. This theory explains the importance of delivering appropriate sensory information at critical periods, given the timing of each sensory systems development throughout gestation, and informs us of when auditory information is appropriate, and even needed, which is critical when

discussing the implementation of a bedside reading intervention. Ultimately, these three theories help inform the rationale of this study.

Biopsychosocial model

The biopsychosocial model developed by George Engel and John Romano (1977) systematically considers biological, psychological, and social factors and their complex interactions in health care delivery. While traditional biomedical models focus on pathophysiology and other biological approaches to disease, the biopsychosocial model emphasizes the importance of understanding human health and illness (Placencia & McCullough, 2012).

Infants born prematurely are at greater risk of medical instability and following discharge, they often require more frequent medical visits, hospital admissions, and in-home care services. Parents and caregivers experience greater care demands, which may pose stress and strain on the child's caregivers and, consequentially, on the family unit as a whole. Placencia and McCullough (2012) detailed the American Academy of Pediatrics Committee on Fetus and Newborn's policy statement titled, "Hospital Discharge of the High-Risk Neonate," which includes preterm infants and those with special health-care needs or who are dependent on home ventilation or other medical supports. The statement described the risk for familial stress and dysfunction as well as for illness of the primary caregiver, and calls for hospital care providers to be aware of caregiving burdens, anticipate and plan for them, and assist with the coordination of appropriate home care (Placencia & McCullough, 2012).

Stress Theory

Various theoretical understandings of stress exist within the literature. Magnussen (1982) described stress as an individual's reactions to demands that approach or exceed the limits of her

coping resources. Stressors exist within this model as physical or psychosocial elements of a situation that impose demands on an individual and lead to a stress response. The stressor may refer to an actual or perceived situation, and takes into account an individual's perception, interpretation, and cognitive representation of the situation at hand (Magnussen, 1982). Environmental stressors are emphasized in this model, and can range from a micro to macro level. In the NICU environment, there are physical, interpersonal, and psychosocial transactions and elements that affect the family and parent. This model was utilized in the development of the Parental Stress Scale: Neonatal Intensive Care Unit (PSS:NICU), a scale measuring the degree of stress felt by the parents of infants hospitalized in a NICU following birth. The PSS:NICU can serve as a either a research or clinical measure that aims to evaluate stressors experienced by parents with infants hospitalized in a NICU (Miles, Funk, & Carlson, 1993).

Synactive Theory of Development

The Synactive Theory of Developmental developed by Heidelise Als (1982) provides a theoretical framework for understanding and assessing the individual infant, more specifically those born prematurely. This model focuses on the interplay between various subsystems within the child including the autonomic system, the motor system, state organizational system, attentional-interactive system, and self-regulatory system. Throughout development, these various subsystems interact with the environment, and when there is imbalance within one subsystem, all subsystems are affected. A child must negotiate the early and emerging developmental process within the context of their environment.

The nervous system's areas of function include autonomic, sensory, motor, and state regulation. Autonomic function refers to the self-regulation of respiration, heart rate, blood pressure, temperature, and nutritional intake. In terms of sensory function, sensory systems

develop in a predetermined order beginning with the tactile senses, and followed by vestibular or proprioception, the olfactory system or smell, gustatory or taste, auditory or hearing, and visual or sight senses (Als, 1982). Sensory system stimulation initially occurs internally, but external stimulation is needed at a critical point in development for each subsystem. An infant's motor function develops with the maturation and coordination of neurological and muscular development. Patterns of sleep and arousal define state regulation. Stimulation and environmental experiences impact the development of all of these systems and ultimately generate changes in brain development, both positive and negative (Altimer & Phillips, 2013).

When the development of these systems occurs in the context of a NICU environment, the infant is exposed to and must navigate unfavorable and sometimes noxious stimuli. Infants may experience bright lights, the loud sounds of medical equipment, and positioning on a flat, nonhuman surface in an isolette or crib. Many of these stimuli are negative and even harmful for the developing brain of the neonate. Understanding how the infant traverses critical developmental periods within this intensive care setting urges practitioners to structure the NICU in a developmentally-supportive manner to the greatest extent possible.

Implications of Theory for Practice

Developmental care. Family involvement is an essential component of decreased familial stress and positive effects on physical, cognitive and psychosocial development of infants, especially those in a neonatal intensive care unit (Craig et al., 2015). When family members are integral in decision making and feel empowered by increasing the time with and proximity to their baby, the relationship between the parent and child may be strengthened. Prior to an understanding of the importance of involving families in their infant's care, the model of care for a NICU baby involved separation between the mother and family, with the baby

surrounded by technology and cared for by the medical staff. When the baby was ready for discharge, the family was notified. Separation between the infant and mother is now understood to have negative physiological effects on the infant, with additional lasting psychosocial and neurological outcomes. With this understanding, measures to support a family's involvement in care, specifically developmentally supportive care, has become a priority.

The Neonatal Integrative Developmental Care Model uses neuroprotective interventions as strategies to support optimal synaptic neural connections, promote normal development, and prevent disabilities. Seven neuroprotective core measures for family-centered developmental care (FCDC) of the premature neonate are addressed: healing environment, partnering with families, positioning and handling, minimizing stress and pain, safeguarding sleep, protecting skin, and optimizing nutrition (Altmier & Phillips, 2013).

A healing environment is the physical environment of the infant including space, privacy and safety, as well as the sensory environment including temperature, touch, proprioception, smell, taste, sound, and light. Elements of both the physical and sensory environment the infant is exposed to in the NICU may have lasting structural and functional neurological effects. This occurs both directly through sensory and experiential learning and indirectly through epigenetics altering gene expression (Altmier & Phillips, 2013). Family involvement is another critical factor. Admission to the NICU is often a crisis event for families involving separation between the parents and child, frightening medical intervention, and altered opportunities for the development of the parent-child bond. Welcoming parents to the bedside, providing education on behavioral cues and how to provide developmentally supportive care, active listening throughout the NICU experience, and promotion of health and well-being of the families as well as the infant are all priorities. The positioning and handling of NICU babies is another critical

element of this model. Infants in utero are contained within the boundaries of the uterus with well-defined boundaries and support in maintaining a physiological flexion position. The posture of an infant in the NICU is often flat, extended, asymmetrical with the head to one side, and with the extremities abducted and externally rotated. Supportive positioning practices to encourage flexion and prevent the effects of both gravity and extensor movement patterns of the premature baby are imperative. Appropriate positioning measures assist with not only the physiological wellness of the infant, but also long-term motor outcomes and movement. Additionally, slow, modulated movements are preferred when handling preterm infants, rather than sudden or quick changes in positioning (Altmier & Phillips, 2013).

Another core measure included in this model is safeguarding sleep. Individual sleep patterns with Rapid Eye Movement (REM) and Non-Rapid Eye Movement (NREM) sleep periods begin to emerge as early as 28 weeks gestation. These periods mature throughout the later weeks of gestation, becoming constant closer to term-corrected gestational age. Both REM and NREM sleep is critical for neuroplasticity, learning and memory, and neurodevelopment (Altmier & Phillips, 2013). Sleep deprivation, which may occur when care is not clustered in the NICU environment, has been shown to lead to smaller brains, altered learning, and long-term effects on an infant's behavior and developmental outcomes. Protection of sleep cycles, shielding an infant's eyes from direct light exposure, cycling lighting each day to help with circadian rhythm development, avoiding high doses of sedative medications, and developmental care practices are all critical practices for helping to protect sleep (Altmier & Phillips, 2013). The fifth core measure of this model is minimizing stress and pain. Noxious sounds, lights, and painful procedures along with separation from the mother are all elements of an early premature infant's experience in the NICU environment. A premature infant's sensory experience is

significantly altered in the early weeks and months and even simple caregiving acts just as feeding, diapering, bathing, and general handling can be stressful to the infant. These stressors may raise cortisol levels, limit neuroplasticity, and impact physiological status. Long-term consequences are also plausible given the impact on brain organization during critical and sensitive periods of development (Altmier & Phillips, 2013).

The sixth measure within the Neonatal Integrative Developmental Care Model is protecting skin. Skin, the body's largest organ, is very different in a premature infant and requires specialized practices to maintain its health and function. Skin is responsible for thermoregulation, barrier protection of bacteria and toxins, as well as touch, pain, and pressure sensation (Altmier & Phillips, 2013). Utilizing evidence-based skin care guidelines to insure the health of the preterm infant's skin is considered a standard of care.

The seventh core measure of this model is optimizing nutrition. Promotion of breastfeeding as the optimal nutrition for infants is encouraged, as breastfeeding is the most powerful preventive tool in reducing infant morbidity. Higher rates of negative outcomes, including NEC, ROP, and sepsis occur when breastmilk is not utilized (Altmier & Phillips, 2013). Additionally, the extant literature supports increased IQ, improved neurodevelopmental outcomes, and generally increased brain volumes for infants that receive breastmilk. Supporting feeding progression through infant-driven feeding practices as the premature infant learns to coordinate his or her suck, swallow, and breathe patterning is also an important element of care during a premature infant's hospitalization (Altmier & Phillips., 2013).

Family Centered Developmental Care. Providing family-centered care specifically in a NICU has been endorsed by the American Academy of Pediatrics and many other health-care organizations (Craig et al., 2015). Combining this concept with the known positive effects of

developmental care practices leads to delivering family-centered developmental care (FCDC) and encourages the involvement of the family as an essential contributor to the provision of individualized, developmentally-supportive care of each baby. Family-centered developmental care recognizes the family as vital members of the NICU health-care team, and thus, families are urged to participate in the decision-making processes and collaborate in their baby's medical care (Craig et al., 2015). Family-centered developmental care has positive effects, including decreased maternal stress, improved parent-infant attachment, improved infant weight gain, and higher rates of breastfeeding at discharge (Craig et al, 2015).

Recent literature has documented the process of implementing family-centered developmental care in the NICU environment, while exploring the relationship between FCDC and variables such as parental stress, maternal-infant attachment, and knowledge of infant cues. A specific family-based intervention to address infant–parent relationships in the NICU was developed by Browne and Talmi (2005). Mothers completed measures of stress (Parenting Stress Index) and knowledge of infant cues (Knowledge of Preterm Infant Behavior Scale) during their NICU stay. These mothers then participated in a demonstration of infant reflexes, attention, motor skills, and sleep-wake states. When mothers had greater knowledge following this intervention, they had more sensitive interactions with their newborns. Based on these findings, knowledge, sensitivity, contingency, and stress may all be enhanced by a short-term, family-based NICU intervention (Browne & Talmi, 2005).

Purpose of the Study

Resiliency & Reading

Reading supports the growing bond between parent and child, which is a critical activity, especially within a NICU environment. A study by Zauche and colleagues (2017) found that by

teaching parents both how and why to treat their child as a conversational partner and by modeling such interactions, pediatric health care providers can help parents support their child's literacy, educational success, and health. In a NICU environment, where there are barriers to a positive reciprocal parent-infant relationship, reading is an opportunity for positive engagement and fostering of feelings of comfort, security, and love. Parents with infants hospitalized in a NICU following their birth, are often overwhelmed and are less likely to engage in typical parenting activities. Typical parenting activities, including reading, can help parents engage with their child in a positive, supportive manner (Bialoskurski, Cox, & Hayes, 1999).

Authors publishing in the psychological literature base also suggest that reading to children at a young age is instrumental in experience-dependent learning and brain development and the development of language and reading skills (Larivviere & Rennick, 2011). The development of the auditory system, which requires the skills of auditory differentiation and function, develops based upon the quality of sounds of which infants are exposed. Researchers have suggested that language in books is richer than the language of everyday speech or other environmental sounds (Wade & Moore, 1998).

Exposure to Speech and Language

Infants born prematurely and hospitalized in a NICU setting are exposed to a variety of noxious noises from monitors, alarms, and equipment as well as periods of silence. This is unlike a full-term infant's exposure to sound and language in utero. It is not fully understood how this altered early sensory experience contributes to later language development and potential language delay, which is often observed in this population (Krueger, 2010).

Caskey, Stephens, Tucker, and Vohr (2013) examined the association between word counts at 32 and 36 weeks gestation in the NICU and later cognitive and language developmental

functioning via the Bayley Scales of Infant and Toddler Development, Third Edition (Bayley-III) cognitive and language scores. Adult word counts, or increased exposure to parental talk, in the NICU, was determined to be positively correlated with developmental functioning at both seven and 18 months when the developmental assessments were performed following the child's NICU stay.

Exposure to parental talk has also been associated with increased preterm infant vocalizations. In a study by Caskey, Stephens, Tucker, and Vohr (2011), results indicated preterm vocalizations are present as early as 32 weeks gestation. They found that when a parent was present in the NICU, more conversational turns per hour were observed at both 32 and 36 weeks corrected gestational age. Additionally, exposure to parental talk was a stronger predictor of infant vocalizations at 32 weeks, and conversational turns at both 32 and 36 weeks over language from other adults including nursing or other medical staff in the NICU environment (Caskey et al., 2011).

Specific exposure to maternal voice has also been investigated in the NICU. Krueger (2010) reviewed prior literature investigating the effects of exposure and experience with maternal voice in the NICU. Of the studies reviewed, many utilized sound levels at a higher decibel level than is recommended for preterm infants; thus, findings are difficult to interpret as any negative responses may be due to the adverse levels of auditory stimulation. One study did generate significant positive effects; however, several other studies reviewed showed only positive trends and did not meet significance, while two reported negative effects following exposure to maternal voice (Krueger, 2010).

Literature Regarding Reading in the NICU

Knowing the positive effects of parental speech and the need for appropriate stimulation of the auditory system in a NICU environment, parents reading to their infants is a strategy to elicit both positive stimulation and cultivate positive familial relationships. Walker (2013) described parental reading to infants in the NICU as an intervention that can connect a parent and child and offer a way to positively engage parents in caregiving. Various positive effects on the parent and infant relationship are possible through this simple practice.

Lariviere and Rennick (2011) examined the specific effects of a parent book reading intervention on parent and child interaction in the NICU and its impact on the frequency of reading to infants following discharge. In a Canadian 26-bed NICU, 136 parents were enrolled, and 116 parents completed the study. Questionnaires examining parenting activities, specifically reading, were mailed to families three months following their child's discharge and were then completed by telephone. These measures included the Parenting Stress Index Short Form, the Parent-Infant Activity sheet, and the Parent-Infant Interaction During Reading Questionnaire which was a questionnaire created for use in this study. A Books for Babies reading program was utilized for the intervention during the infant's NICU stay. With this intervention, parents were provided with education on the benefit of reading, and were given a book to read in the NICU and to take home following discharge. Sixty-nine percent of parents reported an increase in their sense of control and normalcy, as well as increased intimacy with their infants when reflecting on reading to their infants in the NICU setting (Lariviere & Rennick, 2011). Additionally, twice as many parents reported reading three or more times a week to their child once home from the hospital following this intervention. Parents reported that reading to their infant positively affected their interactions with their child, and noted that it helped them develop

a greater sense of control and intimacy, and sense of normalcy during the difficult period of their child's NICU stay (Lariviere & Rennick, 2011).

This study was one of the first to evaluate a parent book reading program with infants in the NICU. However, the program did not measure parental stress and parent interaction during reading during the child's inpatient stay, as the questionnaires were only given three months following the intervention. Information on the initial levels of parental stress during the inpatient stay would be assistive in interpreting if a change in parental stress was affected specifically by this intervention. Additionally, the mean gestational age of infants were 36.9-37.32 weeks, indicating that participants were generally within the late preterm categorization, and not significantly preterm. Additional research is required to determine if such an intervention is effective for a very and extremely low preterm infant population.

Present Study

Infants born prematurely, especially those suffering from the neurological impacts of intraventricular hemorrhage, are at risk for an array of neurodevelopmental delays and disabilities. These increased risks additionally impact families and the developing bond between the parent and child. Increased levels of stress impact the parent-child relationship in the NICU and this has lasting effects on the relationships and development of the infant throughout childhood and into school age and adolescence. Interventions in the NICU setting to promote positive developmental care practices and appropriate developmental stimulation are widely supported. Combining this with strategies to lower parental stress and improve bonding benefit not only the infant, but also the parent-child dyad. Current research has not yet explored the degree of parental stress during the NICU stay in relation to reading programs. Beyond this, there has not been a thorough evaluation of the parent and child attachment relationship in the

NICU unit in relation to parental stress and reading to the premature infant. Examining the degree of stress experienced by parents, specifically mothers, of preterm infants with varying grades of IVH in the NICU setting before and after the implementation of a parent reading intervention will help researchers and practitioners better understand the nature of the stressors parents experience and how to mediate these stressors to some degree to optimize the parent-child interaction and ultimately, the mother-infant attachment relationship.

Chapter III Methods

Overview

For the purpose of this study, mothers of infants born prematurely and hospitalized in the NICU at Children's Hospital of Pittsburgh of UPMC will be asked to take part in a NICU-based bedside parent-infant reading initiative. Mothers will be educated on the benefits of reading at bedside to their infant, including its positive implications for development, parental attachment relationships, and decreasing parental stress. Beginning at the time of their enrollment, regular weekly meetings for six weeks will be conducted, with education and support provided regularly during this time. Information regarding maternal levels of stress and the maternal-infant attachment relationship will be collected prior to and following this intervention for the intervention group, and at comparable time points for the control group. Specific details regarding the participants, the measures utilized, the study's research design and procedures, and the subsequent data analysis are outlined below.

Participants

Participants enrolled in this study will be the mothers of infants born prematurely and hospitalized in the Neonatal Intensive Care Unit (NICU) at the University of Pittsburgh Medical Center (UPMC) Children's Hospital of Pittsburgh (CHP). Initially, recruitment planned to include infants born between 23 and 31 weeks gestation and who were medically stable (e.g., able to tolerate the stimulation and not in medical crisis) will be specifically targeted. Early gestation of under 31 weeks typically indicates a hospitalization lasting at least 6-8 weeks, assuring adequate time for the intervention to take place; however, limiting recruitment to these gestational ages was found to be too restrictive in the NICU environment at UPMC Children's Hospital of Pittsburgh and thus enrollment was expanded to include all premature infants, thus

any infant born under 37 weeks gestation. At the time of enrollment, infants will be at least 26 weeks corrected gestational age, and be considered medically stable and able to tolerate the intervention at the time of its initiation.

An a priori power analysis was completed to determine the number of participants required to detect a moderate effect size. Based on this analysis, 40 mother-infant dyads will be enrolled, with 20 assigned to the intervention and 20 to the control group. Attrition rates will be tallied, and strategies to address missing data will be documented.

Measures

The Parental Stressor Scale: Neonatal Intensive Care Unit (PSS:NICU) (see Appendix A) and the Maternal Attachment Inventory (MAI) will be the primary measures utilized during this study. These measures will be delivered to mothers of infants in the NICU setting and administered prior to initiation of the intervention, and again upon its conclusion. Along with pre- and post-maternal attachment and stress measurements, infant and parent demographics will be measured with targeted questions during a parental interview. For the purposes of treatment integrity, a reading log will also be distributed and completed by parents, indicating the extent to which they are reading to their infant on a daily basis.

Infant and Maternal Demographic Survey. Demographic data will be obtained at the time of informed consent. Parental information including maternal age, marital status, ethnicity, education, and occupation will be obtained via parental report at the time of informed consent. Data collected on the infants will include demographic information such as gestational age at birth, gestational age at the initiation and conclusion of the intervention, birthweight, diagnosis, and hospital length of stay.

Parental Stressor Scale: Neonatal Intensive Care Unit (PSS:NICU). Parental stress, specifically that of the mother of the preterm infant, will be measured utilizing the Parental Stressor Scale: Neonatal Intensive Care Unit. The PSS:NICU is designed to measure parental perception of stressors arising from the physical and psychosocial environment of the NICU (Miles & Funks, 1987; Miles, Funks, & Carolson, 1993). This scale consists of 41 items grouped into four subscales measuring stress related to: a) sights and sounds, b) appearance and behavior of the infant, c) the impact on parents' role and their relationship with their baby, and d) the parents' relationship and communication with the staff. Responses are scored on a 5-point Likert scale ranging from 1 point indicating "not at all stressful," 2 points for "mild stress," 3 points for "fairly moderate stress," 4 points for "very stressful," and 5 points for "extreme/severe stress." Higher scores indicate higher levels of stress (Miles & Funks, 1987). A mean score is calculated from the total raw score for all items, (e.g. mean score = 3.69).

To evaluate the construct validity of the PSS:NICU, it was compared to State Anxiety Scores, which deliver a cross-section of a person's emotional life at the time of the test taking (Spielberger, 1989). As defined by Spielberger (1989), anxiety states are characterized by subjective feelings of tension, apprehension, nervousness, and worry, and by activation or arousal of the autonomic nervous system. Based on this definition, this was deemed to be an appropriate comparison measure in evaluating construct validity. Pearson correlation coefficients were computed between the scores on both measures and all correlations were found to be significant at the $p<0.05$ level (Spielberger, 1989).

Reliability for the scale via internal consistency for the PSS:NICU was calculated via Cronbach's alphas for each subscale and the total instrument. The alpha coefficients were acceptable for all scales, and appropriate for the entire scale and two separate metrics, metric 1

being the stress occurrence level and metric 2, the overall stress level. All item correlations were positive, but varied significantly, ranging from 0.39 (considered unacceptable) to 0.81 (considered very good) for metric 1 and 0.30 to 0.74 for metric 2 (Miles & Funks, 1987).

Internal consistency was again analyzed and reported as alpha > 0.70 for all domain scales and alpha = 0.89–0.90 for the entire instrument (Miles, Funk, & Carlson, 1993). Further evaluations of reliability and internal consistency include Franck and colleagues (2005) evaluation of the PSS:NICU for use in the United Kingdom (UK). They found PSS:NICU scores to be similar in the UK and American samples, with high internal consistency reliability for all metrics. The total score, or Overall Stress, was α=0.94 for both samples (Franck, Cox, Allen, & Winter, 2005).

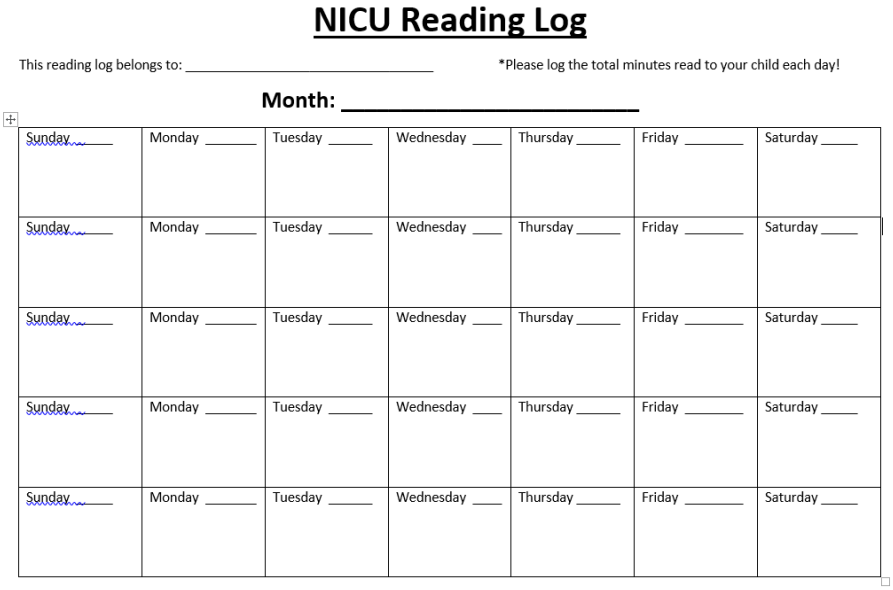
Maternal Attachment Inventory (MAI). To achieve an understanding and measurement of parent-infant relationships in the NICU setting, the Maternal Attachment Inventory (MAI) will be utilized. The MAI was developed and tested to provide a practical measure of maternal attachment to their infant (Muller, 1994). This scale consists of 26 items, organized into a four-point Likert scale. Respondents can indicate how they generally feel in relation to thoughts (e.g. 'My thoughts are full of my baby'), feelings (e.g. 'I feel love for my baby') and situations (e.g. 'I watch my baby sleep'). With the 4-point Likert scale, 1 stands for "never," 2 stands for sometimes," 3 stands for "often," and 4 stands for "regularly." A total raw score is obtained from the sum of all items, where a high score is a sign of high maternal attachment. The lowest score is 26, and the highest is 104. Internal consistency for the MAI was α=0.85 for 4-week-old babies, and α=0.76 for 4-month-old babies, consistent with the age ranges present in the NICU. The MAI demonstrated evidence of validity through significant correlations

with other indicators of maternal attachment (the How I Feel About the Baby Now Scale, ($r=.45$, $p<0.001$) and the Maternal Separation Anxiety Scale ($r=0.46$, $p<0.001$) at all time points.

In regard to reliability, a study by Damato (2004) evaluating correlations between prenatal and postnatal maternal attachment found internal consistency of the MAI to be $\alpha=0.92$ and $\alpha=0.93$. Shin and Kim (2007) sought to validate a Korean version of the MAI. In this process, they reported internal consistency to be $\alpha=0.94$ for the full measure. In terms of factors, they found internal consistency of $\alpha=0.94$ for Factor 1, $\alpha=0.91$ for Factor 2, and Factor 3 of the MAI maintained an internal consistency of $\alpha=0.65$ (Shin & Kim, 2007). No evaluations of test-retest reliability were reported for the MAI.

Reading Log. In order to collect data regarding treatment integrity and establish levels of time spent reading as an independent variable, a reading log, will be distributed to families receiving the intervention at the initiation of the program for parents to track the minutes read to their infants each day (see Figure 1). This log will be collected at the conclusion of the program. Mothers will be instructed to include only minutes they read to the infants, and not those of other caregivers, as they will be the primary figure involved with the program. If families request the ability to track total number of minutes read to infants including time read by staff or caregivers, this will be allowed as long as time mothers were reading was differentiated and separately noted along with the total amount. For infants assigned to the control group, a survey will be given to mothers following the completion of the MAI and PSS:NICU to survey their reading behaviors. Mothers will be asked to report on if they read to their infant during their hospitalization, and if so, on average how many days per week, and how many minutes per day. A reading log was not distributed to the control group to avoid influencing their engagement in this behavior, thus this

allowed for estimation of mother's time spent reading at bedside, even when not receiving the specific education on the benefits of this activity.



NICU Reading Log

This reading log belongs to: _____ *Please log the total minutes read to your child each day!

Month: _____

Sunday ____	Monday _____	Tuesday _____	Wednesday ____	Thursday _____	Friday _____	Saturday ____
Sunday ____	Monday _____	Tuesday _____	Wednesday ____	Thursday _____	Friday _____	Saturday ____
Sunday ____	Monday _____	Tuesday _____	Wednesday ____	Thursday _____	Friday _____	Saturday ____
Sunday ____	Monday _____	Tuesday _____	Wednesday ____	Thursday _____	Friday _____	Saturday ____
Sunday ____	Monday _____	Tuesday _____	Wednesday ____	Thursday _____	Friday _____	Saturday ____

Figure 1: Parental Reading Log tracking daily minutes read by mothers in the NICU.

Procedures

Following the admission of an infant to the NICU, available family members, specifically the infant's mother, will be approached in their child's hospital room at least 7 days, but no more than 14 days from admission. This time period was proposed to allow for some degree of adjustment to the NICU environment and assurance of medical stability. Infant age will be at least 26 weeks corrected gestational age at the time of enrollment. Mothers of qualifying infants will be asked to provide consent for the study. After providing consent, participants will be administered the initial measures, including the demographic survey, PSS:NICU and MAI. At this time, mothers will be apprised of education regarding the possible benefits of reading through verbal instruction and specified handouts. Mothers will be provided with a board book to keep, to assure that reading material is available in the infants' hospital rooms. Mothers will

also have access to additional, free reading materials in the NICU child life play room, and in the hospital library. The printed materials on the benefits of reading, and a reading log will be left in the room for families to document when they read to their infant each day and the number of minutes of reading, in order to assure compliance with reading in between sessions. The log left at the bedside allowed parents to track the number of minutes spent reading each day.

Weekly meetings will be conducted over the course of six weeks with mothers to provide support, additional education on the benefits of reading as well as developmental guidance, and to discuss progression with the reading program. If mothers are not at bedside during working business hours when the researcher is present at the hospital, a phone call will be made to conduct the sessions by phone. Differentiation between in-person and phone call meetings will be logged and considered in analyses. The total number of sessions will total six sessions to assure consistency despite the infant's hospital length of stay, as this may differ across subjects dependent on their gestational age at birth and medical course. At the conclusion of the six sessions, the MAI and PSS:NICU measures will again be distributed and completed, and reading logs will be collected. The rate of return for reading logs will be documented. All enrolled participants will complete the PSS:NICU and MAI at both time points.

Treatment Integrity

To assure the integrity of the treatment, or the degree to which treatment is implemented as intended, we introduced several steps throughout the intervention. Treatment integrity is necessary to make valid conclusions regarding treatment outcomes (Sannetti & Kratochwill, 2009). Various models for treatment integrity exist, many including the dimensions of content, or what intervention steps were delivered, the quality, or specifically how well the intervention steps were delivered, the quantity, or how much of the intervention was provided; as well as

process, or how the intervention was delivered (Sannetti & Kratochwill, 2009). These dimensions were considered when designing the NICU-based mother-premature infant bedside reading initiative.

Considering these dimensions, for the purposes of treatment fidelity, the content, quality, quantity, and process were carefully constructed. To address the integrity of the content as well as the quantity of the intervention, the intervention was designed based on previous literature's developed models of bedside reading interventions in NICU settings. To address quality, the amount that mothers applied the information delivered to them was monitored, specifically the amount of reading they completed following their education on the benefits of reading to their premature infant. To address monitoring of the process, a reading log was created for mothers to complete based on their engagement in active reading at bedside.

Research Design

A quasi-experimental pre- and post-test design will be utilized for the study. A quasi-experimental design without random assignment was selected due to the threat to internal validity that may arise given the nature of the NICU environment. Families of infants hospitalized in the NICU for extended periods of time often form relationships and communicate in various forums during their child's hospitalization. In addition to family's close proximity, they also share caregivers with bedside nursing, physicians, and ancillary services. If random assignment were to be utilized, mothers or other caregivers in the intervention group may communicate the positive effects of the intervention to those enrolled in the control group in some manner, threatening internal validity. Thus, a baseline control group was collected prior to the initiation of the intervention.

The independent variable will be participation in the reading education and intervention programming. Total number of minutes read by the mother to her infant at bedside will be considered a covariate. The dependent variables will include the levels of parental stress as measured by the PSS:NICU and maternal-infant attachment as measured by the MAI. Additional demographic variables will include infant-focused variables including the infants' gestational age, corrected gestational age at the initiation and conclusion of the intervention, length of infants' hospitalization, birth weight, and primary medical diagnosis including presence of intraventricular hemorrhage, and parental variables including parents' age, marital status, ethnicity, education, and occupation. Again, total number of minutes read will be considered to be a covariate.

There will be both control and intervention groups. A baseline control group will be collected first, as described above. For both groups, a baseline measurement of parental stress and maternal-infant attachment will be collected in the Children's Hospital NICU. Infants born between 23 and 37 weeks gestation, who were medically stable, and were at least 26 weeks corrected gestational age at the time of enrollment will be identified. Mothers of these infants will be given the PSS:NICU and MAI at this time, and again distributed these measures six weeks later, following the six weekly meetings. This baseline measurement will allow for an understanding of natural progression and changes in stress and attachment relationships with premature infants and their mothers in a NICU setting across a hospitalization. For the control group, no education will be delivered to mothers on the benefits of reading to their premature infant. The treatment group will receive this education and will log the amount of reading they complete with their child on a daily basis. To factor in that some mothers may read to infants at bedside, even without receiving the education in the intervention, a brief survey of participation

in bedside reading will be conducted for those within the control group. When delivered the PSS:NICU and MAI post-test, mothers will be asked if they engaged in reading during their child's hospitalization, and if so, how often and what amount.

Proposed Data Analyses

Research question 1 explores if a NICU-based, mother-premature infant bedside reading initiative impacts levels of maternal stress during a premature infant's hospitalization in a NICU. Research question 2 examines how a NICU-based, mother-premature infant bedside reading initiative impact the mothers' report of the maternal-infant attachment relationship during their premature infant's NICU hospitalization. In order to investigate these first 2 research questions, a repeated measures multivariate analysis of covariance (MANCOVA) will be utilized. Intervention status is the single independent variable for the study. The two levels of independent variable include 1) parent participation in the bedside reading initiative and 2) a NICU treatment as usual, no bedside reading initiative control condition. Dependent variables will include reported levels of stress and maternal-infant attachment and pre- and post-test time points. Because it is possible that amount of time a parent reads beside with the infant may impact self-reported parent stress and parent-infant attachment ratings, total number of minutes read beside will also be included as a covariate within the MANCOVAs. Computed total number of minutes read will be generated from the reading log. Additional demographic information collected will include infant-focused variables including the infants' gestational age, corrected gestational age at the time of initiation and conclusion of the intervention, length of hospitalization, birth weight, and primary medical diagnosis including presence of intraventricular hemorrhage. Additional demographic information collected related to the mother include maternal age, marital status,

ethnicity, education, and occupation. Simple *t*-tests may be utilized to evaluate these demographic variables and if they differ across intervention and control groups.

Research question 3 examines how the degree of prematurity and level of IVH relate to parental stress and maternal-infant attachment, and if the effects of a NICU-based mother-premature infant bedside reading initiative differ in their impact maternal-infant attachment and parental stress during a premature infant's hospitalization in the NICU based on level of prematurity and degree of IVH. For this analysis the dependent variables will be maternal stress and maternal-infant attachment, and independent variables will include prematurity and IVH. A covariate of total number of minutes read will again be utilized. A repeated measures multivariate analysis of variance (MANOVA) will be utilized for this analysis.

Additionally, a *t*-test will be completed to evaluate the covariate, total number of minutes read, across both groups. Control and intervention groups will be compared to determine if the number of minutes read in the intervention group was truly significantly greater following delivery of the intervention.

Chapter IV Results

This chapter presents the results from all statistical analyses completed to address this study's multiple proposed research questions. Statistical analyses did differ from those proposed due to unprecedented circumstances that occurred as this study was conducted. Study recruitment and participation was initiated in the Fall of 2019, and continued through Winter and early Spring of 2020. With the onset of the COVID-19 pandemic in Spring 2020, the setting of this study, UPMC Children's Hospital of Pittsburgh, implemented both care and research restrictions, specifically within the Neonatal Intensive Care Unit. These restrictions limited clinician contact at patients' bedsides, and paused research study enrollment and participation. Given the timeline of these restrictions, it was determined that recruitment of subjects for the purposes of this study must conclude early, reducing the sample size to approximately half of the intended subjects. With these changes, statistical analyses were adjusted with committee advisement. Initial proposed analyses and modifications given the reduction in sample size are detailed below.

Additionally, a modification to the independent variable of "number of minutes read", which documented the time mothers spent reading to their infants at bedside, was required. Enrolled participants in the intervention group reportedly found completion of the proposed reading calendar that documented the daily number of minutes read to be unfeasible given the demands and stress of the ICU setting. Despite reporting daily engagement in reading with their infants at bedside, mothers were unable to document this reading with the exact number of minutes consistently, and completion of these calendars was variable and incomplete. Thus, the variable was adjusted from "number of minutes read" to a binary variable of "participation in the

reading intervention", which accounted for daily reading by mothers in the NICU setting. All mothers within the intervention group reported reading 1 or more books to their infants each day.

Descriptive Statistics

Descriptive statistics were collected for all proposed variables, providing critical information on the makeup of participants within the study as seen in Table 1 and Table 2. Overall, eighteen participants were recruited, with nine mothers in the control group, and nine mothers in the intervention group receiving the mother-premature infant bedside reading intervention. Study sizes were approximately half of the proposed total sample size of 40 participants, given the limitations on enrollment in the context of the COVID-19 pandemic.

Table 1

Descriptive Statistics for Maternal and Infant Focused Variables for Participants including Control and Intervention Groups

	Group	N	Mean	Std. Deviation
Maternal Age	Control	9	30.44	5.70
	Intervention	8	29.13	5.33
Number of Children	Control	9	2.00	1.23
	Intervention	9	1.56	.53
Infant GA (weeks)	Control	9	31.27	4.997
	Intervention	9	26.44	3.21
Infant BW (grams)	Control	8	1434.50	833.10
	Intervention	8	869.38	554.16

Table 2

Descriptive Statistics for Categorical Maternal and Infant Focused Variables for Participants including Control and Intervention Groups

	Group	N (Percentage
Maternal Race	White or Caucasian	14 (77.8%)
	Black or African American	3 (16.7%)
	American Indian or Alaska Native	0 (9%)
	Native Hawaiian or other Pacific Islander	0 (0%)
	Asian	0 (0%)
	Not Reported	1 (5.6%)
Maternal Ethnicity	Hispanic or Latino	0 (0%)
	Not Hispanic or Latino	18 (100%)
Maternal Level of Education	Less than 12th Grade	0 (0%)
	Completed 12th Grade	4 (22.2%)
	Some College	3 (16.7%)
	Completed College	7 (38.9%)
	More than College	4 (22.2%)
Maternal Marital Status	Single	2 (11.1%)
	Relationship	7 (38.9%)
	Married	9 (50.0%)
	Divorced	0 (0%)
	Widowed	0 (0%)
Infant Sex	Male	10 (55.6%)
	Female	8 (44.4%)
IVH	Yes	10 (55.6%)
	No	8 (44.4%)
IVH Grade (1-4)	Grade 1	4 (40.0%)
	Grade 2	2 (20.0%)
	Grade 3	2 (20.0%)
	Grade 4	0 (0%)

Maternal Descriptive Statistics

Of the mothers enrolled, average maternal age was 29.82 years old (*SD = 5.40*). In regard to maternal race, 3 mothers reported their race as Black or African American (*16.7%*) and fourteen as White or Caucasian (*77.8%*). One mother chose not to report her race (*5.6%*). All mothers reported their ethnicity as Not Hispanic or Latino. Maternal level of education was also recorded, with 4 mothers completing high school (*22.2%*), 3 completing some college (*16.7%*), 7 completing college (*38.9%*), and 4 completing a degree beyond their Bachelors (*22.2%*). In regard to relationship status, 2 mothers were reportedly single (*11.1%*), 7 were in a relationship (*38.9%*), and 9 were married (*50.0%*). In terms of family size, most mothers reportedly had between 1-2 children (*M = 1.78 children, SD = 0.943*).

Infant Descriptive Statistics

When examining characteristics of the infants of mothers enrolled in the study, 8 infants were female (*44.4%*), and ten were male (*55.6%*). All infants were born prematurely, under 37 weeks gestation, and the average gestational age was 28.86 weeks (*SD = 4.77*), and average birth weight was 1151.94 grams (*SD = 743.21*). Ten infants had intraventricular hemorrhage (*55.6%*), while 8 did not (*44.4%*). Of those with intraventricular hemorrhage, 4 infants had a Grade 1 hemorrhage (*40.0%*), 2 had a Grade 2 hemorrhage (*20.0%*), and 2 had a Grade 3 hemorrhage (*20.0%*).

Preliminary statistical analyses were conducted to further examine the makeup of the control and intervention groups, ultimately determining if significant group differences were present. This was especially important in consideration of the reduced sample sizes. Independent sample *t*-tests were completed to examine the maternal variables of age and number of children,

and also the infant variables of gestational age (weeks) and birth weight (grams) across control and intervention groups. Chi Square tests of independence were conducted for the categorical maternal variables of race (1 = American Indian or Alaska Native, 2 = Asian, 3 = Black or African American, 4 = Native Hawaiian or other Pacific Islander, 5 = White), ethnicity (1 = Hispanic or Latino, 2 = Not Hispanic or Latino), level of education (1 = Less than 12th grade, 2 = Completed 12th grade, 3 = Some College, 4 = Completed College, 5 = More than College), and marital status (1 = Single, 2 = Relationship, 3 = Married, 4 = Divorced, 5 = Widowed), and the infant categorical variables of gender (1 = Female, 2 = Male), presence of IVH (0 = no IVH, 1 = IVH), and grade of IVH (Grade 1-4). With an alpha level of 0.01, independent sample *t*-tests revealed there were no significant differences between control and intervention groups for maternal age ($t(16) = 0.49, p = 0.63$) or number of children ($t(16) = 0.15, p = 0.33$). There were also no significant differences between control and intervention groups for the infant-focused variables of gestational age ($t(16) = 2.44, p = 0.03$) or birth weight ($t(16) = 1.60, p = 0.13$). Chi square tests of independence were conducted for the categorical variables, and there were not significant differences based on group for the variables of maternal race ($X^2(1, N = 17) = 3.24, p = 0.07$), level of education ($X^2(3, N = 18) = 0.476, p = 0.924$), and marital status ($X^2(2, N = 18) = 2.25, p = 0.32$). Chi square tests examining infant variables including gender ($X^2(1, N = 18) = 3.60, p = 0.06$), presence of IVH ($X^2(1, N = 18) = 3.60, p = 0.06$), and level of IVH ($X^2(3, N = 18) = 5.60, p = 0.13$) also revealed no significant differences between control and intervention groups. Because all mothers self-reported their ethnicity as Not Hispanic or Latino, a chi square test was unable to be performed as the variable of ethnicity is exactly the same between groups. These results from both *t*-tests and chi square tests suggest comparable patient makeups in both

control and intervention groups in regards to both the maternal- and infant-related variables explored.

Next, the scores generated from maternal completion of both the Maternal Attachment Inventory (MAI) and Parental Stressor Scale: Neonatal Intensive Care Unit (PSS:NICU) tools were examined. Of note, MAI scores may range from scores of 26 up to 104, with higher scores indicating a maternal rating of a stronger mother-infant attachment relationship, while the PSS:NICU scores range from 26 to 130, with increasingly higher scores indicating greater levels of perceived stress. First, for the control group's ratings on the MAI, the average MAI baseline score was 100.78 (*SD = 4.14*), and average follow-up score was 102.89 (*SD = 2.32*). For the intervention group, the average baseline MAI score was 102.22 (*SD = 1.64*), and average follow-up score was 103.44 (*SD = 1.13*). For the control group's PSS:NICU ratings, the average PSS:NICU baseline score was 79.33 (*SD = 17.16*) and follow-up score was 83.78 (*SD = 27.47*), while the intervention group's average baseline PSS:NICU score was 83.67 (*SD = 14.11*), and follow-up score was 79.33 (*SD = 21.51*).

A paired sample *t*-test was then conducted to preliminarily examine baseline and follow-up scores for the Maternal Attachment Inventory (MAI) and the Parental Stressor Scale: Neonatal Intensive Care Unit (PSS:NICU). When evaluating scores for the entire sample, including both control and intervention groups, no significant difference existed between baseline and follow-up MAI scores (*M = -1.0, SD = 2.765, p= 0.14*), or between PSS:NICU scores (*M = 0.06, SD = 13.80, p = 0.99*). Scores for all participants, both control and intervention groups, across baseline and follow-up time points can be seen below for the MAI in Figure 2 and PSS:NICU in Figure 3. Separate *t*-tests were then completed for both intervention and control groups to test for the presence of any significant differences between baseline and

follow-up MAI and PSS:NICU scores. Results are described below along with corresponding research questions.

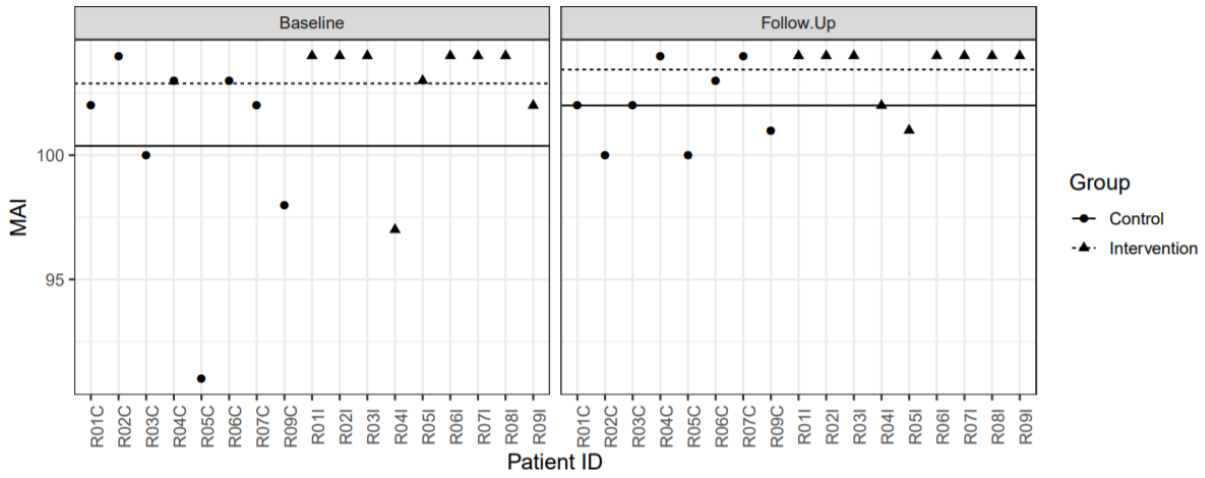


Figure 2: MAI Scores for both Control and Intervention Groups at Baseline and Follow-up

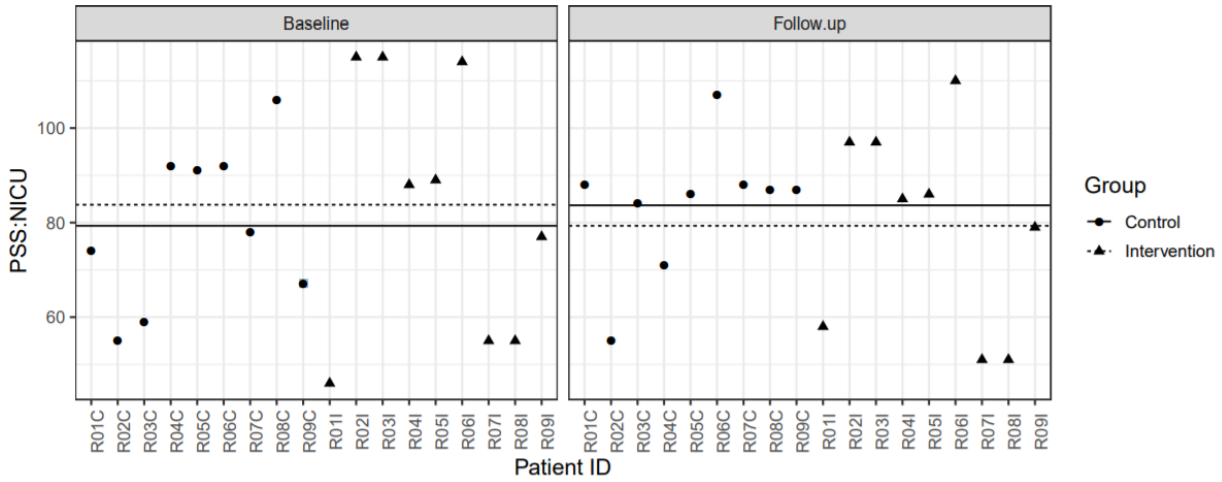


Figure 3: PSS:NICU Scores for Control and Intervention Groups at Baseline and Follow-up

Statistical Analyses

To analyze the proposed research questions 1-3 listed below, an array of statistical analyses were conducted; however, these analyses include adjustments to the initially proposed

analysis plan were required given the study's procedural changes and reduced sample size due to the COVID-19 pandemic.

Research Question 1: Does a NICU-based, mother-premature infant bedside reading initiative impact levels of parental stress during the premature infant's hospitalization in a NICU?

Research Question 2: How does a NICU-based, mother-premature infant bedside reading initiative impact the mothers' report of the maternal-infant attachment relationship during their premature infant's hospitalization in the NICU?

To analyze the first and second research questions, multivariate analysis of variance (MANOVA) tests were proposed, with an independent variable of participation in the reading intervention and dependent variables including reported levels of stress (PSS:NICU) and maternal-infant attachment (MAI) at pre- and post-test time points. However, given the reduced sample size recruited for the study, it was determined a MANOVA would not be an appropriate analysis, and instead, *t*-tests were utilized to evaluate changes in MAI and PSS:NICU scores between baseline and follow-up time periods for both the control and intervention groups.

A paired samples *t*-test comparing MAI scores at baseline and follow-up periods for the control group revealed an average difference between scores of -1.44 points (*SD = 3.47*). This difference was not found to be significantly different (*t(8)= -1.25, p = 0.25, ES = 0.03*). An average difference of -4.33 points (*SD = 16.6*) on the PSS:NICU for the control group between baseline and follow-up time points was also not statistically significant (*t(8) = -0.78, p = 0.46*). Effect size was also calculated to examine the strength of the relationship and magnitude of the effect. The effect size for control participants between baseline and follow-up time points on the

MAI indicated close to a medium size effect (*d = 0.45*) and on the PSS:NICU a small effect size (*d=0.28*) was found based on Cohen's (1988) convention for effect size.

For the intervention group, another paired samples *t*-test comparing MAI scores at baseline and follow-up periods revealed an average difference between baseline and follow-up MAI measurements of -0.56 points (*SD = 1.94*), that was not significantly different (*t(8) = -0.86, p = 0.416*). The effect size for the intervention group MAI score's between baseline and follow-up time points indicated a small to medium effect size (*d = 0.30*). The intervention group's PSS:NICU scores averaged a difference of 4.44 points (*SD = 9.25*) between time points; however this difference was again not found to be significant (*t(8)= 1.44, p = 0.19*), and the effect size was small (*d=0.18*).

Finally, despite the lack of significance found in the completed t-tests, the effect size was calculated utilizing the change score between baseline and follow-up time points for both the MAI and PSS:NICU comparing control and intervention groups. Utilizing Cohen's convention for effect size, for the MAI the effect size was small to medium (*d = 0.31*), while the effect size for the PSS:NICU was medium to large (*d = 0.65*).

Research Question 3: How do the degree of prematurity and level of intraventricular hemorrhage (IVH) relate to parental stress and maternal-infant attachment, and do the effects of a NICU-based mother-premature infant bedside reading initiative differ in their impact maternal-infant attachment and parental stress during a premature infant's hospitalization in the NICU based on level of prematurity and degree of IVH?

Analyses for the final research question were proposed to include another MANOVA with independent variables of level of prematurity and degree of IVH, and dependent variables

of reported levels of stress (PSS:NICU) and maternal-infant attachment (MAI) at baseline and follow-up time points. Given the smaller sample size enrolled, a sufficient sample size was not present to allow for this analysis to be conducted. Instead, *t*-tests were again utilized to examine the data collected.

An independent samples *t*-test was completed to compare the change in MAI scores and PSS:NICU scores in infants with or without the presence of an intraventricular hemorrhage. The change in MAI scores between baseline and follow-up time points for infants with intraventricular hemorrhages was 1.30 points (*SD = 3.30*), and was 0.63 points (*SD = 2.07*) for infants without IVH; considering an alpha level of 0.01, there was no significant difference between groups (*t(16)= 0.50, p = 0.06*). The change in PSS:NICU stress related scores between baseline and follow-up time points for infants with IVH averaged 2.4 points (*SD = 15.47*), and was 2.75 points (*SD = 19.98*) for infants without IVH. Again, this difference between groups was not found to be significant (*t(16)= -0.04, p = 0.97*).

To evaluate the relationship between level of prematurity and MAI and PSS:NICU scores, an independent samples *t*-test was conducted. To run this analysis, a grouping variable of prematurity was generated, with a cutoff score of 28-weeks gestation. With this cutoff score, 6 infants were born at gestations above 28-weeks, and twelve infants were below 28-weeks gestation. This cut point was chosen in consideration of the designation of the 'very premature' categorization, which designates infants into groups based on their gestational age, with the 'very premature' group including infants born below 28 weeks. For infants born at or below 28-weeks gestation, the average change in MAI scores between baseline and follow-up time points was 0.50 points (*SD = 1.68*). For infants born above 28-weeks gestation, the average change is MAI scores across time points was 2.0 points *(SD = 4.24*). Overall, the change in MAI scores between

baseline and follow-up time points was not significantly different based on prematurity ($t(16) = 1.09, p = 0.29$).

For the PSS:NICU, the average change in scores between baseline and follow-up time points was -1.33 points ($SD = 18.47$) for infants born less than 28-weeks gestation and was 10.33 points ($SD = 11.43$) for infants born greater than 28-weeks gestation; however, this point differential between time points for the PSS:NICU was not statistically significant ($t(16) = 1.41, p = 0.18$).

Chapter V Discussion

Nearly half a million infants are born prematurely in the United States each year (CDC, 2017), while 13 million preterm deliveries occur per year worldwide. Infants born prematurely are subject to increased mortality rates, and also a range of short and long-term morbidities (Altmier & Phillips, 2014). Premature infants may experience extensive hospitalizations in a neonatal intensive care unit (NICU) following birth, but even after discharge, these children are at increased risk for lasting medical issues and developmental delay or disability (Altmier & Phillips, 2014). This risk is heightened for infants that develop significant neurological complications, specifically intraventricular hemorrhage (IVH), which increases the risk for a number of lasting neurologic issues and deficits (Ballabh, 2010)

Neurosensory development is particularly impacted in the premature infant, as development of the sensory systems are meant to occur during the gestational period in an optimal in-utero environment. When an infant is born prematurely, sensory systems are forced to mature within a bright, loud, and often noxious NICU setting. Physical, chemical, sensory, and social-emotional exposures within the NICU environment are known to influence the development of sensory systems (Graven, 2000), and when this stimulation and exposure occurs at the wrong time in the developmental trajectory and at a level of intensity that is not appropriate, there may be lasting neurodevelopmental consequences. Interventions adapting the NICU environment to support appropriate sensory exposures and healthy brain development are paramount (Graven & Browne, 2008). Specifically, appropriate levels of auditory sensory information through exposure to speech and language once the auditory system is mature and able to handle this stimulation, can positively influence auditory system development and later speech and language (Graven & Browne, 2008).

The stressors of the NICU are not experienced solely by the infant. Premature birth and the corresponding medical complications infants face may result in increased situational, personal, and environmental stress for parents (Als et al., 1994). The appearance of their critically ill child, the sights and sounds of the ICU, change in their expected parental role, and potential difficulties with staff communication are all commonly cited parental stressors (Zeanah & Jones, 1982). Parents are limited in their engagement in their child's care due to their infant's medical complexity, physical barriers such as equipment or an isolette, and potentially poor communication between families and medical staff. These factors may impede parental understanding of their infant's behavioral cues and medical needs, and can impact their readiness for discharge home. Given these stressors, parents of premature infants are also at increased risk for their own mental health issues, including postpartum depression, anxiety, post-traumatic stress disorder, and other stress-related conditions (Ishizaki, 2013). With the knowledge of factors that contribute to parent stress as well as parental mental health, medical professionals can and must facilitate parent coping to promote more optimal parent–infant relationships and subsequently support infant development (Carter, Mulder, & Darlow, 2007). This may in part be achieved with the implementation of family-centered, developmental care interventions in the NICU setting.

The factors above may also impact the developing parent-child relationship. The stressors of the NICU can have lasting effects on the burgeoning parent-child attachment relationship, as parents are unable to engage in normal newborn caregiving, and carry the burden and stress of caring for their medically fragile infant in a stressful ICU setting. In a study by Plunkett, Meisels, Stiefel, Pasick, and Roloff (1986), attachment patterns of thirty-three high-risk premature infants with hospitalizations of more than one month following birth were compared to attachment

patterns of healthy, premature infants initially hospitalized for less than one month. Infants with more complex medical diagnoses and moderate to lengthy hospitalizations displayed more anxious-avoidant attachment patterns than infants in the healthy, premature group (Plunkett et al., 1986). Recognizing the importance of early parent-infant attachment relationships, and the risk of unhealthy relationship patterns to NICU families, strategies to engage parents and involve families in the daily medical and developmental care of their infant during their NICU hospitalization is crucial and has the ability to facilitate positive development of early attachment relationships, even from the earliest moments of the infant's life (Craig et al., 2015).

Family involvement is an essential component of attachment, but also has the capacity to play a role in decreasing familial stress and generating positive effects on physical, cognitive and psychosocial development of infants, especially those in a NICU (Craig et al., 2015). This may be achieved through family-centered, or family-integrated, developmental care. Family-centered developmental care interventions aim to engage parents and modulate the stressors experienced by infants. These interventions have a variety of positive effects, including decreased maternal stress, improved parent-infant attachment, improved infant weight gain, and higher rates of breastfeeding at discharge (Craig et al, 2015).

Parents reading to infants at their NICU bedside is one example of a family-centered developmental care intervention. From birth, reading supports the growing bond between a parent and child. Zauche and colleagues (2017) found that by teaching parents both how and why to treat their child as a conversational partner and by modeling such interactions, pediatric health care providers can help support a child's literacy, educational success, and health. Typical parenting activities, including reading, can help parents engage with their child in a positive,

supportive manner (Bialoskurski, Cox, & Hayes, 1999). This can be true in a NICU environment as well.

Reading to children at a young age is instrumental in experience-dependent learning and brain development, especially in the development of language and reading skills (Larivviere & Rennick, 2011). This learning and development can begin from the child's first days of life, even when those days are spent in a NICU setting. Parental reading to infants in the NICU can connect a parent and child and offer a way to positively engage parents in caregiving in the NICU (Walker, 2013). It also has the capacity to positively impact later infant development. Caskey, Stephens, Tucker, and Vohr (2013) discovered that adult word counts, or increased exposure to parental talk in the NICU setting, was positively correlated with later developmental cognitive and language performance. This research group also found that when a parent was present at their infant's bedside in the NICU, exposure to parental talk was a predictor of infant vocalizations as early as 32 weeks, and conversational turns at both 32 and 36 weeks. This occurred over exposure to language from other adults including nursing or other medical staff in the NICU environment (Caskey et al., 2011).

The benefits of parental reading in the NICU for infants in regards to language development and cognitive outcomes are clear, but there are additional potential positive impacts of this intervention model for parents and the budding parent-child relationship. Lariviere and Rennick (2011) specifically examined the effects of a parent book reading intervention on parent and child interaction in the NICU and its impact on the frequency of reading to infants following discharge. At the outset of the intervention, psychoeducation on the benefits of reading in the NICU and beyond and actual books to read were given to parents. Parents were encouraged to read frequently to their infants both in the NICU, and once home, following their child's

discharge. Following discharge, measures of parental stress, parent-infant activity, and parent-infant interaction during reading were given to parents. Parents reported an increase in a sense of control, normalcy, and intimacy with their infants and also reported reading more frequently to their children once discharged, feeling that reading positively affected their interactions with their child (Lariviere & Rennick, 2011). This study determined a parent-infant bedside reading intervention to be a time efficient, cost-sensitive family-centered developmental care intervention and found many benefits to both the child and family. However, further investigation of such an intervention's impacts on the parent with real time measurement of the parent-child attachment relationship and parental levels of stress during the intervention period are needed given the known stressors from the NICU during an infant's hospitalization. Additionally, information on initial levels of parental stress during a child's inpatient stay would be assistive for interpreting if a change in parental stress was affected specifically by this intervention.

Premature infants, especially those suffering from the neurological impacts of intraventricular hemorrhage, are at risk for neurodevelopmental delays and disabilities, and also impaired attachment relationships with family members. Increased levels of stress may impact the parent-child relationship in the NICU and have lasting effects for both the parent and child. NICU interventions that promote positive developmental care practices and appropriate developmental stimulation are widely supported. Combined with strategies to lower parental stress and improve bonding, these interventions have the opportunity to serve all parties in both the short and long term. Current research had not yet explored the degree of parental stress during the NICU stay in relation to reading programs, and thorough evaluation of the parent and child attachment relationship in the NICU unit in relation to parental stress and reading to the

premature infant also had not been studied in depth. This study aimed to examine the degree of stress experienced by parents, specifically mothers, of preterm infants with varying grades of IVH in the Children's Hospital of Pittsburgh Neonatal Intensive Unit before and after the implementation of a parent-infant bedside reading intervention. This research aimed to inform researchers and practitioners on the nature of the stressors parents experience in the NICU setting and how to mediate these stressors to optimize the parent-child interaction and ultimately, the mother-infant attachment relationship during the NICU stay and beyond.

Discussion of Specific Results

The results from this NICU-based mother-infant bedside reading intervention were an interesting window into the maternal experience during an infant's NICU hospitalization. The various results of this investigation did not meet levels of significance, however examination of the observed data trends may still be assistive to inform future investigation of brief, cost-effective, and focused interventions to address the topics of maternal stress and maternal-infant attachment in a NICU setting. The COVID-19 pandemic came to fruition in the midst of subject recruitment and intervention completion, causing recruitment to cease earlier than anticipated. This led to a smaller sample size than originally proposed with 18 total patients, 9 control and 9 intervention subjects, rather than 40 total participants as originally designed. This smaller sample led to decreased power in our analyses, requiring modifications to our original analysis plan, specifically changes to the plan to complete various multivariate analyses of variance (MANOVA) tests to investigate group differences. Instead, *t*-tests were utilized to investigate group differences as effect sizes and trends in the data patterns were analyzed.

Control and intervention group makeups were investigated, specifically maternal factors including mothers' age, race, ethnicity, education, marital status and number of children. Infant-

focused variables collected included infant sex, infant gestational age at birth, infant birth weight, presence of intraventricular hemorrhage, and grade of intraventricular hemorrhage if present. The majority of mothers participating in the study were White or Caucasian, and identified as not Hispanic or Latino. The average maternal age was approximately 30 years, and over half of mothers had completed college or beyond a bachelor's degree. In regard to infant factors, the mean gestational age of infants was close to 29 weeks, which falls into the category of very preterm, and the average birth weight was approximately 1152 grams, considered very low birth weight. Approximately half of the total infant sample had an intraventricular hemorrhage, however the degree of severity of hemorrhages varied from Grade 1 to Grade 3.

A variety of chi square tests of independence and *t*-tests were conducted to examine groups, and found no significant differences between control and intervention groups on these factors collected. Although differences between groups did not meet levels of significance on these described factors, the population of mothers and infants enrolled was fairly diverse due to the small sample size in the study. With the decreased sample size and this diverse NICU patient population, a large degree of variance in both the MAI and PSS:NICU responses was present. Despite this variance, trends were examined and are detailed below along with all results collected.

Maternal Attachment Inventory

Differences between control and intervention group responses in measurement of the maternal-infant attachment relationship through the Maternal Attachment Inventory (MAI) both at baseline and follow-up time points were investigated. Although results were not significant, trends in the data were as hypothesized, and showed an increase in ratings of attachment between the baseline and follow-up time points for both the control (*Baseline M = 100.8, Follow-up M =*

102.2) and intervention (*Baseline M = 102.9, Follow-up M = 103.4*) groups. These differences were not statistically significant; however, ratings of attachment were highest for the intervention group at the follow-up time point, which is consistent with our original hypothesis. Ratings of maternal-infant attachment at the highest possible rating point, ceiling of the MAI measure, at both baseline and follow-up time points was observed in both the control and intervention groups.

As anticipated, ratings of attachment increased as mothers had more time to bond with their infants in the NICU between baseline and follow-up testing points; however, there was not a significant difference between control and intervention groups, thus mothers receiving the reading intervention did not find greater degrees of growth in their attachment relationships than other NICU mothers. Of note, many mothers rated their attachment relationship at the highest possible point on the MAI, even from the beginning of their child's NICU stay. This indicates a perception of a very positive parent-infant attachment relationship from the very beginning, despite the many stressors and barriers to building this relationship inherent to a NICU setting. Given the frequent ratings at ceiling on the MAI, a measure with additional items and a wider Likert scale may be assistive in the future to better capture ratings of maternal-infant attachment.

This study also sought to understand how the degree of prematurity and level of intraventricular hemorrhage relate to maternal infant-attachment, and if a reading intervention had differing impacts based on these variables. Mothers of infants with intraventricular hemorrhage did not report differing scores on the MAI, and similarly, there was no significant difference in ratings of the maternal-infant attachment relationships in mothers of infants born more prematurely, below 28-weeks gestation, than those born between 28 and 37 weeks gestation.

Parental Stressor Scale: Neonatal Intensive Care Unit

Ratings of maternal stress during an infant's NICU hospitalization were explored through the completion of the Parental Stressor Scale: Neonatal Intensive Care Unit (PSS:NICU). Although results did not meet a level of significance, we did observe an increase in rated stress in the control group from the time of baseline measurement to follow-up (*Baseline M = 79.3, Follow-up M = 83.7*) and a decrease in ratings of stress over time for the intervention group (*Baseline M = 83.7, Follow-up M = 79.3*). A decrease in ratings of stress was originally hypothesized for both groups, but with a stronger, and more significant decrease in stress predicted for mother's receiving the reading intervention. Instead, stress decreased for the intervention group as hypothesized, but increased over the course of the NICU stay for the control group. Given these results, further investigation of baseline trends in maternal stress over the course of a NICU stay is warranted. Although differences between the groups were not significant for the infant's gestational age, birth weight, etc., we hypothesize that additional infant or maternal focused variables that were not collected may account, at least in part, for this surprising trend.

Maternal ratings of stress with and without the presence of the bedside reading intervention in consideration of the degree of infant prematurity and level of intraventricular hemorrhage was also investigated. PSS:NICU scores for mothers of infants with intraventricular hemorrhage did not differ significantly from those without the presence of IVH. There also was no significant difference in ratings of stress in mothers of infants born more prematurely, below 28-weeks gestation, than those born at later gestational ages. Although the difference was not significant, mothers of infants born at higher gestational ages (greater than or equal to 28-weeks gestation), saw a greater increase in MAI ratings of the maternal-infant attachment relationship

between baseline and follow-up time points. However, a high level of variability in ratings of stress in all groups was present, indicated by large standard deviations, and must be considered when interpreting results.

Limitations

Limitations to the study were more expansive than originally anticipated, likely given the small sample size due to reduced recruitment in the context of the COVID-19 pandemic. Within this small sample, the population of mothers and infants varied with a wide range of gestational ages, primary diagnoses, and hospital courses. With a diverse sample of both mothers and infants found in most NICU settings, a larger sample size would be crucial for more elaborate investigation of the trends within this study.

Despite limitations in the analyses performed, specifically the inability to perform multivariate analyses, we were able to observe data trends to inform future study. These trends, although informative, do not appear to not be explained fully by the variables collected, as additional variables may be confounding results. Potential confounders or future variables to evaluate may include familial socio-economic status, the severity of infant illness not captured by gestational age or birth weight, and aspects of the infant's hospital course such as their length of stay. Infants experiencing certain primary diagnoses or more severe medical courses may require more stress-inducing medical treatment that may add to the already present stressors of the NICU for parents, influencing the mother's completion of the PSS:NICU. Likewise, certain neurological-based diagnoses on top of the complications of premature birth may influence a child's behavioral functioning, and lend to changes in how they interact with their caregivers, influencing the maternal-infant attachment relationship and maternal responses on the MAI. Furthermore, timing of maternal completion of the MAI and PSS:NICU assessments while

inpatient may have coincided with family's receiving news regarding setbacks or poor prognosis, influencing mother's assessment results and amplifying feelings of stress. Additional future variables such as infant temperament and parenting self-efficacy may further inform the effectiveness of interventions as well as maternal mental health history, which may be important to draw upon given the perception and handling of stress while in the NICU.

Another potential limitation may lie with the measures utilized given the setting of the study, at the UPMC Children's Hospital of Pittsburgh Level IV NICU. A Level IV NICU offers the highest level of neonatal care, located in hospitals that can provide surgical repair of complex congenital or acquired conditions. Level IV NICUs offer a full range of pediatric medical and surgical subspecialties for infants with varying critical illnesses. The Maternal Attachment Inventory was not created specifically for a NICU population and the nature of attachment-related difficulties or problems, especially for the critically ill patients within the CHP Level IV NICU, may exceed that which can be captured with the MAI. Although the PSS:NICU was created in consideration of the NICU setting, the severity of patients present at the CHP NICU may fall within the most medically acute rather than the broader spectrum of illness for which the measure was normed on. Assessment of maternal stress and maternal-infant attachment relationships within a unique Level IV NICU setting may require expansion or further development of appropriate evidence-based measures.

Additionally, in regards to instrumentation, utility of the MAI to capture the unique attachment relationships developing in a NICU setting must be further considered. Many study participants rated their mother-infant attachment relationships at the highest possible point, at ceiling level of the MAI measure. Some degree of the Hawthorne effect, where study participant's behavior is impacted by their awareness of participating in research and the

attention paid to their responses, may be impacting maternal attachment ratings (Diaper, 1990). Mothers may tend to respond more positively on some questions such as "I feel love for my baby" or "I feel warm and happy with my baby," knowing their answers will be examined ((Muller, 1994). The Hawthorne effect should be considered when interpreting results for the purposes of this study and future examination of attachment relationships in a NICU setting. This effect also further emphasizes the need for a NICU-specific measure of attachment, with more specified NICU-based questions which mothers may feel more open and comfortable completing.

As we were required to utilize intact groups for control and intervention groups in the clinical setting by first collecting the control data and then working with the intervention group, a study format randomizing patients to both groups may be a consideration moving forward if this randomization does not interfere with the integrity of the study. Randomization would eliminate potential confounding variables of timing, such as the season of the year, as well as a change in environment or culture that may be differ in the NICU setting based on the timing of the study.

Finally, a variable of minutes read to infants at bedside which was originally proposed as a study variable, was unable to be collected. Mothers found completion of the reading calendar to be unfeasible during their child's NICU stay given the environmental stressors and parenting requirements surrounding them. Strategies to collect such a variable in future research, while not taxing parents and causing undue burden, should be explored.

Recommendations for Future Research

Given the immense stress experienced by both infants and parents following the premature birth of an infant and their subsequent NICU hospitalization, time- and cost-sensitive family-centered developmental care interventions are critical given the many benefits they offer

to both the child and family. The benefits of a bedside reading intervention program in the NICU setting have been explored previously, but with a focus on longitudinal assessment of effectiveness following a patient's discharge from the NICU. Lariviere & Rennick (2011) found that through a NICU-based reading intervention, parents later reported reading more frequently to their children, and felt that reading positively affected their interactions with their child, fostering a sense of normalcy, control, and intimacy during the difficult period of their child's NICU stay. This current study elaborated on those findings by likewise educating parents on the benefits of reading and encouraging them to engage regularly in the activity at their infant's bedside, but also measuring ratings of maternal stress and the maternal-infant attachment relationship in real time, with baseline and follow-up assessment time points during the infant's hospitalization.

Through this study, a NICU-based mother-infant bedside reading intervention was found to be affordable, time efficient, and easily implemented. Results were variable for mothers, due to the small sample size but also potentially in part due to the multifaceted stressors present for families based on both infant and maternal factors that varied over the course of the child's hospitalization. Although various infant and maternal variables were collected, we hypothesize that some variability in maternal ratings of stress and mother-infant attachment was unable to be captured in the variables collected. Future studies may consider collection of an infant clinical classification scale, to determine if the infant's medical status at the time of the mother's assessments impacted their responses, and may explore additional ways to capture the amount of reading parents were engaging in at bedside without overly taxing parents to complete calendars or additional forms. Larger sample sizes in future studies may allow for more elaborate statistical analyses controlling for the many variables that likely contribute to maternal ratings of stress and

attachment. Development a NICU-specific measure of the maternal-infant attachment relationship may also be warranted for future study. Future research should continue to evaluate the specific benefits of reading to infants at bedside to support maternal-infant attachment relationships, provide appropriate sensory stimulation to developing infants, and optimize the environment for family in a family-centered care model.

Conclusions

A NICU-based mother-infant bedside reading intervention has a variety of potential benefits for both the mother and the infant in both the short and long term. Past research has demonstrated the importance of family-integrated, developmental care interventions, as well as the need for supportive environmental and sensory stimulation for the infant to optimize neurodevelopmental and social-emotional outcomes (Craig et al., 2015; Krueger, 2010). Implementation of such an intervention with analysis of maternal factors during the infant's hospitalization can be complicated given the high stress of the environment, and the unpredictability of clinical care needs. Even so, analysis of maternal stress and the budding maternal-infant relationship during the actual NICU hospitalization allows for real-time clinical support to both mother and child to facilitate growth in the relationship and provide psychosocial supports to help families weather the difficulties of the NICU.

Despite a lack of significant findings, study results were generally consistent with extant theoretical positions from prior literature. An increase in the reported maternal-infant attachment relationship over time in the NICU setting, and a decrease in ratings of maternal stress over time were observed in the reading intervention group. Surprisingly, an increase in stress between the baseline and follow-up time points was observed in the control group; this may be somewhat explained by the study variables, or more fully explained by confounding variables outside of

those collected such as psychosocial stressors or other maternal or infant driven factors. Additionally, the implemented reading intervention did not differ significant in its impacts for infants born more prematurely, or for those experiencing intraventricular hemorrhage.

With a larger sample size and more elaborate analysis capabilities, some degree of significance may have been achieved, confirming at least in part, some degree of benefit to such an intervention. However, given the restrictions on this study in the face of the COVID-19 pandemic, recruitment and enrollment were limited.

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Appendix A

PARENTAL STRESS SCALE: NEONATAL INTENSIVE CARE UNIT

We are interested in knowing more about the stresses experienced by parents when a premature is sick and hospitalized in an neonatal intensive care unit (NICU). We would like to know about your experience as a parent whose child is presently in the NICU.

This questionnaire lists various experiences other parents have reported as stressful when their baby was in the NICU. We would like you to indicate how stressful each item listed below has been for you. **By stressful, we mean that the experience has caused you to feel anxious, upset, or tense.** On the questionnaire, circle the single number that best expresses how stressful each experience has been for you. The numbers indicate the following levels of stress:

1 = Not at all stressful the experience did not cause you to feel upset, tense, or anxious
2 = A little stressful
3 = Moderately stressful
4 = Very stressful
5 = Extremely stressful

If you have not experienced an item, please circle NA "not applicable"

Now let's take an item for an example: **The bright lights in the NICU**.

If for example you feel that the bright lights in the neonatal intensive care unit were extremely stressful to you, you would circle the number 5 below:

NA 1 2 3 4 **5**

If you feel that the lights were not stressful at all, you would circle the number 1 below:

NA **1** 2 3 4 5

Below is a list of the various **SIGHTS AND SOUNDS** commonly experienced in an NICU. We are interested in knowing about your view of how stressful these **SIGHTS AND SOUNDS** are for you. Circle the number that best represents your level of stress. If you did not see or hear the item, circle the NA meaning "Not applicable."

1.	The presence of monitors and equipment	NA 1 2 3 4 5
2.	The constant noises of monitors and equipment	NA 1 2 3 4 5
3.	The sudden noises of monitor alarms	NA 1 2 3 4 5
4.	The other sick babies in the room	NA 1 2 3 4 5

5.	The large number of people working in the unit	NA 1 2 3 4 5

Below is a list of items that might describe the way your **BABY LOOKS AND BEHAVES** while you are visiting in the NICU as well as some of the **TREATMENTS** that you have seen done to the baby. Not all babies have these experiences or look this way, so circle the NA, if you have not experienced or seen the listed item. If the item reflects something that you have experienced, then indicate how much the experience was stressful or upsetting to you by circling the appropriate number.

6.	Tubes and equipment on or near my baby	NA 1 2 3 4 5
7.	Bruises, cuts or incisions on my baby	NA 1 2 3 4 5
8.	The unusual color of my baby (for example looking pale or yellow jaundiced)	NA 1 2 3 4 5
9.	My baby's unusual or abnormal breathing patterns	NA 1 2 3 4 5
10.	The small size of my baby	NA 1 2 3 4 5
11.	The wrinkled appearance of my baby	NA 1 2 3 4 5
12.	Having a machine (respirator) breathe for my baby	NA 1 2 3 4 5
13.	Seeing needles and tubes put in my baby	NA 1 2 3 4 5
14.	My baby being fed by an intravenous line or tube	NA 1 2 3 4 5
15.	When my baby seemed to be in pain	NA 1 2 3 4 5
16.	When my baby looked sad	NA 1 2 3 4 5
17.	The limp and weak appearance of my baby	NA 1 2 3 4 5
18.	Jerky or restless movements of my baby	NA 1 2 3 4 5
19.	My baby not being able to cry like other babies	NA 1 2 3 4 5

The last area we want to ask you about is how you feel about your own **RELATIONSHIP** with the baby and your **PARENTAL ROLE**. If you have experienced the following situations or feelings, indicate how stressful you have been by them by circling the appropriate number. Again, circle NA if you did not experience the item.

20.	Being separated from my baby	NA 1 2 3 4 5
21.	Not feeding my baby myself	NA 1 2 3 4 5
22.	Not being able to care for my baby myself (for example, diapering, bathing)	NA 1 2 3 4 5
23.	Not being able to hold my baby when I want	NA 1 2 3 4 5
24.	Feeling helpless and unable to protect my baby from pain and painful procedures	NA 1 2 3 4 5
25.	Feeling helpless about how to help my baby during this time	NA 1 2 3 4 5
26.	Not having time alone with my baby	NA 1 2 3 4 5

Thank you for your help.

Feel free to write about other situations that you found stressful during the time that your baby was in the neonatal intensive care unit?