Implementation of a Structured Mother-Infant Reading Program to Reduce Postpartum Depression and Maternal Stress and Measure Infant Physiologic Stability in the NICU

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Abstract

Purpose: Mothers of infants in the Neonatal Intensive Care Unit (NICU) are at greater risk for postpartum depression and altered maternal infant bonding. Strategies to encourage care participation while offering normalcy during hospitalization in the NICU may reduce postpartum depression and maternal stress while presumptively enhancing maternal infant attachment. Maternal voice exposure may also have positive physiologic effects on the premature infant. The purpose of this study was to evaluate the implementation of a NICU based reading program on both maternal and infant outcomes. Does participating in a structured mother-infant reading program over a 4-week period decrease maternal perception of depression and stress? Does maternal voice exposure through reading reduce infant mean heart rate and increase SpO2 readings during reading when compared to 30 minutes before and 30 minutes after reading?

Methods: Fourteen mothers, including the mother of fraternal twins, were enrolled in a 4-week mother-infant reading intervention utilizing a reading program called the NICU Reading Garden developed by the author. Maternal depression and stress scores were obtained prior to the intervention. Participants received nurse practitioner delivered education, support, and encouragement to read to their infant. After 4 weeks of reading, maternal depression and stress scores were reassessed. Based on reading times, heart rate and oxygen saturation levels were assessed at three time points including 30 minutes before, during, and 30 minutes after each reading time. Thirteen mothers completed the intervention, including the mother of twins.

Results: There was a statistically significant reduction in maternal depression scores after the 4-week invention (Md=9 vs Md=3, p= 0.007). There was no change in stress scores when all mothers were included. When only mothers of singletons were analyzed, there was a statistically significant reduction in stress related to infant behaviors (p=0.0498) and parental role alterations

(p=0.04). The majority of mothers (92.8%) reported that reading made them feel closer to their baby and all (100%) planned to read to their baby after discharge. There was no change in mean HR when compared at three-time intervals. There was a statistically significant increase in mean SpO2 during reading compared to after reading (p=0.002).

Conclusion: Women participating in a 4-week reading intervention had a statistically significant reduction in EPDS scores. Women of singletons also had a statistically significant reduction in stress scores associated with infant behavior and parental role alterations. Mean infant SpO2 levels during reading compared to after reading were higher and this was statistically significant. Reading made mothers feel closer to their infants and was an activity that they planned to continue after discharge. Reading in the NICU as an intervention to address maternal depression and stress is feasible and effective. Maternal voice exposure improves infant oxygen saturations during reading and is well tolerated.

Nursing Implications: Implementation of a reading program achieves unit goals of family centered care while promoting maternal self-efficacy, maternal infant bonding, and supporting maternal mental health. Infant physiologic stability does not appear to be negatively impacted by maternal voice exposure and oxygenation levels may actually improve during reading. Future research should focus on the diagnosis, treatment, and recognition of emotional patterns associated with PPD in NICU mothers; cycles and triggers of maternal stress during hospitalization; and how maternal voice exposure in the early neonatal period impacts infant language acquisition and ultimately, childhood literacy long term.

Keywords: postpartum depression, attachment theory, self-efficacy theory, neonatal intensive care unit, reading program, family centered care, maternal voice exposure, preterm infant physiologic stability

Implementation of a Structured Mother-Infant Reading Program to Reduce Postpartum Depression and Maternal Stress and Measure Infant Physiologic Stability in the NICU

Being the mother of sick or premature infant in the Neonatal Intensive Care Unit (NICU) can be a harrowing experience. The mother or parents may not know from day to day or minute by minute if their infant will survive. Preconceived notions of an uneventful delivery, departing the hospital with a healthy baby, and quiet moments of bonding are quickly replaced by an urgency of care, invasive machines and noxious alarms, and unfamiliar health care providers touching and caring for their infant while they are relegated to being observers. Powerlessness is a common theme experienced by parents as they struggle with negotiating their parental role in an unfamiliar and unexpected environment (Walker, 2013). Altered maternal-infant bonding coupled with the risk for increased stress and depression for mothers make this time in the NICU a critical period for recognition, assessment, and intervention for mother and baby. Maternal and infant well-being are in jeopardy and NICU care providers may hold the key to offering meaningful solutions to improve outcomes for both. Maternal immersion into a developmentally focused reading program may provide a structured activity for care provision that offers avenues for developing self-efficacy and building confidence in parenting while promoting maternal infant bonding and improving infant physiologic stability and neurodevelopmental outcomes.

Background

Postpartum Depression

Maternal mental health is considered a major public health challenge as its impact is twofold, with the potential for adverse outcomes in not only the mother related to her own health burdens and functional status but also in the infant and child, influencing breast feeding rates, maternal child bonding, and long-term developmental outcomes (Beck, 2002; Cummings and

Davies, 1994; Halpern. Brand, and Malone, 2001). Postpartum depression (PPD) is a major health issue for child-bearing women. The World Health Organization (WHO) estimates that 20% of mothers in developing countries experience clinical depression after child birth during the initial postpartum or postnatal period (World Health Organization Millennium Development Goals, 2014). The latest statistics from the Centers for Disease Control and Prevention estimated that approximately 12% of all new mothers' experience symptoms that meet the criteria of postpartum depression in the United States (Division of Reproductive Health, National Center for Chronic Disease Prevention and Health Promotion, December 13, 2017). This percentage may vary from state to state and can be as high as one in five or 20%. Postpartum depression (PPD) is defined as a depressive episode in women with onset occurring 4 weeks to 12 months after the birth of a child (National Institutes of Mental Health, Postpartum Depression Facts, 2017). There is a higher prevalence of postpartum depression in mothers of preterm infants with up to 40% of mothers suffering PPD in the early postpartum period (Vigod, Villegas, and Ross, 2010). The greatest predictors of PPD for NICU mothers are lack of social support, prior episodes of anxiety or depression, and the severity of illness of the infant correlating with gestational age and birth weight (McCaffree and Gillaspy, 2014).

Numerous studies have examined various interventions for the prevention of postpartum depression, including: interpersonal group oriented therapy (Zlotnick, Johnson, Miller, Pearlstein, and Howard, 2001; Dennis and Dowswell, 2013); mid-wife directed educational counseling (Waldenstrom, Brown, McLachlan, Forster, and Brennecke, 2000); home visits to high risk populations by psych-trained nurses (Armstrong, Fraser, Dadds, and Morris, 1999); structured support groups (Reid, Glazener, Murray, and Taylor, 2002; Lavender, Richens, Milan, Smyth, and Dowswell, 2013); and exercise initiatives (Lewis et al., 2012; Armstrong and

Edwards, 2003; Armstrong and Edwards, 2004; Drista, DaCosta, Dupuis, Lowensteyn, and Khalife, 2008; Norman, Sherburn, Osborne, and Galea, 2007). Few studies have focused on care provision activities to enhance maternal infant bonding and build maternal self-efficacy.

In an integrated review of postpartum depression in mothers of preterm infants, Tahirkheli, Cherry, Tackett, McCaffree, and Gillaspy (2014), reported successful interventions to reduce PPD in the NICU. These included: coordinated disciplinary teams with a holistic family centered approach utilizing counseling, therapy, and medication; education through a formalized program; promotion of "sharing" through journal writing; and an emphasis on NICU nurse support. Mothers who perceived support from the bedside nurse demonstrated less severe or fewer PPD symptoms (Cherry et al., 2014).

Maternal-Infant Attachment

In addition to the stress, anxiety, and depression risk associated with having a premature baby, NICU parents are at risk for altered parental-child bonding and attachment (Wilkinson and Mulcahy, 2010; Shah, Clements, and Poehlmann, 2011; and Holditch-Davis, Santos, Levy, White-Traut, O'Shea, Geraldo and David, 2015). Bowlby's attachment theory states that it is essential for an infant to be attached to a mother or mother substitute who is present, available, and who can respond to the needs of the infant (Bowlby, 1982). Beck (1995) found that postpartum depression has a moderate to large effect on maternal infant interactions during the first year after delivery. If a mother is emotionally unavailable or affectively unresponsive, synchrony of interaction behaviors is unlikely to occur in the depressed mother-infant dyad. Premature delivery can have a negative effect on attachment. Shah et al. (2011) reported that maternal grief related to preterm delivery led to insecure attachment at 16 months of age in their preterm infants. The quality of interactions between mother and infant affected attachment

security. Maternal sensitivity may be dampened due to the mother's inability to be near the infant either due to the infant's clinical status or the physical barriers created within the NICU. Mothers of medically fragile infants have described a period of ambiguity between pregnancy and being a mother when their role is unclear. Black, Holditch-Davis, and Miles (2009) define a period of "liminality" in which maternal role is unclear and technology, especially the use of ventilator, was seen as a barrier for maternal connection.

Reading to Infants

Parents reading to their child is an activity that has been seen as a positive caregiving interaction that promotes closeness and bonding (Seden, 2008; Zuckerman and Augustyn, 2011; and Walker, 2013). Reading to children at a young age is instrumental in the development of language and reading skills as well as brain development (Karrass and Braungart-Ricker, 2005; Mustard, 2006; Needleman and Silverstein, 2004; Wade and Moore, 1998; Willis, Kabler-Babbitt, and Zuckermann, 2007). For parents of infants in the NICU, reading may be an activity that allows for care participation when there is little else that they can do (Walker, 2013). They cannot hold, feed, or even touch their fragile infant during the early critical interval yet reading to their infant may be the one thing that parents alone can provide. Lariviere and Rennick (2011) found that parents who read to their infant in the NICU felt an increased sense of control, normalcy, and increased intimacy with that child.

Maternal Voice Exposure and the Preterm Infant

In-utero, maternal voice exposure is an important source of sensory stimulation for the developing fetus. Infants born prematurely are deprived of this stimulus and instead exposed to noxious environmental factors including light, sound, and tactile stimulation at levels they otherwise would not have experienced in the womb. Over the last decade, much attention has been

given to developmental strategies and interventions that reduce the negative and potentially detrimental consequences of these stressful exposures in order to reduce the neurodevelopmental impact on the infant (Als, Duffy, McAnulty, Butler, Lightbody, Kosta, et al., 2012). Numerous systematic reviews have illustrated some evidence of positive effects of maternal voices exposure on preterm infants' cardiopulmonary stability and neurodevelopmental outcomes (Filippa, Panza, Ferrari, Frassoldati, Kuhn, Balduzzi, and D'Amico, 2017; Krueger, 2010; Provenzi, Broso, and Montirosso, 2017). However, those results have been inconsistent and lack effect on long term infant outcomes. No studies were found that have evaluated maternal voice exposure on preterm infant stability as guided by gestational age and auditory development so as to structure time, tone, and decibel exposure.

The purpose of this study was to evaluate the implementation of a NICU based reading program on both maternal and infant outcomes. For mothers of preterm infants, does participating in a structured mother-infant reading program over a 4-week period decrease their perception of depression and stress? For preterm infants, does maternal voice exposure through a mother-infant reading program reduce heart rate and increase SpO2 levels when compared at 30 minutes before, during, and 30 minutes after being read to by their mother?

Review of Literature

On-line data bases including Cumulative Index to Nursing and Allied Health Literature (CINAHL), Ovid MEDLINE, PubMed, Cochrane Library, and Google Scholar were accessed and searched using keywords and combinations including *postpartum depression, postnatal depression, attachment theory, social cognitive theory, self-efficacy, Neonatal Intensive Care Unit (NICU), special care nursery, infant literacy, reading program, and maternal reading behaviors*. Searches were limited to dates between 2000-2018, English language, research

articles, and randomized clinical trials (RCTs) initially. Clinical trial status was later liberalized. Various searches were also done during the preceding 4 months using the same data bases with similar keywords but also including *social cognitive theory, transtheoretical model, and social ecological model.* A total of 336 articles were found and reviewed. Articles were included if they contained information about postpartum depression, theoretical frameworks, and had relevance to the NICU. Articles about NICU reading programs as an intervention were also included along with those evaluating maternal voices exposure impact on preterm infant outcomes. Meta-analyses were prioritized and repeat articles that were include in the analysis were removed. Twelve articles remained (Figure 1)

Postpartum Depression and Post-traumatic Stress Interventions

Horsch, Tolsa, Gilbert, Jan du Chene, Mueller-Nix, and Grax (2016) performed a randomized clinical trial to assess the impact of an expressive writing intervention on post-partum depression and post-traumatic stress in mothers of very preterm infants, defined as infants less than 32 weeks gestational age with birth weight less than 1500 grams. Sixty-five mothers participated and were randomly allocated into an intervention group (n=33) utilizing expressive writing or control group (n=32) which received treatment as usual. Mothers were recruited while in the NICU and completed a series of questionnaires when their baby was three months, four months, and six months of age. The expressive writing intervention included written entries for three consecutive days in which mothers were encouraged to share their deepest thoughts and feeling about the birth and hospitalization of their infant. The three entries were then mailed to the authors as confirmation of protocol adherence. Fifty-four women completed all three time points. There was no significant difference in demographic or medical characteristics of mothers and their infants in the intervention and control groups. Statistically

significant reductions in depression (p= 0.001) and post-traumatic stress (p= 0.0029) were found in the intervention group. Mental health improved in both the intervention and control group and was statistically significant for both ($p < 0.001$).

Weis, Zoffman, Greisen, and Egerod, (2013) completed a randomized clinical trial to assess the effect of person-centered communication on parental stress in the NICU. Parents (n=134) of infants less than 34 weeks gestational age were randomly assigned to a standard care group (n=60) or intervention group (n=74). Family centered care concepts were utilized in the intervention group including nurse-parent dialogues, structured reflection sheets, and person-centered communication. At discharge, parents were asked to complete two self-reporting tools including the Parent Stress Scale: Neonatal Intensive Care Unit (PSS: NICU) and the Nurse Parents Support Tool (NPST). No statistically significant difference was found in stress scores amongst the control and intervention groups. There was also no difference in the perception of nurse support between groups. Mothers reported more stress than fathers ($p< 0.001$) overall.

Kraljevic and Warnock (2013) did a systematic review of early education and behavioral randomized clinical trial (RCT) interventions to reduce maternal symptoms of psychological trauma following preterm birth. Eight qualifying RCTs were synthesized. Heterogeneity prohibited calculations of pooled estimates. Interventions applied during and after hospitalization that were grounded in coping and self-regulation strategies had a small to moderate effect on reducing maternal depression, anxiety, and stress for up to 2-12 months respectively. Interventions included individualized education addressing infant cues, family organization, care giving, and resources; evidence-based demonstration of infant's reflexive, physiologic, and developmental response with maternal participation; and cognitive behavioral therapy.

Doupnik, Hill, Palkshappa, Worsely, Bae, Shaik, Qui, et al. (2017) performed a meta-analysis to assess parent coping support interventions during acute pediatric hospitalization. Twelve studies meet criteria for the meta-analysis and of those, nine were based in the NICU. The most commonly measured outcomes were parent depression, anxiety, and stress symptoms. In the meta-analysis, combined intervention effects significantly reduced parent anxiety (-0.29, 95% CI: -0.53 to -0.57) and stress (-0.78, 95% CI: -1.24 to -0.32) but not depression (-0.014, 95% CI: -0.18 to 0.15). Interventions were focused on education, self-care, and social support.

A meta-analysis was also performed by Mendelson, Cluxton-Fuller, Vullo, Tandon, and Noazin in 2017. The focus was NICU based interventions to reduce maternal depressive and anxiety symptoms. After a systematic review, twelve studies were identified, however two were excluded from quantitative analyses for high risk of bias. Interventions included various themes on education, cognitive behavioral therapy, and psychological support. The pooled effect of interventions to reduce depressive symptoms was -0.16 (95% CI, -0.32 to -0.002, p=.05). The pooled effect to reduce anxiety symptoms was -0.12 (95% CI, -0.29 to -0.05, p=.17). Cognitive based therapies were associated with significant improvements in depressive symptoms (-0.44, 95% CI, -0.77 to -0.11, p= 0.10). No studies were found that specifically looked at a parent participation activity such as reading as an intervention to decrease postpartum depression or stress in NICU mothers.

Maternal Voice Exposure Studies

Numerous studies have evaluated the effects of maternal voice exposure on preterm infants. Doheny, Hurwitz, Insofts, Ringer, and Lahav (2012) examined whether systematic exposure to maternal sounds would reduce the frequency of cardio-respiratory events (CREs). Fourteen infants with gestational ages ranging from 26-32 weeks, served as their own controls

when exposed to either maternal sound stimulation or routine hospital sounds. Maternal sounds included heart beat and voice recordings that the infants were exposed to for 30 minutes, four times per 24-hour period. There was an overall decrease in CREs with age (p= 0.05). A lower frequency of events was observed in infants greater than 33 weeks post conceptual age (p= 0.03).

Piccoilini, Porro, Meazza, Gianni, Rivoli, Lucco, Barretta et al. (2014) investigated the effect of exposure to maternal voice, administered by bone conduction, on preterm autonomic and neurobehavioral development in a prospective, longitudinal, explorative, case control study. Enrollment was over 5 years and included infants with birth weight less than 1500 grams, of reasonable gestational age with normal head ultrasounds, requiring no additional support for breathing or cardiovascular stability. For each infant that met criteria for enrollment into the intervention group, the next consecutive infant who was matched for gestational age and weight, was assigned to the control group. The intervention included exposure to recorded maternal voice, played at a decibel (dB) reading less than 50 dB. The intervention took place daily and lasted for 21 days. The procedure included utilization of a device placed on the infant's wrist allowing for vibration and voice transmission through a transducer to immolate bone conduction. Heart rate (HR) and oxygen saturation (SpO2) were monitored continuously. Vital signs were recorded for 1 minute during the listening sessions at three different stages: at the beginning (before exposure), in the middle (at 15 minutes), and the end of the exposure (30 minutes after). Neurobehavioral exams were performed at 40 weeks corrected gestation age, 3 months and 6 months corrected age. Data was analyzed on seventy-one infants including the control group (n=34) and the intervention group (n=37). There was no statistically significant demographic or characteristic difference in the intervention and control groups. HR and SpO2 trends were similar between groups at the onset of the intervention. HR evaluated as a mean for all intervals was

significantly lower in the interventional group (M=151.5 +/- 14.4) compared to the control group (M=15.4 +/- 14.7, $p< 0.01$). There was no difference in SpO2 between the groups. Visual attention ($p< 0.01$) and general movement ($p< 0.01$) at term was better in the treatment group than in the control group. Neurofunctional assessments scores at 3 months were higher in the treatment group ($p< 0.01$). No significant difference was seen at 6 months ($p> 0.50$).

Krueger (2010) did a review to compare studies investigating the effect of exposure to maternal voice on preterm infants. Studies were included from 1972 to 2007. Seven human studies were identified including five that evaluated maternal voice exposure in the NICU and two that addressed the preterm infants' ability to differentiate maternal voice from the voice of a stranger. Two studies showed statistical significance. Segall (1972) used an experimental design where infants in the intervention group were exposed to 30 minutes of recorded maternal voice on a daily basis for 4 to 8 weeks. Decreased heart rate in response to maternal voice and better heart rate habituation were seen in the intervention group. Johnston, Filion, and Nuyt (2007) evaluated pain response with and without maternal voice exposure during heel-stick. They found no change in pain response but a greater decrease in oxygen saturation rates in the voice exposure group compared to the group that did not have maternal voice exposure prior to heel-stick ($p< 0.01$). Krueger concluded that the studies "highlighted the potential importance of providing developmentally appropriate longitudinal exposure to maternal voice in the altered environment of the NICU" (pg. 16). She raised concerns that all studies exposed infants to decibel levels above current recommendations for preterm infants in the NICU.

A systematic review of 15 studies from the years of 2000-2015 evaluating the effectiveness of maternal voice interventions on clinical outcomes and development in preterm infants was performed by Filippa et al (2017). A total of 512 infants were included in the studies.

Participants were born at less than 37 weeks gestation with a birth weight less than 2500 grams. Live and recorded maternal voice interventions had to be the focus of the study with a designated intervention and control group. Designs included RCTs, crossover trials, and quasi-experimental trials. Six main outcomes domains were identified including physiologic (HR, SpO2, respiratory rate, and CREs), behavioral (state, stress, stability), neurological (cortical activation), feeding (weight gain and feeding status), pain, and maternal (stress). Live and recorded maternal voice exposure was associated with physiologic and behavioral stabilization for preterm infants, with fewer CREs in the short term. The evidence was insufficient to evaluate mid or long-term effects.

Provenzi et al. (2017) did a similar systemic review with some overlap in studies included by Filippa et al. (2017). Eighteen studies from 1996 to 2016 were reviewed. Infant characteristics, maternal characteristics, modalities for maternal voice exposure, age at time of exposure, duration and frequency of exposure, and outcome variable findings were extracted. Wide differences emerged in infants' characteristics and maternal voice exposure modalities. There was variable inconsistency in evidence showing an impact on physiologic stability. However, findings supported improved feeding behaviors, better weight gain, and increased success with feeding. Consistent findings also emerged for cognitive and neuro-developmental behaviors.

NICU Reading Programs

Literature on NICU reading programs as an intervention are sparse. Levesque, Tran, Levesque, Shrestha, Silva, Adams, Valles et al. (2018) did a quality improvement initiative to increase language exposure utilizing an established reading program called Reach Out and Read (ROR). They measured availability of books, accessibility of parents, percent of infants who were read to, and analyzed qualitative data received from parent surveys. They reported that 82%

of eligible infants were enrolled and of those, 70% were read to on average every 2 to 3 days. Parent surveys offered insight into the program, showing that reading was a favorite activity for many parents and that they felt they were helping their infant developmentally. Some did not like reading aloud and struggled with not being able to visit or read as often as they liked, wondering if what they were doing was really helping their baby.

Only one study (Lariviere and Rennick, 2011) provided an evaluation of reading program effectiveness in a NICU. The authors measured the impact of reading on parent-infant interactions and the incidence of continued reading at 3 months after discharge. A non-randomized, participant blinded interventional study was conducted using a historical control group (n=57) from 3 months prior to the study. The intervention group (n=59) included parents of infants admitted to the NICU after the introduction of a parent infant reading program. *The Books for Babies*® reading program provided families with books in 20 different languages. Nurses served as facilitators, implementors, and supporters of the reading program, encouraging parent participation in the reading activity. Parents in the control and intervention group completed 3 questionnaires including the Parenting Stress Index Short Form, the Parent-Infant Activity Sheet, and the Parent- Infant Interaction During Reading Questionnaire. Follow-up was done 3 months after discharge and included a phone call from the study investigators. Demographic data, severity of infant illness, and parent reading behaviors were also collected on both groups. There was no statistically significant difference in the demographic characteristics of the control group (CG) and intervention group (IG). They found that 86% of IG parents agreed that reading was something they enjoyed and 69% stated that it helped them feel closer to their baby. At three months after discharge, 78% of IG parents compared to 28% CG parents were reading to their infant ($p< 0.001$). The reading intervention accounted for the largest variance in

whether or not a parent was likely to read to their infant post-discharge (odds ratio [OR]=12.8; 95% confidence interval [CI]=4.6-34.9). The authors concluded that the reading intervention positively affected parent infant interactions, stating that parents achieved a greater sense of control, intimacy, and normalcy. Results from this study provide a foundation for implementing a reading program in the NICU and further assessing the impact on maternal mental health including depression and stress.

After review of the literature, there is evidence that activities that support coping, improve self-care, and enhance social support decrease depression and stress in NICU mothers (Table 1). There is a gap in the literature regarding the utilization of infant care provision activities as an intervention to reduce maternal stress and depression. A reading intervention has been shown to have a positive effect on parent infant interactions creating a possible platform for this proposed maternal infant reading intervention. The impact of maternal voice exposure on preterm infant physiologic stability has been inconsistent. Some benefits have been demonstrated in the short term. No studies were found that assessed physiologic response to altered decibel level or reading times based on the infant's gestational age.

Conceptual Frameworks

The conceptual frameworks supporting the reading program intervention are Bandura's Theory of Self-Efficacy (Bandura, 1997) and Bowlby's Attachment Theory (1982).

Self-Efficacy

"Perceived self-efficacy is defined as people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives" (Bandura, 1994). Self-efficacy beliefs determine how people process information, motivate themselves, and put these components into action. Action and response are produced through

four major processes. They include cognitive, motivational, affective, and selection processes (Bandura, 1994). “A strong sense of efficacy enhances human accomplishment and personal well-being. People with high assurance in their capabilities approach difficult tasks as challenges to be mastered rather than as threats to be avoided. Such an efficacious outlook produces personal accomplishments, reduces stress, and lowers vulnerability to depression” (Bandura, 1994). Maternal self-efficacy is defined as mothers’ beliefs about their ability to be successful in the parenting role (Leahy-Warren, McCarthy, ad Corcoran, 2011). Using a structured activity to promote maternal care participation through education, social and nursing network support, encouragement and reward activities, and behavior re-enforcement would adhere to Bandura’s theoretical framework.

Attachment Theory

Attachment theory describes how a parent’s interactive behavior influences future infant development, social-emotional functioning, and attachment behaviors (Bowlby, 1969; Ainsworth, Blehar, Waters, and Wall, 1978). The central theme of attachment theory is that mothers who are available and responsive to their infant's needs establish a sense of security in their children. The infant knows that the caregiver is dependable, which creates a secure base for the child to then explore the world. Babies are born equipped with behaviors like crying, cooing, babbling, and smiling to ensure adult attention. Adults are biologically programmed to respond to infant signals. The four phases of attachment according to Bowlby (1982) are pre-attachment, attachment in the making, clear cut attachment, and the formation of reciprocal relationships.

Ainsworth et al. (1978), based on observed parent infant interactions, determined that there are four different styles of attachment including secure attachment, avoidant attachment, resistant attachment, and disorganized or disoriented attachment. Other authors including

Whiffen and Johnson (2006) have further expanded attachment theory to the postpartum period and transition to parenthood using the influence of the maternal support system including marital context, as a basis for successful attachment. A woman who feels supported by her spouse and her own mother is more likely to have secure attachment (Whiffen and Johnson, 2006). Identification of reading as a maternal care activity would allow for the mother to have a focused mechanism for contributing to her infant's care and meeting infant needs that she alone would provide. Using gestational age and stimulation tolerance as a guide, advancing through the reading program, would allow for the mother to assess, adapt, and respond to infant needs and demands.

Methods

The purpose of this study was to evaluate the implementation of a NICU based reading program on both maternal and infant outcomes. The specific questions that were asked included:

1. For mothers of preterm infants, did participating in a structured mother-infant reading program over a 4-week period decrease their perception of depression and stress?
2. For preterm infants, did maternal voice exposure through a mother-infant reading program reduce mean heart rate and increase mean SpO2 levels when compared at 30 minutes before, during, and 30 minutes after being read to by their mother?

The hypotheses were:

1. Maternal perception of depression and stress will decline after participation in a 4-week maternal-infant reading intervention.
2. Preterm infant mean heart rate will decrease during reading when compared at time intervals of 30 minutes before and 30 minutes after.

3. Preterm infant mean oxygen saturation (SpO2) level will increase during reading when compared at time intervals of 30 minutes before and 30 minutes after maternal voice exposure.

Independent variables included the interventions being applied. The maternal intervention included nurse practitioner delivered education about reading to a preterm infant, immersion into the NICU Reading Garden program, and encouragement and support during the reading program. The infant intervention was exposure to maternal voice for variable times at variable decibels. Dependent variables that were measured for the mother included pre and post intervention depression and stress scores (interval variables). Infant mean HR and SpO2 levels (ratio variables) were collected at three time points for each logged reading session.

Definition of Terms:

The following terms are defined:

Preterm infant: Infant born at less than 37 weeks gestational age. For the purpose of this study, infants born at less than 32 completed weeks gestational age will be included to support a four week in-hospital intervention.

Gestational age (GA): Gestational age or menstrual age is the time elapsed between the first day of the last normal menstrual period and the day of delivery expressed as weeks.

Postmenstrual Age (PMA): Postmenstrual age is the time elapsed between the first day of the last menstrual period and birth (gestational age) plus the time elapsed after birth (chronological age). Postmenstrual age is usually described in number of weeks and is most frequently applied during the perinatal period beginning after the day of birth. Therefore, a preterm infant born at a

gestational age of 23 weeks who is currently 10 weeks old (chronological age) would have a postmenstrual age of 33 weeks (American Academy of Pediatrics Policy Statement on Age Terminology during the Perinatal Period, 2004).

Maternal Depression: Maternal depression encompasses a range of conditions that can affect women during pregnancy and up to one year postpartum. This spectrum of conditions includes prenatal depression, postpartum depression, and postpartum psychosis. Postpartum depression (PPD) is defined as a depressive episode in women with onset occurring 4 weeks to 12 months after the birth of a child. Maternal Depression will be measured using the Edinburgh Postnatal Depression Scale (EPDS).

Maternal Stress: Maternal stress is defined as the objective stressors and subjective feelings of distress or strain experienced by mothers related to having a premature infant in the NICU. Maternal Stress will be evaluated using the Parent Stress Scale for the NICU (PSS: NICU).

Maternal Voice Exposure: Maternal voice exposure is defined as vocal sensory stimulation for the preterm infant.

The NICU Reading Garden: The NICU Reading Garden is a progressive reading program developed by the primary investigator and author. It consists of six (6) levels of reading decibels and reading times, introduced based on gestational age and corresponding development of the auditory system. Each level strives to minimize sensory overstimulation by adhering to established noise level restrictions within the NICU. The levels of the program are based on evidence within the literature (Hepper and Shahidullah, 1994; Graven and Browne, 2008; Kenner and McGrath, 2010).

The reading levels correspond to sounds that insects make in the garden and are as follows:

Level 1= **Caterpillar->** Read at a whisper, for 5 minutes or less, up to 3 times per day, with no additional tactile stimulation during the reading session.

Level 2= **Butterfly->** Read at whisper, for 5 to 10 minutes per day, up to 3 times per day, with no additional tactile stimulation during the ready session.

Level 3= **Lady Bug->**Read with a soft voice, for 10 to 20 minutes, up to 3 times per day, with the infant held either skin to skin or in a blanket.

Level 4= **Bumble Bee->**Read with a soft voice, for 20 to 30 minutes, up to 3 times per day, with the infant held either skin to skin or in a blanket.

Level 5= **Cricket->**Read with a soft voice, for 30 minutes, up to 3 times per day while holding the infant.

Level 6= **Blue Bird->**Read as tolerated using normal voice, initiating visual stimulation and holding the infant as tolerated.

By 26 to 28 weeks gestational age (GA), the auditory system is mature enough to produce a physiologic response to loud noise with changes in heart rate, blood pressure, respiratory rate, and oxygenation (Graven et al., 2008). Maintaining physiologic stability is crucial as the central nervous system is developing and the most rapid neuronal formation is occurring. There is partial functionality of the auditory at 24 to 29 weeks GA. The ability to process develops later in gestation at 30 weeks when tonotopic columns necessary to receive, recognize and react to language develop. At 34 to 36 weeks GA, the infant or fetus can distinguish different moods or emotional qualities to speech and retain as memory. At 40 weeks GA, with 10-14 weeks of listening experience, the infant or fetus may be able to discriminate sounds that he or she prefers (Graven et al., 2008).

Due to minimal stimulation guidelines and evidence supporting auditory development the reading program begins once infants are 28 weeks PMA at Level 1 and advances every 2 weeks until the infant is greater than 36 weeks PMA, achieving level 6. Modifications can be made if the infant exhibits sensitivity to stimulation as observed by the mother, bedside nurse or care provider, or the primary investigator.

Design

A single group pre/post-test quasi experimental design study was used to collect qualitative and quantitative data on mothers of preterm infants in the NICU. The intervention was participation in a four-week maternal-infant reading program called the NICU Reading Garden. A time series quasi experimental design study was conducted to collect HR and SpO2 measurements on preterm infants before, during, and after maternal voice exposure. Data for analysis was collected from the electronic medical record (EMR); instruments used to collect maternal depression and stress scores included the EPDS and the PSS: NICU; instruments used to determine severity of infant illness included the Clinical Risk Index for Babies II (CRIB-II) and the Score for Neonatal Acute Physiology and Perinatal Extension II (SNAPP-II); HR and oxygen saturation (SpO2) levels were obtained from central cardio-respiratory monitoring; and a seven question survey for program evaluation allowing for quantitative and qualitative responses. Qualitative responses were sorted based on theme.

Participants

A convenience sample of mothers whose infants were either admitted or already hospitalized in the NICU were screened for participation. Over a six-week period, beginning October 4, 2018 through November 15, 2018, a total of 17 mothers were approached for study participation. Inclusion criteria included:

1. Mothers of infants born less than or equal to 32 weeks' completed GA who were admitted to the NICU.
2. Mothers of infants with PMA less than 36 weeks or whose infant would likely be hospitalized for the 4-week intervention period. This determination was based on diagnosis, clinical condition, and best estimation by the primary NICU medical provider and the primary investigator.
3. Mothers who were able to understand and speak English.
4. Mothers who were able to read or speak to their infant in person at least 3 times per week for the 4- week intervention period.

Three mothers declined participation. Fourteen mothers received and signed consent for participation, including one mother of fraternal twins, for a total of 15 infant participants.

Setting

The study took place in the 51 bed Level IV NICU of a university affiliated, tertiary care children's hospital located within a university medical center. This NICU was a major referral center for the state of Virginia. Approximately 40% of infants admitted to this NICU annually are out-born and transferred after delivery. Approximately 60% of the infants in this NICU are born at the university medical center. The annual admission rate is approximately 650 infants.

Procedure for Protection of Human Subjects

Ethical approval was obtained from the hospital Institutional Review Board (IRB) according to hospital guidelines before recruitment. The study was fully reviewed as biomedical

research (IRB-HR 20908). Maternal consent for participation was obtained. Plan of action should depression be suspected was disclosed at the time of consent. Patient information was de-identified and stored in a secure location.

Procedure and Intervention

Prior to enrollment and during the 2 months of the study, educational in-services were offered to NICU staff and support services including social work and therapy services. This included a power point presentation provided by the primary investigator at staff meetings, updates during morning staff huddles, individualized education to the staff taking care of possible study participants, and written information dispersed in weekly "Friday Footnote" communications. A Staff Education Sheet (Appendix A) was made available on the NICU Intranet Repository as well as at the bedside of each infant who was enrolled in the study. Once mothers and infants were identified for participation, consent was obtained by the primary investigator (PI). The mother received a copy of the consent and an additional copy was kept in a secured filing box within an ID badge accessed office located within the physical space of the NICU.

Standardized education was provided to each mother at the bedside of her infant by the primary investigator. This included the benefits of reading, the unique levels of "The NICU Reading Garden" as described above including length and decibel of reading based on gestational age, auditory development, and tolerance to stimulation (Appendix B), and signs of overstimulation. Each mother was assessed for reading literacy through interview and demonstration. If a mother was uncomfortable reading a children's book aloud to her infant, conversational language as a mechanism for maternal voice exposure was allowed as long as it

adhered to the duration and decibel recommendations of the reading program. Each mother was offered appropriate reading books of her choice within the NICU as well as a log for tracking reading dates and times (Appendix C). The books were provided through a donation to the Children's Hospital by the Soho Center and were available on a reading cart in the NICU. Each mother could pick her own book to read or bring a book from home. Source of reading material was not tracked. The books were kept at the infant's bedside.

Each mother completed the two maternal screening instruments prior to the first reading session. Verbal instructions were given for completion that included thinking about how they had been feeling in the previous 7 days and to base their answers on those feelings. Depression and stress were therefore self-reported. The screens were then reviewed and scored in front of the mother by the PI. At time of consent, the mother was made aware that if mild to moderate depression was identified, social work would be alerted by page or email and additional screening or resources might be offered. If severe depression or a positive response to screening questions regarding self-harm were identified in pre-screening, social work would be alerted immediately and an immediate medical referral would be made. Each mother infant dyad was assigned a participant number. This information was stored with the consent forms. Once scores were collected, the information was de-identified and entered into a spread sheet format using Excel (Microsoft; Redmond, WA). Data was stored on a secured and approved data drive of the university medical center. Severity of Illness instruments were then completed for each infant by the PI, de-identified, and entered into a similar excel spread sheet format for analysis.

Reading by the mother as outlined by the NICU Reading Garden commenced. Stickers of "insects" representing the corresponding levels were placed at each bedside as reading reminders. Mothers completed the reading log each time they read to their infant. The logs were

kept in a folder at the bedside and collected at the end of each week for review by the PI and then stored in a similar fashion in the ID badge access office in a secure file. Over the 4-week intervention, periodic re-enforcement of educational material occurred. Each mother received in person encouragement and verbal acknowledgment of reading success from the PI at least once a week. These interactions varied from weekly to several times a week depending on the PIs presence in the unit and the mothers' visitation pattern. Visitation was variable as some mothers were staying locally and others were traveling from afar to be with their babies. Pattern of visitation did impact frequency of PI contact but every mother, when contacted, received a standardized dialogue of questions and support. This included recognition of reading times and successful completion of the log, re-enforce of reading behaviors, and discussion about readiness to advance in the reading garden along with general questions about maternal well-being. At the end of the 4-week period, mothers completed the post test. This included repeating the two maternal screens in the same manner as the pretest. Mothers were also asked to complete a program evaluation survey at the end of the intervention to assess program ease and accessibility as well as indicators for maternal attachment as measured by "feeling closer to their infant" (Appendix D).

Infant response to maternal voice exposure was accessed based on the maternal reading log with observations made 30 minutes before, during, and 30 minutes after each reading session. HR and SpO2 levels were obtained by the PI from the central monitoring system at the documented time intervals for each observation. Mean values for HR and SpO2 were taken over a five-minute interval, 30-35 minutes before and after reading, in order to best approximate actual vital sign trends. A single value mid read was captured for both HR and SpO2.

Instruments and Measures

Demographic Data

Demographic data was collected from the EMR. This included maternal age, maternal educational level, marital status, maternal race, infant's GA at birth and PMA at time of enrollment, gender, birth weight, diagnosis, and respiratory support at time of enrollment and the commencement of the intervention.

Severity of Illness

The severity of illness of the infant correlating with gestational age and birth weight has been shown to be one of several predictors for PPD in NICU mothers (McCaffree and Gillaspy, 2014). No single clinical tool has been shown to be an ideal prognosticator for the variable disease, clinical, and perinatal factors contributing to neonatal outcomes. Clinical Risk Index for Babies II (CRIB-II) (Appendix E) and the Score for Neonatal Acute Physiology and Perinatal Extension II (SNAPP-II) (Appendix F) are two instruments that have been used extensively in the NICU population to assess morbidity and mortality. Validity and reliability are well established. The original CRIB was created to predict mortality of infants born at less than 32 weeks gestation at birth. It was derived from a cohort of over 800 very low birth weight infants born in the United Kingdom (International Neonatal Network, 1993). Variables were identified that were most predictive of mortality based on the outcomes data including 25% of the infants who died. The CRIB score is the weighted sum of six factors including gestational age, birth weight, blood gas results, oxygen needs in first 12 hours after birth, and presence of congenital malformations. In the original study, the CRIB had good discriminatory ability (area under the

ROC curve: *Az*=0.90). The CRIB-II is a modified version of the original CRIB and utilizes additional factors including gender and admission temperature.

The Score for Acute Neonatal Physiology (SNAP) was developed in the United States and derived from a cohort of over 1600 infants weighing less than 1500 grams (Richardson, Gray, McCormick, Workmann, and Goldmann, 1993). SNAP scores are based on 28 items collected from a variety of sources including every body system and selected blood tests. Variables are weighted according to expert opinion, with a value of 0, 1, 3, or 5 assigned to each variable. SNAP predicted death better than birth weight alone (*Az*=0.87 vs 0.77). The SNAPP II is a simpler version of the original with only six variables (mean blood pressure, lowest temperature, PO2/FiO2 ratio, serum pH, multiple seizures, and urine output). Good discrimination has been shown with SNAPP II (*Az*=0.91) (Darling, Field, and Manktelow, 2004). Both of these tools were used to determine severity of illness for each infant.

Maternal Depression and Stress:

Two instruments used to assess depression and stress were the Edinburgh Postnatal Depression Scale (Appendix G) and the Parental Stressor Scale: NICU (Appendix H). The EPDS is the most well-known and evaluated instrument for postpartum depression (Gibson, McKenzie, Shakespeare, Price, and Gray, 2009). The instrument was developed in Britain by Cox and Holden as an adaptation of pre-existing questionnaires with 13 items. The scale was later reduced to 10 items and validated in a sample of 30 women by the original authors (Cox and Holden, 1987). The scale asks the respondent about their feelings over the previous 7 days. Responses are scored from 0 to 3 in growing order of severity creating a total score of 30. In the initial study by Cox and Holden (1987), the sensitivity and specificity of the EPDS were 86%

and 78% respectively with a positive predictive value of 73% using a score of 9 as a cut off for depression. The American Academy of Pediatrics (AAP) has recommended that the EPDS be used as a screening tool for mothers during early postnatal/neonatal visits with their pediatrician (Earls, 2010).

The Parental Stressor Scale: NICU (PSS: NICU) was developed by Miles, Funk, and Carlson (1993) as an adaption of a previously developed stressor scale for the Pediatric Intensive Care Unit. Based on the stress theory, the instrument was developed to measure parental perceptions of stressors evoked from the physical and psychosocial environment of the NICU. The 37-item instrument asks parents to rate the stressfulness of items on Likert scale from 1 (not at all stressful) to 5 (extremely stressful). The items are categorized into domains based on sights and sounds of the NICU, infant behavior and appearance, parental role alteration, and staff behaviors and communications. The higher the score the more stress the parent is experiencing. The instrument was assessed for internal consistency, inter-scale correlations based on metric considerations, and construct validity (Miles et al.,1993). Metric considerations were based on whether a parent experienced a particular situation. Not all parents experienced every infant behavior or every environmental exposure. Parents were not expected to rate the stressfulness of non-experienced items. Separate metrics were created for stress level occurrence and overall stress level. This strengthened the clinical sensitivity of the instrument. The Cronbach's alpha coefficient for stress occurrence level and overall stress level was calculated to be 0.94 and 0.89 respectively, representing good internal consistency for the entire scale. The four categories or domains of the instrument showed moderate correlation with one another (12% to 40% variance in common) and strongly correlated with the total score on the instrument (sharing 49% to 82% of their variance). "In evaluating the construct validity of the scale, it was hypothesized that the

perceived level of environmental stress would correlate positively with measured anxiety" (Miles et all, 1993). Pearson correlation coefficients were calculated between each of the categories on the scale (infant behavior and appearance, parental role alterations, and sights and sounds) and the State Anxiety scores. All correlations were significant ($p< 0.001$). Correlations with anxiety were high for both infant behavior and appearance (r=.41) and parental role alterations (r=.40) (Miles et al, 1993). A total overall score was calculated based on all 37 items. Self-perception of stress was reported as a single score.

Program Evaluation Survey:

A Likert Scale survey created by the PI was administered to assess program accessibility and ease as well as maternal perception of closeness and bonding. No specific tool has been validated or assessed for reliability however Lariviere and Rennick (2011) used a seven-question survey to assess parent infant interaction during reading. Although the survey did ask about feeling close to their baby as a measure of bonding, the survey does not evaluate the effectiveness of the reading intervention. The survey can be used as comparison but does not suit the design or hypothesis of this study given the specificity of the NICU Reading Garden and therefore it was not used as the program evaluation survey.

Mean HR and SpO2 Measurements:

Each infant in the NICU is routinely placed on continuous electrocardiogram and pulse oximetry monitoring. The GE B850 Model from Carescape with Neonatal Software was utilized for cardio-pulmonary monitoring. The Masimo Radical 7 co-oximeter was used for pulse oximetry monitoring. Pooled information was transmitted to a central monitoring system that

allowed for time specific trending and review. Bed Master software from Excel Medical Electronics, Inc. was utilized to retrieve HR and SpO2 readings 30 minutes before, during (mid-point), and 30 minutes after each reading session.

Data Analysis:

Descriptive and inferential statistical analysis were performed using the IBM Analytics Statistical Package for Social Sciences (SPSS) version 25. Demographic information was assessed for frequency, mean, and median. Given the pre/post-test design of one single group with no control or randomization, interval and ratio variables, less than 30 matched pairs, and the results of tests for skewness and kurtosis, the Exact Wilcoxon Signed Rank test was used to analyze depression and stress scores.

In comparing mean HR and mean SpO2 at three time points, based on tests for skewness and kurtosis, the non-parametric Sign Test was used to assess interval changes in mean. Mean HR and SpO2 readings were calculated for each reading time point including 30-35 minutes before and after each reading and one value from mid-reading session. Each infant had a minimum of 12 reading exposures with variable reading times ranging from 2 minutes to 65 minutes per session. A single mean HR and SpO2 was then calculated from the sum of mean values for those reading times and used for analysis. The total number of reading sessions and length of reading time for each session were tracked. There were 5 mother-infant dyads, representing 6 infants, in which reading times consistently exceeded 20 minutes. The Independent Samples Mann-Whitney U test was used to compare means based of two groups, those who read less than 20 minutes at each session and those who read for greater than 20 minutes.

Mothers of multiples were not excluded from the study. One mother had fraternal twins. Baseline depression and stress scores were elevated but similar to baseline scores for singleton mothers. Since reading to more than one infant had the potential to impact the dose of the intervention and could violate the independence requirement for the proposed analysis, analysis was also done excluding this mother, including the mother with data from one of her infants selected randomly, and including the mother with data from both of her infants.

Results

A total of 14 mothers were initially enrolled, including 15 infants. One mother withdrew two weeks into the intervention leaving 13 mothers for pre and post-test analysis. Data from the reading times of all 15 infants were analyzed. The demographic information for all 14 mothers is displayed in Table 2. Maternal age ranged from a minimum of 20 years to a maximum of 42 years with a mean of 29.43 years (*SD* 5.98). The majority of mothers were Caucasian (71.4%), married (57.1%), and had a high school education (64.3%). Most had no prior history of depression (71.4%). Mothers read a minimum of 12 (with early withdrawal) to a maximum of 47 times during the study period (*M* 20.86, *SD* 11.53). Total reading time over the study period was a minimum of 54 minutes to a maximum of 1239 minutes (*M* 374.07, *SD* 297.04). The characteristics of the infants are displayed in Table 3. The mean birth weight was 1091.87 grams (min 570 gm, max 1718 gm, *SD* 363.9). Mean gestational age at birth was 28.5 weeks (min 24 1/7 weeks, max 32 6/7 weeks, *SD* 2.59) and the mean gestational age at time of consent was 33.3 weeks (min 28 6/7 weeks, max 44 6/7 weeks, *SD* 4.37). The mean CRIB II score was 7.40 (*SD* 4.32). The mean SNAPP II score was 10.93 (*SD* 8.52). On admission to the NICU, 53.3% of the infants were on mechanical ventilation. This declined to 6.7% at the time of consent and for the

first reading session. No infants remained on mechanical ventilation at the end of the intervention with 13.3% on continuous positive airway pressure (CPAP), 20% on nasal cannula, and 66.7% in room air requiring no additional respiratory support. No infants required surgery during the study period. The majority of infants were on caffeine (66.7%) and required no sedation (86.7%) and no cardiovascular medications (93.3%) during the study period.

Depression scores before and after the intervention are summarized in Table 4. Mothers with depression scores greater than or equal to 9 declined from 53.4% pre-intervention to 15.4% post intervention. The exact Wilcoxon Signed Rank test revealed a statistically significant reduction in depression scores following participation in the reading intervention, z =-2.556, p= 0.007. The median score on the EPDS decreased from pre-intervention (*Md*=9) to post intervention (*Md*=3) and were almost the same when the mother of twins was omitted.

Stress scores were analyzed based on the four individual domains, an overall scale score, and each mother's self-reported perceived stress score. These results are presented in Table 5. The exact Wilcoxon Signed Rank test revealed no statistically significant reduction in stress scores in any of the four domains, overall scale score, and self-perceived score pre and post intervention (Domain 1, z =-1.633, p=0.11; Domain 2, z =-1.806, p=0.07; Domain 3, z=-1.689, p=0.09; Domain 4, z =-.0.140, p=0.92; Overall score, z =-1.415, p=0.17; Self-perceived score, z =-1.265, p=0.36) when all mothers were included.

The mean HR for the reading sessions of each infant was obtained for the three-time points of before, during, and after reading (Table 6a). The mean HR during reading (*M* 157.37, *SD* 11.59) was noted to be lower compared to before (*M* 158.7, *SD* 10.58) and after (*M* 159.13, *SD* 10.52). Using the Sign Test, interval means for before and during reading (p=0.118), during and after reading (p=0.302), and after and before reading (p=0.302) were compared. No

statistically significant differences were found (Table 6b). The mean SpO2 for the reading sessions of each infant was obtained in a similar fashion and compared during the same intervals of before and during reading (p=0.581), during and after reading (p=0.002), and after and before reading (p=0.118). The mean SpO2 during reading was higher (*M* 96.89, *SD* 1.48) compared to before (*M* 96.12, *SD* 2.52) and after (*M* 95.76, *SD* 2.03). A statistically significant difference was found for mean SpO2 in the interval of during read to after (Table 6b). Using the independent samples Mann-Whitney U test, there was no difference in the distribution of mean scores based on length of reading times less than 20 minutes per session compared to greater than 20 minutes per session as shown in Table 7. All of the analysis from above were completed with the mother of the fraternal twins and both infants included. Additional testing was done excluding the mother of twins (noted on Table 4 and 5) and including only one randomly selected twin (noted on Table 6a and 6b). Removal of the mother did not change the significance for depression score reduction but did create statistical significance between pre and post stress scores in Domain 2 representing infant behaviors and Domain 3 representing parental role alterations (p=0.0498 and p=0.040 respectively). There was also evidence of reduction in overall scale score (p=0.097). There remained statistical significance in mean SpO2 in the interval of during and after reading when including only one twin (p=0.003).

Thirteen mothers completed the 7-item survey. These results are presented in Figure 2. When asked if reading had made them feel closer to their baby, 92.8% agreed or strongly agreed that it did. When asked if the they were encouraged to read to their baby during the intervention, 100% agreed or strongly agreed. When asked if they plan to read to their infant after discharge, 100% agreed or strongly agreed. Comments included, “Reading made me feel closer to my

baby", "This was a great program to participate in", "I am reading more now to my 18-month old at home", and "I would recommend parents participate in this program and read to their babies".

Discussion

The majority of women enrolled in the study were Caucasian, high school educated, married, and had no prior history of depression. Their infants were born from 24 to 32 weeks gestation, weighed 570 to 1718 grams, required mostly CPAP or nasal cannula support, and had relatively low mean severity of illness scores overall. The literature suggests that prior history of depression and the severity of illness of the infant correlating with gestational age and birth weight are major predictors of depression in the NICU (McCaffree and Gillaspy, 2014). Of the 57% who scored equal to or greater than 9 on the initial screen, 63% were African American, 50% were married, and 50% had college or graduate degree. The most striking characteristic was that all 4 women who had a prior history of depression scored over 10 on the screen. Although not on medication during pregnancy or at the time of enrollment, these women clearly represented a high-risk category of mothers. The mother with the smallest infant weighing 570 grams with moderate severity of illness scores (CRIB II=11 and SNAPP II=21) had a pre-intervention EPDS of 11, declining to 5 after the 4-week intervention period. The mother with the youngest infant at 24 weeks GA with moderate severity of illness scores (CRIB II=11 and SNAPP II=21) had the lowest pre and post intervention EPDS scores of 1 and 0 respectively. The convenience study population was a sampling of mother-infant dyads in the NICU at a particular 6-week period in time. As a Level IV referral center for infants, sicker and smaller infants are cared for in this unit. Given the low acuity and relative stability of the infants contained within the study sample, the incidence of PPD during periods of higher census and

higher acuity could be higher. All of the mothers with prior history of depression scored high on the EPDS emphasizing the need for an accurate prenatal and maternal mental health history to aid in screening.

Post-partum depression in the NICU is not well recognized, in part, due to lack of adequate screening, the stigmatization associated with depression, and lack of knowledge for both care providers and women on symptom development. The standard screening mechanism utilized in this NICU prior to this study was a social worker implemented Patient Health Questionnaire-2 (PHQ-2) screen. The primary study investigator, in administering the EPDS, made several observations. As a care provider in the NICU, previous daily conversations with these mothers, offering clinical updates on their infant's status, did not provide adequate opportunities for observation of maternal depressive symptoms as the EPDS revealed elevated scores in over 50% of the mothers. Brief conversations at the bedside did not reveal or probe the mothers' true affectual manner. Once enrolled, screened, with inquiry and conversations about depression and stress, it was observed that several mothers were more forthcoming in sharing their feelings and emotions.

Social work was alerted to all mothers who scored greater than or equal to 9 on the initial screen. Although counseling and resources were offered, documentation within the EMR from social work indicated that these resources were not utilized. Two mothers scored greater than 15 on their initial screen. Both women were in their early twenties, single, and African American. Both had a prior history of depression. Both consented to alerting their primary care provider (PCP) should depression be suspected and, although self-reported that they sought care from their PCP during the study period, neither mother was treated with anti-depression medication. Both declined additional counseling. These mothers, given their initial screens, were retested

after 1 week by social work and then again at the end of the study intervention by the PI. Post intervention scores were less than 9. One of these mothers read 14 times over the 4-week period for a total of 54 minutes. The other read 24 times over the 4-week period for total of 511 minutes. Both strongly agreed that reading made them feel closer to their infant and was an activity they planned to continue at home even though their reading frequency and reading length were quite different. Utilization of the EPDS proved to be a vital tool in assessing for depression. Although not analyzed, there appeared to be was no discernable pattern or impact of dose (total number of reads and total minutes of reading) on depression score reduction.

Timing of screening may be important. Three mothers were consented and screened within the first week post-partum. Two of these mothers scored greater than 9 on the pre-intervention screen, one of whom had a prior history of depression, again supporting past history of depression as a risk factor. Of those three women, one mother had a higher post intervention screen of 9 (at 5 weeks postpartum) compared to her pre-intervention screen of 3 (at 1 week postpartum) with no prior history of depression. She was the only mother with an increase in her depression screening score post intervention. She read 14 times during the study intervention for a total of 278 minutes. On the reading survey, she reported she had "no opinion" on whether reading made her feel closer to her baby although, she "strongly agreed" that she was encouraged to read and planned to read once discharged. The post intervention screen may have been detecting developing depression at 5 weeks. Unfortunately, the screen was completed on the day of infant's discharge.

The optimal time to screen for postpartum depression is at the first prenatal visit or 4 to 6 weeks after delivery (Sit and Wisner, 2009). The epidemiologic patterns of postpartum depression suggest that the onset is within the first month. Depressive symptoms are uncommon

in the initial postpartum days, with an incidence of less than 2.5% in the first few days after delivery (Pawar, Wetzker, and Gjerdinger, 2011). The incidences of PPD increase significantly during the first three months with a threefold higher incidence approximately 5 weeks after delivery (Kettunen, Koisten, and Hintikka, 2014). There is a decrease in the incidence of PPD at 6 months and no change or increase at one year (Kumar and Robson, 1984). The other mothers included in the study were screened from 2 weeks to 4 months post-partum. The pattern of development suggests that for mothers, who are in the NICU with infants who have prolonged hospitalization, repeat screening during the hospitalization may prove beneficial and reveal symptoms that might have been missed during the initial 2-4 weeks after delivery. There was a statistically significant reduction in EPDS post intervention supporting the initial hypothesis.

Parental stress is well reported in the NICU. The birth of a sick or premature infant can be a traumatic event (Varghese, 2015). Physical, emotional, and financial stress have been equated with NICU hospitalization (Alkozei et al., 2014; Binder et al., 2011; Busse et al., 2013; Dubek-Shriber et al., 2004; and Shelton et al., 2014). Results from the PSS:NICU revealed that the majority of mothers (67%) perceived their stress to be moderate to high, scoring 3 or greater on the Likert scale, before the intervention. That number was relatively unchanged (64%) after the intervention. There were no statistically significant differences in pre and post scores for the other 4 domains of the screen however the median scores for all domains declined. The reduction in pre and post scores for infant behavior and appearance and parental role alterations were statistically significant when the mother of the fraternal twins was excluded from analysis supporting the initial hypothesis for mothers of singletons. The overall scale score had a suggestion of reduction when the mother of fraternal twins was excluded as well. As the infant's clinical status improves over time and some of the invasive monitoring and physical barriers,

such as an endotracheal tube or CPAP mask are removed, the appearance of the infant and how they behave may be perceived as more consistent with a newborn infant. As a mother acclimates to the NICU and begins to identify ways to parent, such as with the reading intervention, the relationship with her infant may evolve. As the infant's clinical status improves and the doubts for survival subside, attachment and relationship development may become more natural. The reading survey revealed that the majority of mothers felt that reading brought them closer to their infant and provided comfort.

Several mothers scored higher on Domain 4 of the screen post-intervention compared to pre-intervention although the overall median was lower. Domain 4 assesses the impact of staff behaviors and communication on stress. It was observed that these mother infant dyads were preparing for discharge. During hospitalization, potential triggers such as acute clinical changes, movement to a new or different bed location, changes in parental role expectations, exposure to new care providers, miscommunications, and witnessing clinical situations such as sick admissions, discharges of infants with shorter NICU stays, and the death of pod mates, may create cycles of stress that ebb and flow. When all is well, stress may be low. When circumstances begin to change, such as preparing for home, stress may increase. Providers must recognize the impact that these triggers have on maternal (and paternal) stress and parenting behaviors.

Total number of reads and reading times varied amongst participants. This was a factor of maternal preference and desire to read, visitation patterns impacting opportunities to read, and dictated by the NICU Reading Garden framework. One mother infant dyad started at level 1 (caterpillar); 2 dyads started at Level 2 (butterfly); 7 dyads started at Level 3 (Lady Bug); 4 dyads started at Level 4 (Bumble Bee); and one dyad started at Level 5 (Cricket). At the end of

the 4-week intervention, all dyads had progressed to Level 3 or greater including 3 dyads at Level 3; 5 dyads at Level 4; 6 dyads at Level 5; and one at Level 6 (Blue Bird). The mother of fraternal twins read the most minutes (1,239 minutes) which was twice as long as the second highest total reading minutes (585 minutes) and over 20 times as long as the lowest total reading minutes (54 minutes). Two mothers read more total times (39 and 47 times respectively) compared to the mother of twins (34 times) even though she read to each twin individually. Removing the mother of twins from data analysis did not impact depression scores but did impact stress scores. Having more than one infant in NICU would logically increase ones feeling of stress.

Reading times were as short as 2 minutes to as long as 65 minutes per reading session. There was no statistically significant reduction in mean HR found when comparing the three-time intervals of before and during, during and after, and after and before. The mean HR at the single time point of during reading was however lower. More notable, the mean HR during reading or with maternal voice exposure was not higher suggesting that, although voice exposure may not lead to significant HR reductions when compared to before or after, it doesn't appear to lead to HR increases either. This is significant when determining physiologic stability. Voice exposure at the different decibels and different time intervals of the NICU Reading Garden was tolerated with no significant impact on HR. The mean SpO2 during reading was higher and there was a significant increase during reading when compared to before and after reading. This supports the initial hypothesis that oxygenation improves during maternal voice exposure. Auditory stimulation via maternal voice exposure was tolerated.

Study Strengths and Limitations

Using a quasi-experimental study design was feasible and conducive to the time limitations and limited resources of such a study. The logistical constraints of true experimental designs with randomization and large population sampling were not present. A single group design controlled for some potential extraneous variables by using each participant as her own control. The results are generalizable. The design allows for fairly easy replication which can support the cause and effect relationship between reading and depression/stress reductions.

Using a focused care provision activity to address postpartum depression in the NICU was innovative. No study was found in the literature that evaluated reading to an infant in the NICU as a targeted intervention to reduce maternal stress and depression. The NICU Reading Garden program in itself was unique. Other NICUs have instituted reading programs, encouraging reading at all times and to all ages. No study was found that has utilized a program that was developmentally based. Gestational age, auditory development, and tolerance to environmental stimulation are the framework for the NICU Reading Garden program. Progression through the garden has been a creative initiative to demonstrate infant developmental maturation and to highlight the effectiveness of reading as a bonding activity to even the smallest of patients. Based on study results, reading time revisions may be warranted.

Another strength of this study was the utilization of theoretical concepts to direct the study interventions. Empowering NICU mothers to provide a focused care provision activity that they alone can offer had merits in promoting maternal self-efficacy by illustrating the unique role that the NICU mother can offer. Education about reading benefits, infant development, and stimulation tolerance gave these mother cognitive and motivational foundations for successful parenting. Staff encouragement, infant response, and progression through the NICU Reading

Garden promoted a sense of accomplishment for the mothers, buffering the effect of stress and anxiety while decreasing the perception of depression. Maternal infant attachment was encouraged through the intimate activity of reading. The mother met a need for the infant that no other care provider was providing during hospitalization. Education about infant tolerance to stimulation offered the mother a tool to use for instinctive response. Education offered tools that could be used to interpret physiologic parameters and nonverbal cues from the baby that indicated the infant's state of content. This re-enforced the role of mother and offered a mechanism for effective bonding and attachment.

Because of the lack of randomization and a true experimental group, there was a weakening of internal validity of results. Pre-existing factors and co-variants were not taken into account which makes it difficult to ascertain that the treatment or intervention of reading, education, and support were the sole factors influencing the outcome. Investigator bias was a concern as the PI was not blinded to initial depression and stress scores. Mothers who visited frequently had more exposure to the staff and the PI, often translating to more opportunities for encouragement, interaction, and support. Depression scores greater than or equal to 9 necessitated social work intervention and the offering of additional resources. Although there was no documentation of additional counseling, this was not tracked or investigated and so additional external influences, known and unknown, could have impacted depression and stress scores.

This was a convenience sample obtained over a 6-week period. The sample had low severity of illness scores, no infants with prolonged ventilation, and no infants with significant clinical deteriorations or surgeries. This is uncharacteristic of this Level IV NICU based on internal treatment and outcomes data. Depression and stress may therefore still be under

reported. There were several research studies being conducted within the NICU. Although there were efforts not to overlap or approach mothers on the same day, there was one mother enrolled in this study and another study that included infant interaction interventions.

Although there was no significant difference in mean HR and SpO2 when comparing groups based on reading time greater than or less than 20 minutes, it is unclear if an effect from either total number of reading times or total number of reading minutes was influential on study results. Removal of the mother of fraternal twins and analysis with one twin was an attempt to control for obvious dose effect.

Nursing Implications and Future Research

Implementation of a reading program can achieve unit goals of family centered care while promoting maternal self-efficacy, maternal infant bonding, and supporting maternal mental health. Assessing and addressing PPD and PTS supports global maternal mental health initiatives as outlined by the World Health Organization. In compliance with recommendations from the American Academy of Pediatrics (Earls, 2010) regarding implementation and screening for PPD in pediatric practice, screening mothers in the NICU captures a population of women who based on the evidence, are at even greater risk for PPD. Given the epidemiologic patterns of PPD, screening at various intervals during prolonged hospitalization may be beneficial.

Infant physiologic stability does not appear to be negatively impacted by maternal voice exposure and oxygenation levels may actually improve during reading. Previous implementation of noise deprivation in an effort to minimize infant stimulation should be re-evaluated as maternal voice exposure during the NICU hospitalization appears to be beneficial for both mother and infant. Future research should focus on the diagnosis, treatment, and recognition of

the emotional patterns associated with PPD in NICU mothers; cycles and triggers of maternal stress during hospitalization; and how maternal voice exposure in the early neonatal period impacts infant language acquisition long term. The potential physiologic and neurodevelopmental benefits of maternal voice exposure for preterm infants are still being discovered. Nurses play a key role in educating parents about reading benefits and encouraging developmentally focused, family centered interventions that promote attachment and support infant stability.

Conclusion

Women participating in a 4-week reading intervention had a statistically significant reduction in EPDS scores. Women of singletons also had a statistically significant reduction in stress scores associated with infant behavior and parental role alterations. Mean infant SpO2 levels during reading compared to after reading were higher and this was statistically significant. Reading made mothers feel closer to their infants and was an activity that they planned to continue after discharge. Reading in the NICU as an intervention to address maternal depression and stress is feasible and effective. Maternal voice exposure improves infant oxygen saturations during reading and is well tolerated.

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Table 1

Description of Reviewed Studies

Author (year)	Design	Participants	Intervention	Measure	Outcomes
Depression and Anxiety:					
Doupnik et al. (2017)	Meta-analysis (12 studies)	9 NICU based studies including mothers, fathers, and care givers	Coping support measures, Education, Self Care, Social support	Depression, stress, anxiety (various instruments)	Combine effects significantly reduced anxiety (-0.29, 95% CI, -0.53 to -0.57) and stress (-0.78, 95% CI -1.24 to -0.32); not depression (-0.014, 95% CI -0.18 to 0.15)
Horsch et al. (2016)	RCT	65 mothers of preterm infants < 32 weeks and < 1500 gm	Expressive writing intervention (IG=33, CG=32)	Perinatal PTSD Questionnaire and EPDS	Reductions in stress (p=.0029) and depression (p=.001) in IG. Mental health improvements in both groups (p<.001)
Kraljevic and Warnock (2013)	Systematic review of RCTs	8 RCTs looking at maternal outcomes	Early education and behavioral interventions	Depression, stress, anxiety with various instruments	Interventions associated with coping and self-regulation with small to moderate effect on maternal depression, anxiety, and stress for up to 2-12 months respectively.
Mendelson et al. (2017)	Meta-analysis	10 RCTs were analyzed (2 excluded based on high bias)	NICU based interventions to reduce maternal depressive and anxiety symptoms	Various instruments for depression and stress	The pooled effect to -0.16 (95% CI, -0.32 to -0.002, p=.05); reduce anxiety symptoms was -0.12 (95% CI, -0.29 to -0.05, p=.17). CBT associated with improvements in symptoms (-0.44, 95% CI, -0.77 to -0.11, p=0.1).

Weis et al. (2013)	RCT	Parents of infants less than 34 weeks gestational age (n=134)	Standard care or person centered (family centered) communication intervention (IG=74, CG=60)	Self-reported PSS:NICU and Parent Support Tool (PST)	No difference in stress scores. No difference in perceptions of nurse support. Mothers reported greater stress than fathers (p<.001)
Maternal Voice Exposure:					
Doheny et al. (2012)	Quasi experimental	14 preterm infants ages 26-32 weeks gestation serving as their own controls	Exposure to routine hospital sounds or maternal sounds (heart beat and recorded voice)	Frequency of cardio-respiratory events (CREs)	Decrease in CREs with age (*p*=.05) Lower frequency of events at > 35 weeks (*p*=.03)
Filippa et al (2017)	Systematic review (15 studies) RCTs. Cross over trials and quasi-experimental trials	512 infants less than 37 weeks and birth weight less than 2500 gm	Live and recorded maternal voice exposure	Six outcome domains (physiologic, behavioral, neurologic, feeding, pain, maternal stress)	Physiologic and behavioral stabilization with fewer CREs in the short term No mid or long-term effects
Kruger et al. (2010)	Systematic review	7 studies for 1972 to 2007	Maternal voice exposure in the NICU (above recommended guidelines)	Physiologic outcomes (heart rate and oxygen saturation); pain response	One study with decrease in HR and better habituation after exposure (*p*< .01). One with decrease in oxygen saturation after maternal voice exposure before heel stick raising concern that high decibel level could be aversive to infant
Piccoilini et al. (2014)	Prospective longitudinal explorative case control study	71 infants birth weight less than 1500 grams, normal head ultrasounds, no additional support for breathing or cardiovascular support (IG=37, CG=34)	Maternal voice exposure by bone conduction daily for 21 days	Vital signs, neurobehavioral exams at term, 3 months and 6 months	Heart rate mean lower in IG (*p*=.01); No difference in oxygen saturation; Visual attention and general movement better in IG at term (*p*<.01); no difference at 3 and 6 months (*p*>.50).

Provenzi et al. (2017)	Systematic Review	18 studies from 1996 to 2016)	Maternal voice exposure (various modalities, frequency, and duration)	Physiologic stability and behavioral outcomes	Inconsistency in evidence of physiologic stability. Improved feeding behaviors, better weight gain, and success with feeding as well as improved cognitive and neurodevelopmental behaviors.
NICU Reading Programs:					
Lariviere et al. (2011)	Non-randomized participant blinded interventional study	NICU parents including historical control group (n=57) and intervention group (n=59)	Books for Babies reading program; nurse facilitators	Self-reported; Parents filled out Parents Stress Index, Parent Infant Activity Sheet, and Parent Infant Interaction during reading Questionnaire	86% of IG enjoyed reading and 69% of IG felt closer to infant; 78% (IG) compared to 28% (CG) were reading to infant at 3 months after discharge (p<.001)
Levesque et al. (2018)	Quality Improvement Initiative	98 infants (40 before initiative and 58 after initiative)	Increase language exposure in NICU through Reach out and Read program	Availability of books, accessibility of parents, percent of infants read to, qualitative data from parent survey	82% of eligible infants were enrolled and 70% were read to average of 2-3 days per week. Parents survey noted reading was favorite activity and that parents felt they were helping their infants

Note: NICU=Neonatal Intensive Care Unit. CI=Confidence Interval. RCT=randomized clinical trial. PTSD=post-traumatic stress disorder. EPDS=Edinburgh postnatal depression score. PSS:NICU=Parent Stressor Scale: Neonatal Intensive Care Unit. IG=Intervention Group. CG=Control Group.

Table 2

Demographics and Characteristics of NICU Mothers (N=14)

Characteristics	Frequency (n)	M (SD)	Minimum	Maximum
Age (years)		29.43 (5.98)	20	42
Race				
Caucasian	71.4% (10)			
African American	21.4% (3)			
Other	7.2% (1)			
Education				
High School	64.3% (9)			
College	28.6% (4)			
Graduate School	7.1% (1)			
Marital Status				
Single	42.9% (6)			
Married	57.1% (8)			
Pregnancy				
Singleton	92.9% (13)			
Multiple	7.1% (1)			
Location of Birth				
Inborn	78.6% (11)			
Out born	21.4% (3)			
Prior Depression				
Yes	28.6% (4)			
No	71.4% (10)			
Current Depression Medication				
Yes	0% (0)			
No	100% (14)			
Total Number of Readings		20.86 (11.53)	12	47
Total Minutes of Reading		374.07 (297.04)	54	1239

Note: M=mean. SD= standard deviation

Table 3

Infant Characteristics (N=15)

Characteristics	Frequency (n)	Mean (SD)	Minimum	Maximum
Birth Weight (grams)		1091.87 (363.9)	570	1718
Gestational Age of birth (weeks)		28.5 (2.59)	24 1/7	32 6/7
Gestational Age at consent (weeks)		33.3 (4.37)	28 6/7	44 6/7
CRIB II Score		7.4 (4.32)	1	13
SNAPP II Score		10.93 (8.52)	0	28
Diagnoses on Admission				
RDS	100% (15)			
Prematurity	100% (15)			
Observation for Sepsis	100% (15)			
VSD	6.7% (1)			
Respiratory Support on Admit				
Mechanical Vent	53.5% (8)			
CPAP	46.7% (7)			
Nasal Cannula	0 (0)			
Room Air	0 (0)			
Respiratory Support at consent				
Mechanical Vent	6.7% (1)			
CPAP	46.7% (7)			
Nasal Cannula	26.7% (4)			
Room Air	20.0% (3)			
Respiratory Support during study				
Mechanical Vent	6.7% (1)			
CPAP	33.3% (5)			
Nasal Cannula	40.0% (6)			
Room Air	20.0% (3)			
Respiratory Support at End				
Mechanical Vent	0 (0)			
CPAP	13.3% (2)			
Nasal Cannula	20.0% (3)			
Room Air	66.7% (10)			
Surgical Procedure				
Yes	0 (0)			
No	100% (15)			
Caffeine during study				
Yes	66.7% (10)			
No	33.3% (5)			
Sedation during study				
Yes	13.3% (2)			
No	87.7% (13)			
Cardiovascular Medications				
Yes	6.7% (1)			
No	93.3% (14)			

Note: SD= standard deviation. CRIB II= Clinical Risk Index for Babies [6 items scored with weighted sums from 0 to 27 with higher score indicating greater risk for mortality]. SNAPP II= Score for Acute Neonatal Physiology [9 items scored with weighted sums from 0 to 80 with higher scores indicating greater in risk for in hospital mortality]. RDS=respiratory distress syndrome. VSD= ventricular septal defect. CPAP= continuous positive airway pressure

Table 4:

EPDS scores pre and post intervention and exact Wilcoxon Signed Rank Test (N=13)

EPDS	Frequency (n)	Median	*z* score	*p*-value
Pre-Intervention				
Greater than or equal to 9	53.4% (7)	9	-2.556 (-2.450[a])	0.007*, (0.012[a])*
Less than 9	46.6% (6)			
Post Intervention		3		
Greater than or equal to 9	15.4% (2)			
Less than 9	84.6% (11)			

Note: Higher scores represent greater risk for depression.
[a] Results when excluding mother of fraternal twins.
*p <0.05

Table 5:

PSS: NICU scores pre and post intervention and Exact Wilcoxon Signed Rank Test (N=13)

Components	Pre Median	Post Median	*z*-score	*p*-value
Domain 1: Sights and Sounds [6 item subscale: possible range 0-30]	11	8	-1.633 (-1.633[a])	0.107 (0.107[a])
Domain 2: How Baby Looks and Behaves [13 item subscale: possible range 0-65]	25	21	-1.806 (-1.959[a])	0.073 (0.05[a])*
Domain 3: Relationship with Baby [7 item subscale: possible range 0-35]	21	14	-1.689 (-2.047[a])	0.094 (0.040[a])**
Domain 4: Staff behavior/communication [11 item subscale: possible range 0-55]	13	11	-0.140 (-0.339[a])	0.922 (0.813[a])
Overall Scale Total [average of 37 items: range 0-5]	1.9	1.5	-1.415 (-1.693[a])	0.169 (0.10[a])***
Self-Perception of Stress [1 item subscale: possible range 1-5]	3	3	-1.265 (-1.265[a])	0.359 (0.359[a])

Note: Parental Stress Scale: NICU with Likert scale response of 0 (or not applicable) through 5. Value of 1 represents "not at all stressful" and vales 5 represents "extremely stressful". Total scores were used for Domains 1 through 4. Average score for all 37 items was calculated for Overall Scale Total. Higher scores represent greater stress.
[a] Results when excluding mother of fraternal twins.
**p* =0.0498; ***p*< 0.05; ****p*=0.097

Table 6a:

Mean, Median, Minimum, and Maximum HR and SpO2 at three-time points associated with maternal voice exposure (N=15)

Variable	Mean (SD)	Median	Minimum	Maximum
HR before read	158.7 (10.58)	158.33	136	177
HR during read	157.37 (11.59)	160.46	131	171
HR after read	159.13 (10.52)	155.08	142	175
SpO2 before read	96.12 (2.52)	96.38	90	99
SpO2 during read	96.89 (1.48)	96.56	95	99
SpO2 after read	95.76 (2.03)	95.61	93	99

Note: HR= heart rate; SpO2= oxygen saturation.

Table 6b:

Sign Test for change in HR and SpO2 over three-time intervals

Variable	*p*-value
HR before reading compared to during	0.118 (0.180[a])
HR during reading compared to after	0.302 (0.424[a])
HR after reading compared to before	0.302 (0.424[a])
SpO2 before reading compared to during	0.581 (0.774[a])
SpO2 during reading compared to after	0.002* (0.003[a])*
SpO2 after reading compared to before	0.118 (0.180[a])

Note: HR= heart rate. SpO2= oxygen saturation.
[a] Results when excluding mother of fraternal twins.
*p <0.05

Table 7:

Independent Samples Mann-Whitney U test for HR and SpO2 at three time points based on length of reading times—all less than 20 minutes or all greater than 20 minutes (N=15)

Variable	Group 1 (n=6) M (SD), Md	Group 2 (n=9) M (SD), Md	*p*-value
HR before	158.88 (16.83), 160.85	160.06 (15.54), 155.78	0.529
HR during	156.87 (16.37), 156.39	157.14 (15.92), 160.46	0.864
HR after	158.67 (16.86), 154.79	157.05 (17.94), 160.31	1.000
SpO2 before	95.50 (7.07), 95.44	95.95 (4.03), 96.70	0.607
SpO2 during	96.56 (3.12), 96.24	96.79 (3.08), 97.00	0.864
SpO2 after	96.40(4.37), 94.89	95.79 (3.92), 95.61	0.776

Note: HR=heart rate. SpO2= oxygen saturation. M=mean. SD=standard deviation. Md=Median. Reading group 1 includes infants who had all reading times less than 20 minutes; Reading group 2 includes infants who had all reading times greater than 20 minutes.

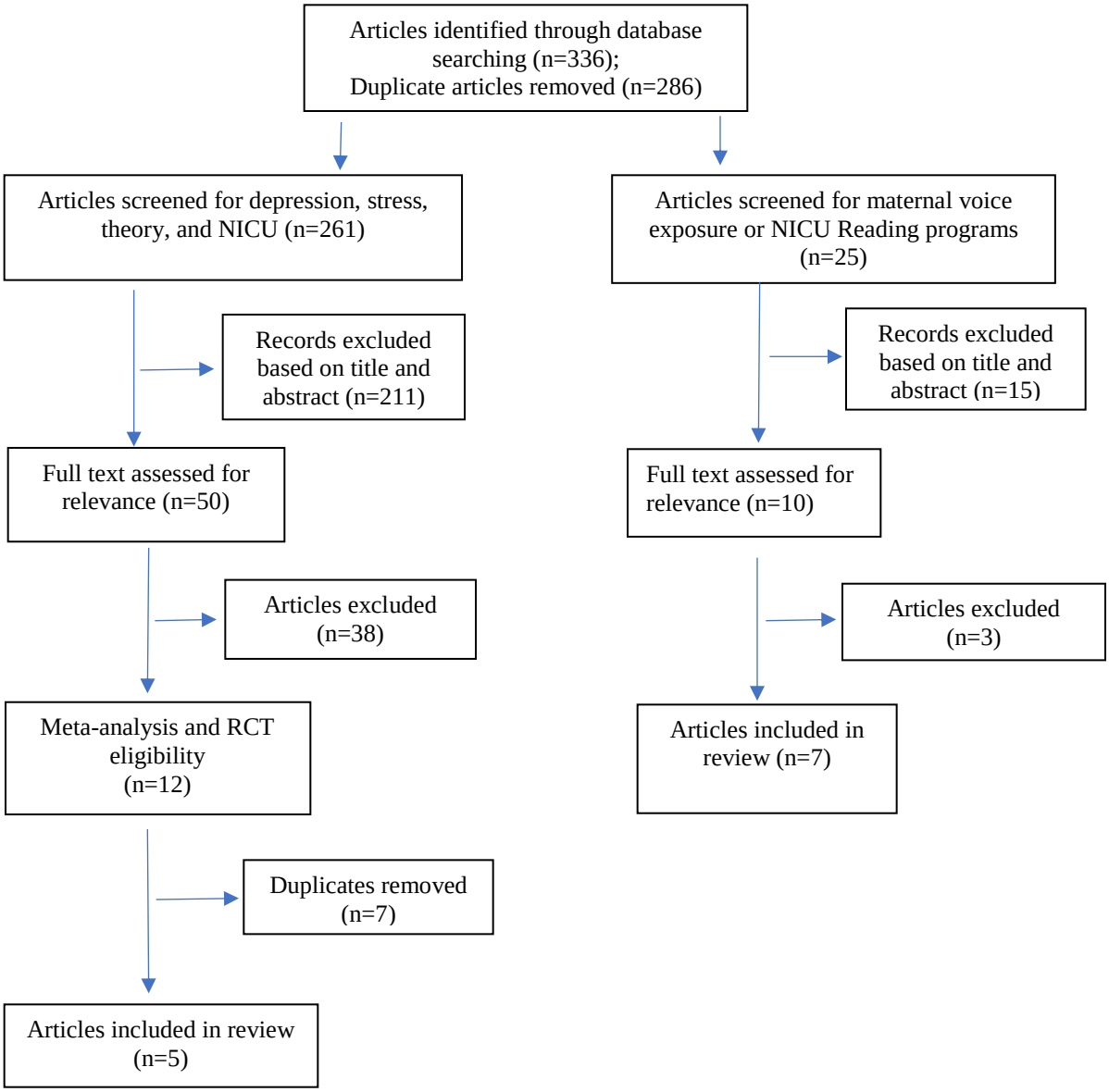


Figure 1: Flowchart for literature review

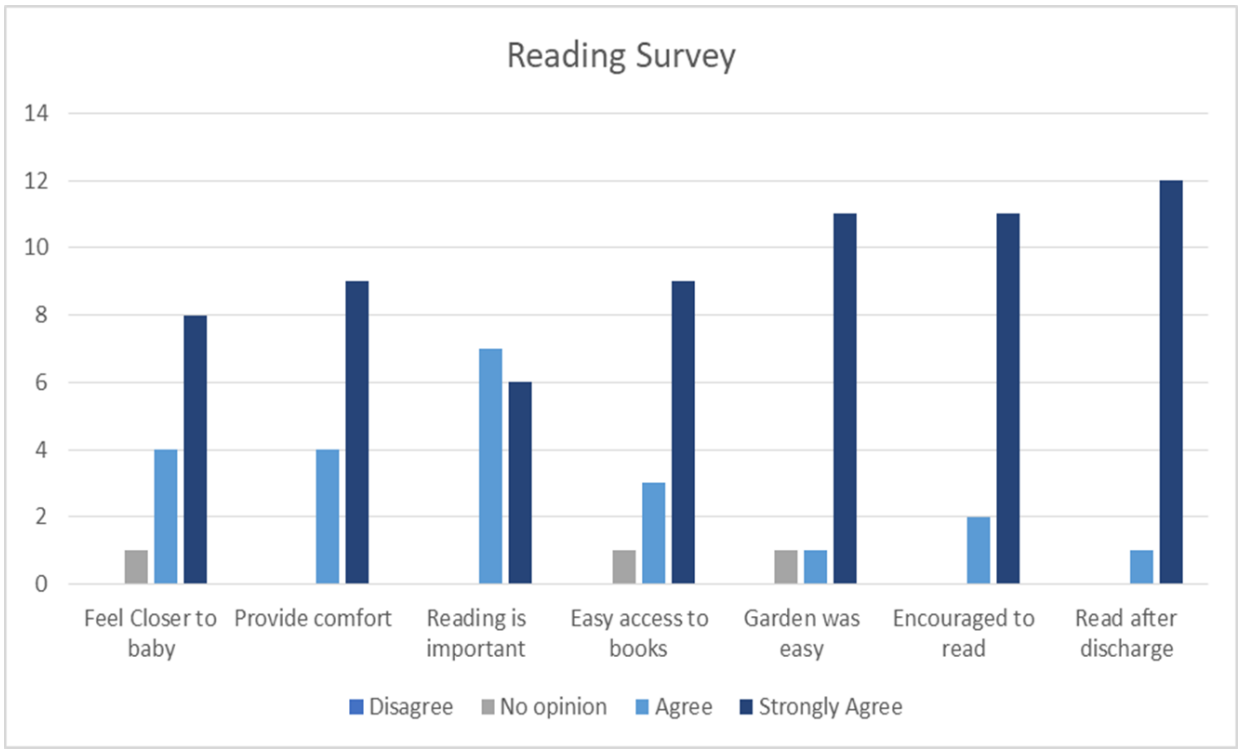


Figure 2: NICU Reading Garden Evaluation with Likert Scale created by primary investigator (see Appendix D)

Appendix A

Reading Program Gestational Age Guide

There is evidence that shows that elevated noise levels in the NICU can have adverse effects on infant physiologic stability and future neurodevelopment. Preterm infants have decreased autonomic and self-regulatory abilities and are vulnerable to high noise levels due to their inability to filter and process noxious stimuli. By 26-28 weeks, the preterm infant's auditory system is sufficiently mature for loud noise to produce physiologic changes in heart rate, blood pressure, respiration, and oxygenation. Therefore, maintaining a stable physiologic state is crucial, especially during the critical time for development of the central nervous system (CNS) when the most rapid neuronal formation is taking place.

Although the auditory system becomes partially functional from 25-29 weeks gestation, the ability to appropriately process sounds develops later in gestation. Tonotopic columns, necessary to receive, recognize, and react to language, music, and meaningful environmental sounds, develop at approximately 30 weeks gestation. At 34-36 weeks gestation, the fetus is capable of distinguishing different moods or emotional qualities to speech that are retained as part of accumulated memories. By 40 weeks, the fetus has as much as 10-12 weeks-worth of actual listening experience and may actually develop discrimination as to what sounds he or she prefers. These significant milestones in auditory development may play a crucial role in the preterm infant's ability to recognize and respond to maternal sounds.

As we introduce the SoHo reading program in the NICU, it is essentially that we adapt to the developmental needs of the premature infant. Below is a guide for the introduction of auditory stimulation with potential signs of intolerance or over-stimulation.

Reading Levels:

Level 1= Caterpillar-> Read at a whisper, 5 minutes or less, up to 3 times per day, no touching

Level 2= Butterfly-> Read at whisper, 5-10 minutes per day, up to 3 times per day, no touching

Level 3= Lady Bug->Soft reading voice, 10-20 minutes, up to 3 times per day, can be held

Level 4= Bumble Bee->Soft reading voice, 20-30 minutes, up to 3 times per day, can be held

Level 5= Cricket->Soft reading voice, 30 minutes, 3 times per day, can be held

Level 6= Blue Bird->Read as tolerated, can initiate visual stimulation if tolerating voice, can be held

23-25 weeks

No reading at this time

Humidity first week of life to keep warm

Skin to Skin with Mom or Dad by week of life 2-3

Reading program initiated once 28 weeks PMA (level 1)

Signs of intolerance include HR accelerations and SpO2 desaturations

26-27 weeks

Humidity first week of life to keep warm

Skin to Skin with Mom or Dad by week of life 2

Reading program once 28 weeks PMA (level 1)

Signs of intolerance include HR accelerations and SpO2 desaturations

28-30 weeks

Skin to Skin with Mom or Dad once stable

Begin reading program at level 2

Signs of intolerance include HR accelerations and SpO2 desaturations

30-32 weeks

Skin to skin with Mom or Dad once stable

Begin reading program at Level 3

Signs of intolerance include:

Hand salute, stop sign or finger splaying (protective maneuvers)

Frown, grimace, grunt

Yawn, sneeze or hiccup, tongue thrusts

Arching, pushing away, looking away, crying

32-34 weeks

Begin Reading program at Level 4

Signs of intolerance include:

Hand salute, stop sign or finger splaying (protective maneuvers)

Frown, grimace, grunt

Yawn, sneeze or hiccup, tongue thrusts

Arching, pushing away, looking away, crying

34-36 weeks

Begin Reading program at Level 5

Signs of intolerance include:

Hand salute, stop sign or finger splaying (protective maneuvers)

Frown, grimace, grunt

Yawn, sneeze or hiccup, tongue thrusts

Arching, pushing away, looking away, crying

36+ weeks and older

Begin Reading program at Level 6

NOTE: If minimal stimulation required for diagnosis (example: PPHN) then modify reading program as needed. Infant educator can also make individualized recommendations for infants. Once out of incubator and in open crib/bassinet, reading can be offered as tolerated.

Appendix B

Reading Program Gestational Age Guide

For parents

- 25-28 week baby can begin to hear sounds
- 30 week baby can hear, recognize, and react to sounds
- 34-36 week baby can tell if the speaker's voice is happy, sad, or nervous
- Term baby begins to like certain noises, like their mobile
- Loud noises have negative effects on your baby's health and brain development

This information about your infants hearing system helps us consider their daily routine. The below NICU Reading Garden will help guide you and your baby's team on the appropriate stimulation for your baby such as voice volume and length of time reading aloud. Your baby will be placed on a level and receive a corresponding animal sticker. We will advance their level as they grow older. The guide also lists signs of over-stimulation to help you understand your baby's cues when they need a break from the noise of reading aloud.

Stress Signs by Gestation

28-30 weeks

Increased heart rate
Decreased oxygen saturation

30-36 weeks

Hand making stop sign
Fingers spreading
Frown, grimace, yawn, sneeze, hiccups
Back arching and looking away
Crying

Welcome to the NICU Reading Garden

"Caterpillar" Level 1

Soft reading/whisper
No more than 5 minutes
Up to 3 times per day
If talking, no touching

"Bumble– Bee" Level 4

Soft reading/whisper
20-30 minutes
Up to 3 times per day

"Butterfly" Level 2

Soft reading/whisper
5-10 minutes
Up to 3 times per day
If talking, no touching

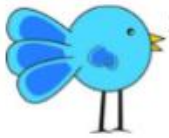
"Cricket" Level 5

Reading for 30 minutes
Up to 3 times per day

"Lady Bug" Level 3

Soft reading/whisper
10-20 minutes
Up to 3 times per day

"Blue Bird" Level 6



Reading as Tolerated

Appendix C

Maternal Reading Log

Participant Number:_____ Start Date:_____

Week 1 ☐

Week 2 ☐

Week 3 ☐

Week 4 ☐

Date	Reading book or Conversational language	Start time	Infant State Awake Asleep	End time	Infant state Awake Asleep	Held during reading	Other comments

Appendix D

NICU Reading Garden Evaluation

Please think about your experience reading to your baby and answer these questions.

Scale for answers: 1-strongly disagree, 2-disagree, 3-no opinion, 4-agree, 5-strongly agree

1. Reading to my baby helps me feel closer to my baby.	1	2	3	4	5
2. Reading to my baby is something I can do to provide him or her with comfort.	1	2	3	4	5
3. I learned about the importance of reading to my baby.	1	2	3	4	5
4. I had easy access to the books, logs, and resources I needed to read to my baby.	1	2	3	4	5
5. The steps of the Reading Garden were easy to follow.	1	2	3	4	5
6. I was encouraged to read to my baby.	1	2	3	4	5
7. I plan to read to my baby once we are discharged from the NICU.	1	2	3	4	5

Other comments and suggestions:

Appendix E

Scoring systems for ICU and surgical patients:

CRIB II (Clinical Risk Index for Babies)

Variables	Values	Points (help)
	Male infants	
Gestation (weeks)	0	0
Birthweight (g) (enter the value)	0 Enter	
	Female infants	
Gestation (weeks)	0	0
Birthweight (g) (enter the value)	0 Enter	
Temperature at admission (°C)		0
Base excess (mmol/L)		0
Compute Clear	**Predicted Death Rate :** 0	**Total CRIB II score :** 0
	Logit = -6.476 + 0.45 * CRIB II Predicted death rate = $e^{Logit}/(1+e^{Logit})$	Total CRIB II score = Sum (points) The range of possible CRIB II score is 0 to 27

Reference

- G. Parry et al. CRIB II : an update of the Clinical Risk Index for Babies score. *Lancet* 2003;361(9371):1789-91

Appendix F

Ressources et utilitaires

Scoring systems for ICU and surgical patients:

SNAP-II and SNAPPE II (Score for Neonatal Acute Physiology and SNAP Perinatal Extension)

Variables	Values	Points
Mean Blood Pressure		0
Lowest temperature		0
$P0_2$ (mmHg) / FIO_2 (%)		0
Lowest serum pH		0
Multiple seizures		0
Urine output (mL/kg.h)		0
SNAP II :	0	
Apgar score		0
Birth weight		0
Small for gestational age (help)		0

SNAPPE II : 0 In- hospital mortality : see below Data are collected within the first 12 hours after admission to the NICU

Clear

Ref: D K. Richardson et al . SNAP-II and SNAPPE-II: Simplified newborn illness severity and mortality risk scores. *J Pediatr* 2001; 138: 92-100

<< Back to scores list

Gestational age (wk)	3rd percentile birth weight (g)
	0

Back to SNAPPE II

Calibration of mortality risk model, by birth weight category
(Logistic regression equation is not available)

		Observed deaths		Expected deaths	
SNAPPE-II	Total	No.	%	No.	%
For all birth weights					
0-9	16,274	48	0.3%	51	0.3%
10-19	3,923	61	1.6%	61	1.6%
20-29	1,952	74	3.8%	71	3.6%
30-39	1,262	93	7.4%	101	8.0%
40-49	790	124	15.7%	116	14.7%
50-59	476	105	22.1%	102	21.4%
60-69	310	101	32.6%	100	32.3%
70-79	142	55	38.7%	63	44.4%
> = 80	141	94	66.7%	90	63.8%

		Observed deaths		Expected deaths	
SNAPPE-II	Total	No.	%	No.	%
For <1500 g					
0-9	1,526	9	0.6%	7	0.5%
10-19	1,092	30	2.7%	24	2.2%
20-29	772	40	5.2%	38	4.9%
30-39	645	61	9.5%	60	9.3%
40-49	497	79	15.9%	78	15.7%
50-59	318	72	22.6%	72	22.6%
60-69	260	85	32.7%	84	32.3%
70-79	121	46	38.0%	53	43.8%
> = 80	132	88	66.7%	85	64.4%

		Observed deaths		Expected deaths	
SNAPPE-II	Total	No.	%	No.	%
For >=1500 g					
0-9	14,748	39	0.3%	45	0.3%
10-19	2,831	31	1.1%	37	1.3%
20-29	1,180	34	2.9%	33	2.8%
30-39	617	32	5.2%	40	6.5%
40-49	293	45	15.4%	38	13.0%
50-59	158	33	20.9%	30	19.0%
60-69	50	16	32.0%	16	32.0%
70-79	21	9	42.9%	10	47.6%
> = 80	9	6	66.7%	5	55.6%

Appendix G

uments/EPDS.pdf

Edinburgh Postnatal Depression Scale (EPDS)

Date:_____ Clinic Name/Number:_____

Your Age:_____ Weeks of Pregnancy/Age of Baby:_____

Since you are either pregnant or have recently had a baby, we want to know how you feel. Please place a **CHECK MARK** (✔) on the blank by the answer that comes closest to how you have felt **IN THE PAST 7 DAYS**—*not just how you feel today.* Complete all 10 items and find your score by adding each number that appears in parentheses (#) by your checked answer. This is a screening test; not a medical diagnosis. If something doesn't seem right, *call your health care provider regardless of your score.*

Below is an example already completed.

I have felt happy:
Yes, all of the time ____ (0)
Yes, most of the time ✔ (1)
No, not very often ____ (2)
No, not at all ____ (3)

This would mean: "I have felt happy most of the time" in the past week. Please complete the other questions in the same way.

1. I have been able to laugh and see the funny side of things:
   As much as I always could ____ (0)
   Not quite so much now ____ (1)
   Definitely not so much now ____ (2)
   Not at all ____ (3)

2. I have looked forward with enjoyment to things:
   As much as I ever did ____ (0)
   Rather less than I used to ____ (1)
   Definitely less than I used to ____ (2)
   Hardly at all ____ (3)

3. I have blamed myself unnecessarily when things went wrong:
   Yes, most of the time ____ (3)
   Yes, some of the time ____ (2)
   Not very often ____ (1)
   No, never ____ (0)

4. I have been anxious or worried for no good reason:
   No, not at all ____ (0)
   Hardly ever ____ (1)
   Yes, sometimes ____ (2)
   Yes, very often ____ (3)

5. I have felt scared or panicky for no good reason:
   Yes, quite a lot ____ (3)
   Yes, sometimes ____ (2)
   No, not much ____ (1)
   No, not at all ____ (0)

6. Things have been getting to me:
   Yes, most of the time I haven't been able to cope at all ____ (3)
   Yes, sometimes I haven't been coping as well as usual ____ (2)
   No, most of the time I have coped quite well ____ (1)
   No, I have been coping as well as ever ____ (0)

7. I have been so unhappy that I have had difficulty sleeping:
   Yes, most of the time ____ (3)
   Yes, sometimes ____ (2)
   No, not very often ____ (1)
   No, not at all ____ (0)

8. I have felt sad or miserable:
   Yes, most of the time ____ (3)
   Yes, quite often ____ (2)
   Not very often ____ (1)
   No, not at all ____ (0)

9. I have been so unhappy that I have been crying:
   Yes, most of the time ____ (3)
   Yes, quite often ____ (2)
   Only occasionally ____ (1)
   No, never ____ (0)

10. The thought of harming myself has occurred to me:*
    Yes, quite often ____ (3)
    Sometimes ____ (2)
    Hardly ever ____ (1)
    Never ____ (0)

TOTAL YOUR SCORE HERE ▶

* **If you scored a 1, 2 or 3 on question 10, PLEASE CALL YOUR HEALTH CARE PROVIDER (OB/Gyn, family doctor or nurse-midwife) OR GO TO THE EMERGENCY ROOM NOW** to ensure your own safety and that of your baby.

If your total score is 11 or more, you could be experiencing postpartum depression (PPD) or anxiety. **PLEASE CALL YOUR HEALTH CARE PROVIDER (OB/Gyn, family doctor or nurse-midwife) now** to keep you and your baby safe.

If your total score is 9-10, we suggest you **repeat this test in one week or call your health care provider** (OB/Gyn, family doctor or nurse-midwife).

If your total score is 1-8, new mothers often have mood swings that make them cry or get angry easily. Your feelings may be normal. However, if they worsen or continue for more than a week or two, call your health care provider (OB/Gyn, family doctor or nurse-midwife). Being a mother can be a new and stressful experience. Take care of yourself by:

- ▶ Getting sleep—nap when the baby naps.
- ▶ Asking friends and family for help.
- ▶ Drinking plenty of fluids.
- ▶ Eating a good diet.
- ▶ Getting exercise, even if it's just walking outside.

Regardless of your score, if you have concerns about depression or anxiety, please contact your health care provider.

Please note: The Edinburgh Postnatal Depression Scale (EPDS) is a screening tool that does not diagnose postpartum depression (PPD) or anxiety.

See more information on reverse. ▶

Edinburgh Postnatal Depression Scale (EPDS). Adapted from the *British Journal of Psychiatry*, June, 1987, vol. 150 by J.L. Cox, J.M. Holden, R. Segovsky.

Edinburgh Postnatal Depression Scale (EPDS) Scoring & Other Information

ABOUT THE EPDS

Studies show that postpartum depression (PPD) affects at least 10 percent of women and that many depressed mothers do not get proper treatment. These mothers might cope with their baby and with household tasks, but their enjoyment of life is seriously affected, and it is possible that there are long term effects on the family.

The Edinburgh Postnatal Depression Scale (EPDS) was developed to assist health professionals in detecting mothers suffering from PPD; a distressing disorder more prolonged than the "blues" (which can occur in the first week after delivery).

The scale consists of 10 short statements. A mother checks off one of four possible answers that is closest to how she has felt during the past week. Most mothers easily complete the scale in less than five minutes.

Responses are scored 0, 1, 2 and 3 based on the seriousness of the symptom. Items 3, 5 to 10 are reverse scored (i.e., 3, 2, 1, and 0). The total score is found by adding together the scores for each of the 10 items.

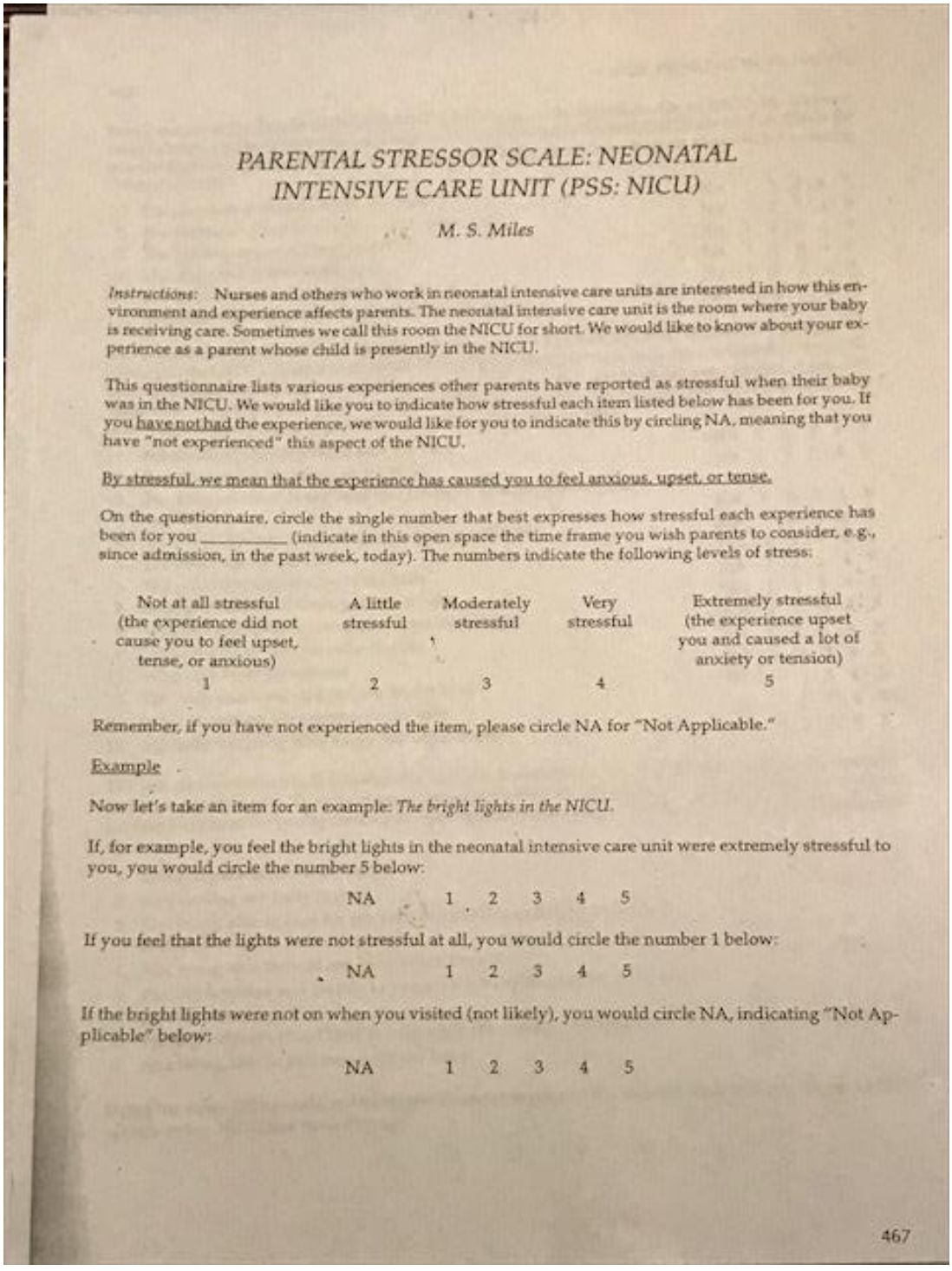
Mothers scoring above 12 or 13 are likely to be suffering from depression and should seek medical attention. A careful clinical evaluation by a health care professional is needed to confirm a diagnosis and establish a treatment plan. The scale indicates how the mother felt during the previous week, and it may be useful to repeat the scale after two weeks.

INSTRUCTIONS FOR USERS

1. The mother checks off the response that comes closest to how she has felt during the previous seven days.
2. All 10 items must be completed.
3. Care should be taken to avoid the possibility of the mother discussing her answers with others.
4. The mother should complete the scale herself, unless she has limited English or reading difficulties.
5. The scale can be used at six to eight weeks after birth or during pregnancy.

Cox, J. L., Holden, J. M., & Sagovsky, R. (1987). Detection of postnatal depression: Development of the 10-item Edinburgh Postnatal Depression Scale. *British Journal of Psychiatry*, 150, 782-786. The Spanish version was developed at the University of Iowa based on earlier Spanish versions of the instrument. For further information, please contact Michael W. O'Hara, Department of Psychology, University of Iowa, Iowa City, IA 52245, e-mail: mikeohara@uiowa.edu.

Appendix H



PARENTAL STRESSOR SCALE: NEONATAL INTENSIVE CARE UNIT (PSS: NICU)

M. S. Miles

Instructions: Nurses and others who work in neonatal intensive care units are interested in how this environment and experience affects parents. The neonatal intensive care unit is the room where your baby is receiving care. Sometimes we call this room the NICU for short. 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. If you have not had the experience, we would like for you to indicate this by circling NA, meaning that you have "not experienced" this aspect of the NICU.

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 _____ (indicate in this open space the time frame you wish parents to consider, e.g., since admission, in the past week, today). The numbers indicate the following levels of stress:

Not at all stressful (the experience did not cause you to feel upset, tense, or anxious)	A little stressful	Moderately stressful	Very stressful	Extremely stressful (the experience upset you and caused a lot of anxiety or tension)
1	2	3	4	5

Remember, if you have not experienced the item, please circle NA for "Not Applicable."

Example

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

If, for example, you feel 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

If the bright lights were not on when you visited (not likely), you would circle NA, indicating "Not Applicable" below:

NA 1 2 3 4 5

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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
6. Having a machine (respirator) breathe for my baby	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 you have experienced, then indicate how much the experience was stressful or upsetting to you by circling the appropriate number.

1. Tubes and equipment on or near my baby	NA	1	2	3	4	5
2. Bruises, cuts, or incisions on my baby	NA	1	2	3	4	5
3. The unusual color of my baby (for example, looking pale or yellow jaundiced)	NA	1	2	3	4	5
4. My baby's unusual or abnormal breathing patterns	NA	1	2	3	4	5
5. The small size of my baby	NA	1	2	3	4	5
6. The wrinkled appearance of my baby	NA	1	2	3	4	5
7. Seeing needles and tubes put in my baby	NA	1	2	3	4	5
8. My baby being fed by an intravenous line or tube	NA	1	2	3	4	5
9. When my baby seemed to be in pain	NA	1	2	3	4	5
10. When my baby looked sad	NA	1	2	3	4	5
11. The limp and weak appearance of my baby	NA	1	2	3	4	5
12. Jerky or restless movements of my baby	NA	1	2	3	4	5
13. 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 they have been for you by circling the appropriate number. Again, circle NA if you did not experience the item.

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

Using the same rating scale, indicate how stressful in general the experience of having your baby hospitalized in the NICU has been for you.

1 2 3 4 5

Thank you for your help. Now, was there anything else that was stressful for you during the time that your baby has been in the neonatal intensive care unit? Please discuss: (Use back of sheet)

Optional Scale

We are also interested in whether you experienced any stress-related STAFF BEHAVIORS and COMMUNICATION. Again, if you experienced the item, indicate how stressful it was by circling the appropriate number. If you did not experience the item, circle the NA meaning "Not Applicable." Remember, your answers are confidential and will not be shared or discussed with any staff member.

1. Staff explaining things too fast	NA	1	2	3	4	5
2. Staff using words I don't understand	NA	1	2	3	4	5
3. Telling me different (conflicting) things about my baby's condition	NA	1	2	3	4	5
4. Not telling me enough about tests and treatments being done to my baby	NA	1	2	3	4	5
5. Not talking to me enough	NA	1	2	3	4	5
6. Too many different people (doctor, nurses, others) talking to me	NA	1	2	3	4	5
7. Difficulty in getting information or help when I visit or telephone the unit	NA	1	2	3	4	5
8. Not feeling sure that I will be called about changes in my baby's condition	NA	1	2	3	4	5
9. Staff looking worried about my baby	NA	1	2	3	4	5
10. Staff acting as if they did not want parents around	NA	1	2	3	4	5
11. Staff acting as if they did not understand my baby's behavior or special needs	NA	1	2	3	4	5

Source:

Scoring instructions: The instrument can be scored in the following three ways:

(1) Metric 1: stress occurrence level (level of stress produced when a situation occurs). In this case, only those who reported having the experience receive a score on the item; those reporting that they did not experience an item are coded as missing. Scale scores are then calculated by averaging stress responses for the items on each scale and for the total scale. The denominator for obtaining the average for each scale is the number of items on that scale experienced by the parent.

(2) Metric 2: overall stress level (overall stress from the environment). In this case, parents who did not report having an experience on an item are scored a 1, indicating no stress was experienced. Scale scores are calculated by averaging these stress responses for the items on each scale and for the total scale. The denominator for obtaining the average for each scale is the number of items on the scale.

(3) In addition, the number of items experienced by the parent on each of the three scales may be calculated by simply counting the number of "yes" responses given by the parent to items on each of the three scales. These counts can then be summed to indicate the total number of items the parent has experienced.

The instrument author recommends use of Metric 1 if focus is on the NICU environment; she recommends Metric 2 if focus is on the parents.

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Appendix I

Advances in Neonatal Care Online Submission and Review System

Author Guidelines

Thank you for your interest in Advances in Neonatal Care, the official journal of the National Association of Neonatal Nurses (NANN)! This guide is intended to help authors when structuring the writing of their paper as well as format their files according to our specifications.

Papers submitted for publication are assumed to be original, not previously published, and not under consideration by any other journal. The journal is a peer-reviewed publication. All manuscripts will be sent out for an initial peer review; and then manuscripts will also be reviewed by the Section Editor, and one or both Co-Editors before a decision is made. Revisions are typically requested, which will be further reviewed by the editors at their discretion.

All manuscripts should be submitted through the journal's online management system, Editorial Manager: http://www.editorialmanager.com/anc/default.asp

Original Research

This section contains reports of original research completed with the newborn/neonatal population and their families. Studies may focus on both acute care and post-discharge questions about the care of high-risk infants and their families.

*Please note that Quality Improvement articles would be better categorized under our Clinical Issues in Neonatal Care section.

Use the following headings to structure the manuscript:

Background and Significance: Include a description of the background and importance of the research focus. End this section with a clear purpose statement.

Literature Review: Provide an overview of research related to this topic, including seminal work. Identify the gaps, or what isn't known. End this section with research questions. It may be possible to combine the Background and Significance section with the Literature Review.

Methods: Include in the following order: design, sample (including inclusion/exclusion criteria), instruments, statistical analysis, and procedures, including IRB approval. Note: All studies using human subjects must include a statement of IRB approval in their Methods section.

Results: Begin with sample demographics. Then, results can be reported for each research question. Include actual p values. Use tables and figures to display your findings when appropriate. Please do not duplicate data between the text, tables, and figures.

Discussion: Describe how your study findings compare to other studies, highlighting significant results. Have subsections discussing the implications of your study findings for practice and future research.

Please use the following guidelines for specific studies.

Authors of randomized controlled trials should consult the Consolidated Standards of Reporting Trials (CONSORT) checklist which identifies key items to report.

If you are doing a quality improvement report, please follow the SQUIRE guidelines.

Qualitative Research articles should follow the Standards for Reporting Qualitative Research.

Reporting Guidelines for a wide variety of study designs are available at the Equator Network.

In the text of the manuscript report the software used for data analysis. If p values are reported in the text, include the test statistic, confidence interval and odds ratios as appropriate. The decimal format is recommended for numbers used with units of measure. Numerical values less than 1 require placement of 0 before the decimal marker. Preferred: 0.123 Avoid: .123.

However, certain statistical values, such as α levels and P values, should be reported without the use of 0 before the decimal marker. Exact P values are preferred, regardless of statistical significance. In most cases, P values should be expressed to 2 digits to the right of the decimal point, unless the first 2 digits are zeros, in which case 3 digits to the right of the decimal place should be provided (e.g., P =.002). P values less than .001 should be designated as " P <.001." If rounding a P value expressed to 3 digits would make the P value non-significant it is acceptable to leave the P value expressed to 3 digits.

Multiple Publications from one Study: It is not uncommon to produce more than one paper from one data set/study. In these circumstances, however, each paper must represent a clearly unique use of the data and be presented in a manner that avoids any perception of self-plagiarism. JANAC requires that authors who submit a paper using data from a previously-published work discuss the following in the body of the paper: (a) information about the previously-published work, including a citation and reference to the original article, as well as citations and references to other articles published from the original data, as pertinent to the submitted paper; (b) how the data used in the submission were analyzed and how (or if) the current analysis differs from analysis in the original article; (c) a description of the participants in the submission and how (or if) the participants differ from those in the original article; and (d) a clear and specific statement about how the submitted work differs from other publications from the study and why the further use of these data is appropriate.

For questions, please contact either Donna Dowling, PhD, RN, at dad10@case.edu OR Shelley Thibeau, PhD, RNC-NIC at sthibeau@ochsner.org.

Cover Letter

A cover letter should accompany your manuscript, explaining why the manuscript should be reviewed. A summary of the study, what it adds to the field, and any other pertinent details should be included. Cover Letters should be submitted as MS Word files and should not merely copy the information provided on the Title Page document.

Title Page

The Title Page should be submitted as a separate MS Word file and include the following information:

Title of the Article

Names, degrees and professional affiliation (position, department, institution, place) of all authors, listed in the order of authorship.

A complete mailing address of corresponding author, including postal codes

Financial Disclosure and acknowledgement of grant support when appropriate. Include grant number, funding agency for the project, an individual author, or both. If no funding was received, please state as such.

Example: “Funding: This work was supported in part by a grant from Institution X (grant number 12345. Additional funding was provided by Institution Y (grant number 6789).”

Competing interests (including financial, consultant, institutional and other relationships that might lead to bias or a conflict of interest) for all co-authors. If no competing interests exist, please state as such.

Example: “Conflicts of Interest: A has received honoraria from Company Z. B is currently receiving a grant (#12345) from Organization Y, and is on the speaker's bureau for Organization X - the CME organizers for Company A. For the remaining authors none were declared.”

A list of acronyms and abbreviations used in the manuscript.

Manuscript File

Manuscripts for all article types should be prepared in MS Word and not exceed 15 pages, except for Review articles, which may be as long as 18 pages. This page count excludes the Abstract, References, and Figure/Table Legends. All manuscripts should follow the same general structure:

Title of Article

Abstract

Keywords

Body of Manuscript

Reference List

Figure and Table Legends

All manuscripts should be formatted as a single-column paper, double-spaced, and in approximately 12 pt. font.

Additional information on manuscript preparation can be found in the Uniform Guidelines for Manuscript Preparation (http://www.icmje.org/index.html) or as published in The New England Journal of Medicine in May of 1997.

Title of Article

The title of your article should clearly reflect the topic & population studied and be in line with your study design. ANC encourages authors to use at least one or more of their keywords in the title of the article itself to enhance searchability of the finished product. A recommended word limit would be 15 words or less.

Abstract

Abstracts are required for all submissions and should not exceed 250 words. The following headings should be used:

Background

Purpose

Methods/Search Strategy

Findings/Results

Implications for Practice

Implications for Research

Please be sure to include your Abstract in your manuscript file in addition to the online submission form in Editorial Manager. This information is needed in both places to help facilitate the review process.

Note: In order to follow CARE Guidelines, case reports will follow a slightly different heading structure. See the Case of the Month section for additional details.

For additional information, please see our Editorial on how to write an Abstract.

Keywords

Identify 5 to 10 words or short phrases for cross-indexing the article and list them after your Abstract. When possible, use terms from the Medical Subjects Headings (MeSH) list of Index Medicus. An excellent reference for MeSH terms is: www.nlm.nih.gov/mesh/MBrowser.html.

ANC encourages authors to use keywords in their article title to enhance searchability of the finished product

Body of Manuscript

In general, all papers will have a background section that explains the need for the paper/investigation, a critical review of the relevant literature, a methods section that describes what and how information/data were collected, findings, discussion, and recommendations for clinical and/or professional development. Review back issues of this section to obtain a sense of the style, depth, and format of published articles.

Please be sure to refer to the “Overview of Article Types” section of these instructions for additional details on your specific article. After completing an outline, it may be helpful to share your work with the section editor for input prior to writing the manuscript. Valuable input attained at the beginning stage may help shape your focus and writing.

Include only the most recent/relevant articles in the literature search; classic/seminal articles may be relevant in the background information. When describing the studies reviewed, please be sure to maintain the original author's interpretation of data rather than making your own comments on the results.

Any literature review included in your manuscript should address the following points:

What do we already know in the research area?

What are the characteristics of the key concepts/factors/variables? What are the relationships between them?

Why pursue the research question?

What are the existing theories?

Where are the gaps and inconsistencies in our knowledge and understanding?

What views need to be further tested?

What evidence is lacking/inconclusive/contradictory/too limited?

What current research designs or methods seem unsatisfactory?

What contribution to the area can your research be expected to make?

If your study used human subjects, please include a statement of Internal Review Board (IRB) approval accordingly.

Please ensure that the journal's preferred nomenclature is used in all cases. For example, "human milk" should be used in lieu of the term "breastmilk", "infant" should be used instead of "baby", etc. Please see our editorial on this subject for additional terms and guidelines.

Please also ensure that proper age terminology is used in your manuscript, following the guidelines of the American Academy of Pediatrics:http://pediatrics.aappublications.org/content/114/5/1362

Use standard neonatal acronyms throughout the text. Non-standard acronyms are strongly discouraged. A list of all acronyms and abbreviations should be provided on the Title Page document with all submissions.

Please note that all figures, tables, and supplemental digital content should have call outs somewhere in the body of the manuscript.

Revisions will be requested for most manuscripts. The section editor will review the manuscript well in advance of the production deadline and provide additional feedback as needed.

Recommended Guidelines for Specific Study Types

Original Research articles should follow the Standards for Reporting Qualitative Research.

Authors of randomized controlled trials should consult the Consolidated Standards of Reporting Trials (CONSORT) checklist which identifies key items to report.

For authors writing about evidence-based practice projects, use either ANC's Original Research guidelines, Evidence-Based Practice Briefs guidelines, or the SQUIRE Guidelines.

Additionally, please see our Editorial on using the SQUIRE Guidelines

If you are doing a literature review, please follow the PRISMA Guidelines.

If you are doing a quality improvement report, please follow the SQUIRE Guidelines.

Case Reports should follow the CARE Guidelines.

Evidence-Based Practice and Educational Training articles should follow the GREET Guidelines.

Professional Growth and Development articles should follow GREET Guidelines if they reflect Evidence-Based Practice and Educational Training.

Professional Growth and Development articles are also sometimes research studies around nursing practice or quality improvement projects and thus, research articles should follow the CONSORT Guidelines and quality improvement reports should follow the SQUIRE Guidelines.

If you are unsure about how to best format your manuscript for publication in Advances in Neonatal Care, please consult one of the co-editors.

Style References

Use Dorland's Medical Dictionary (29th Edition; 2000, W.B. Saunders) for spelling of non-technical words.

Use generic names of all drugs and products. When applicable, put brand name equivalents in parentheses when first mentioned in the text.

Measurements of length, height, weight, and volume should be reported in metric units or their decimal multiples. Report hematologic and clinical chemistry measurements in SI units (International System of Units).

References

References should be prepared using the American Medical Association Manual of Style: Guide for Authors and Editors, 10th Edition (Baltimore, Maryland: Williams & Wilkins, 2007).

In-text citations should be numbered consecutively in the order in which they are first mentioned in the text, starting with 1. Use superscripts for text citations rather than including the number in brackets or parentheses.

Examples:

This1 is the correct way2 to cite references3-7 in the body of your manuscript8

Any of these (11) methods are the incorrect way [7] to cite references (Anderson et al, 2004) in your manuscript

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Avoid using abstracts as references. References to papers accepted for publication should be listed as "in press." Manuscripts that are under review should not be included in the references or included unpublished works (permission from those authors to use those works is required.).

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At the end of your manuscript file, please include a list of names for all figures, tables, and supplemental digital content (SDC) uploaded with the submission. This list should include Figure/Table/SDC numbers as well as the titles and captions, including any citations. An example list would look like:

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Figure 2: Title of the figure. Description of the figure. Permissions/Citation information if applicable.

Supplemental Appendix 1: Description of the file.

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Appendix J

Title: Implementation of a Structured Mother-Infant Reading Program to Reduce Postpartum Depression and Maternal Stress and Measure Infant Physiologic Stability in the NICU

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Background: NICU mothers are at greater risk for postpartum depression and altered maternal infant bonding. Care participation through reading may reduce PPD and stress, enhance maternal infant attachment, and promote physiologic stability in the premature infant.

Purpose: The purpose of this study was to evaluate the implementation of a NICU based reading program on depression and stress and to determine the effect of maternal voice exposure on infant heart rate and SpO2 readings.

Methods: Fourteen mother infant dyads, including a set of fraternal twins, were enrolled in the NICU Reading Garden and received nurse practitioner delivered education, support, and behavior re-enforcement. Depression and stress scores were measured pre and post intervention. Based on reading logs, infant heart rate and SpO2 were assessed at three time points.

Results: Depression scores (*Md*=9 vs *Md*=3, *p*= 0.007) and stress scores related to infant behaviors (*p*=0.0498) and parental role alterations (*p*=0.04) of mothers of singletons declined. The majority (92.8%) felt closer to their baby and all planned to read to their baby after discharge. There was an increase in infant mean SpO2 during reading compared to after reading (*p*=0.002).

Nursing Implications: Implementation of a reading program is feasible and has an effect on both maternal and neonatal outcomes, supporting family centered care initiatives.

Research Implications: Future research should focus on the recognition of emotional patterns associated with PPD, triggers of maternal stress, and the impact of maternal voice exposure in the early neonatal period on language acquisition and childhood literacy long term.

Keywords: postpartum depression, attachment theory, self-efficacy theory, neonatal intensive care unit, reading program, family centered care, maternal voice exposure, preterm infant physiologic stability

Implementation of a Structured Mother-Infant Reading Program to Reduce Postpartum Depression and Maternal Stress and Measure Infant Physiologic Stability in the NICU

Being the mother of sick or premature infant in the Neonatal Intensive Care Unit (NICU) can be a harrowing experience. Preconceived notions of an uneventful delivery, departing the hospital with a healthy baby, and quiet moments of bonding are quickly replaced by an urgency of care, invasive machines and noxious alarms, and unfamiliar health care providers touching and caring for their infant while they are relegated to being observers. Powerlessness is a common theme experienced by parents as they struggle with negotiating their parental role in an unfamiliar and unexpected environment. [1] Altered maternal-infant bonding coupled with the risk for increased stress and depression for mothers make this time in the NICU a critical period for recognition, assessment, and intervention for mother and baby. NICU care providers may hold the key to offering meaningful solutions to improve outcomes for both. Maternal immersion into a developmentally focused reading program may provide a structured activity for care provision that offers avenues for developing self-efficacy and building confidence in parenting while promoting maternal infant bonding and improving infant physiologic stability and neurodevelopmental outcomes.

The NICU Reading was developed by the primary investigator with books provided by the SoHo Center. It consists of six (6) levels of reading decibels and reading times, introduced based on gestational age and corresponding development of the auditory system. Each level strives to minimize sensory overstimulation by adhering to established noise level restrictions within the NICU. Evidence-based recommendations are paired with sounds that insects make in the garden including a caterpillar, a butterfly, a lady bug, a bumble bee, a cricket, and a blue bird (Figure 1).

Background

Postpartum Depression

Maternal mental health is considered a major public health challenge as its impact is twofold, with the potential for adverse outcomes in not only the mother related to her own health burdens and functional status but also in the infant and child, influencing breast feeding rates, maternal child bonding, and long-term developmental outcomes. [2-4] Post-partum depression (PPD) is a major health issue for child-bearing women. The World Health Organization (WHO) estimates that 20% of mothers in developing countries experience clinical depression after child birth during the initial postpartum or postnatal period. [5] The latest statistics from the Centers for Disease Control and Prevention estimated that approximately 12% of all new mothers' experience symptoms that meet the criteria of postpartum depression in the United States.[6] Postpartum depression (PPD) is defined as a depressive episode in women with onset occurring 4 weeks to 12 months after the birth of a child. [7] There is a higher prevalence of postpartum depression in mothers of preterm infants with up to 40% of mothers suffering PPD in the early postpartum period. [8] The greatest predictors of PPD for NICU mothers are lack of social support, prior episodes of anxiety or depression, and the severity of illness of the infant correlating with gestational age and birth weight. [9]

Numerous studies have examined various interventions for the prevention of postpartum depression, including: interpersonal group-oriented therapy [10-11]; mid-wife directed educational counseling [12]; home visits to high risk populations by psych-trained nurses [13]; structured support groups [14-15]; and exercise initiatives. [16-20] Few studies have focused on care provision activities to enhance maternal infant bonding and build maternal self-efficacy.

In an integrated review of postpartum depression in mothers of preterm infants, Tahirkheli et al. reported successful interventions to reduce PPD in the NICU. These included: coordinated disciplinary teams with a holistic family centered approach utilizing counseling, therapy, and medication; education through a formalized program; promotion of "sharing" through journal writing; and an emphasis on NICU nurse support. Mothers who perceived support from the bedside nurse demonstrated less severe or fewer PPD symptoms. [21]

Maternal-Infant Attachment

In addition to the stress, anxiety, and depression risk associated with having a premature baby, NICU parents are at risk for altered parental-child bonding and attachment. [22-24] Bowlby's attachment theory states that it is essential for an infant to be attached to a mother or mother substitute who is present, available, and who can respond to the needs of the infant .[25] Beck found that postpartum depression has a moderate to large effect on maternal infant interactions during the first year after delivery [26]. If a mother is emotionally unavailable or affectively unresponsive, synchrony of interaction behaviors is unlikely to occur in the depressed mother-infant dyad. Premature delivery can have a negative effect on attachment. Shah et al. reported that maternal grief related to preterm delivery led to insecure attachment at 16 months of age in their preterm infants.[27] The quality of interactions between mother and infant affected attachment security. Maternal sensitivity may be dampened due to the mother's inability to be near the infant either due to the infant's clinical status or the physical barriers created within the NICU. Mothers of medically fragile infants have described a period of ambiguity between pregnancy and being a mother when their role is unclear. Black et al. define a period of "liminality" in which maternal role is unclear and technology, especially the use of ventilator, was seen as a barrier for maternal connection. [28]

Reading to Infants and Maternal Voice Exposure

Parents reading to their child is an activity that has been seen as a positive caregiving interaction that promotes closeness and bonding [29-30] Reading to children at a young age is instrumental in the development of language and reading skills as well as brain development.[31-35] For parents of infants in the NICU, reading may be an activity that allows for care participation when there is little else that they can do. They cannot hold, feed, or even touch their fragile infant during the early critical interval yet reading to their infant may be the one thing that parents alone can provide. Lariviere and Rennick found that parents who read to their infant in the NICU felt an increased sense of control, normalcy, and increased intimacy with that child.[36] In-utero, maternal voice exposure is an important source of sensory stimulation for the developing fetus. Infants born prematurely are deprived of this stimulus and instead exposed to noxious environmental factors including light, sound, and tactile stimulation at levels they otherwise would not have experienced in the womb. Over the last decade, much attention has been given to developmental strategies and interventions that reduce the negative and potentially detrimental consequences of these stressful exposures in order to reduce the neurodevelopmental impact on the infant.[37] Numerous systematic reviews have illustrated some evidence of positive effects of maternal voices exposure on preterm infants' cardiopulmonary stability and neurodevelopmental outcomes.[38-39] However, those results have been inconsistent and lack effect on long term infant outcomes. No studies were found that have evaluated maternal voice exposure on preterm infant stability as guided by gestational age and auditory development so as to structure time, tone, and decibel exposure.

The purpose of this study was to evaluate the implementation of a NICU based reading program, the NICU Reading Garden, on depression and stress and to determine the effect of maternal voice exposure on infant heart rate and SpO2 readings. The hypotheses were 1)

Participating in a reading program will reduce maternal depression and stress scores and 2) Maternal voice exposure will decrease infant heart rate and improve infant oxygenation when compared before, during, and after.

Methodology

Design

This study was a single group pre/post-test quasi experimental and a time series quasi experimental design study. Approval was obtained by the institutional review board, IRB HSR 20908. Written informed consent was obtained from the mother by the primary investigator.

Setting

The study took place in the 51 bed Level IV NICU of a university affiliated, tertiary care children's hospital located within a university medical center from October 2018 to December 2018. This NICU is a major referral center for the state of Virginia.

Sample

A convenience sample of mothers whose infants were either admitted or already hospitalized in the NICU were screened for participation. Inclusion criteria included: 1) Mothers of infants born less than or equal to 32 weeks' completed GA who were admitted to the NICU 2) Mothers of infants with PMA less than 36 weeks or whose infant would likely be hospitalized for the 4-week intervention period. This determination was based on diagnosis, clinical condition, and best estimation by the primary NICU medical provider and the primary investigator 3) Mothers who were able to understand and speak English and 4) Mothers who were able to read or speak to their infant in person at least 3 times per week for the 4-week intervention period.

Prior to the enrollment period and during the 3 months of the study, educational in-services were offered to NICU staff and support services including social work and therapy

services. A Staff Education Sheet was made available on the NICU Intranet Repository as well as at the bedside of each infant who was enrolled in the study. Once enrolled, standardized education was provided to each mother at the bedside by the PI. This included the benefits of reading, the unique levels of the NICU Reading Garden (Figure 1), and signs of overstimulation. Each mother completed two maternal screening instruments, the Edinburgh Postnatal Depression Scale (EPDS) and the Parental Stressor Sale: NICU (PSS: NICU) prior to the first reading session. Screens indicative of mild to moderate depression triggered a social work consult. If severe depression or concerns for self-harm were identified, social work and a medical referral were initiated.

Reading by the mother as outlined by the NICU Reading Garden commenced and was tracked over a 4-week intervention period based on self-reported reading logs. Periodic re-enforcement of educational material occurred. Each mother received in person encouragement and verbal acknowledgment of reading success from the PI at least once a week. This included recognition of reading times and successful completion of the log, re-enforce of reading behaviors, and discussion about readiness to advance in the reading garden along with general questions about maternal well-being. At the end of the 4-week period, mothers repeated the two screens (EPDS and PSS: NICU) as well as a program evaluation survey to assess program ease, accessibility, and perceptions of reading as a bonding activity. Infant response to maternal voice exposure was accessed based on the reading log at time points of before, during, and after.

Instruments and Measurement

Demographic Data

Demographic data was collected from the electronic medical record (EMR). This included maternal age, educational level, marital status, and race; infant's gestational age at

birth, time of enrollment, gender, birth weight, diagnosis, and respiratory support at time of enrollment and the commencement of the intervention.

Severity of Illness

No single clinical tool has been shown to be an ideal prognosticator for the variable disease, clinical, and perinatal factors contributing to neonatal outcomes. Clinical Risk Index for Babies II (CRIB-II) and the Score for Neonatal Acute Physiology and Perinatal Extension II (SNAPP-II) are two instruments that have been used extensively in the NICU population to assess morbidity and mortality. Infant data from the EMR was accessed and utilized to score severity of illness.

Maternal Depression and Stress:

The Edinburgh Postnatal Depression Scale and the Parental Stressor Scale: NICU were used to screen for depression and stress. The EPDS is the most well-known and evaluated instrument for postpartum depression [40] It has a sensitivity and specificity of 86% and 78% respectively with a positive predictive value of 73% using a score of 9 as a cut off for depression. The American Academy of Pediatrics (AAP) recommends that the EPDS be used as a screening tool for mothers during early postnatal/neonatal visits with their pediatrician. [41]

The Parental Stressor Scale: NICU (PSS: NICU) is a 37-item instrument that asks parents to rate the stressfulness of items on a Likert scale from 1 (not at all stressful) to 5 (extremely stressful). The items are categorized into domains based on sights and sounds of the NICU, infant behavior and appearance, parental role alteration, and staff behaviors and communications. The higher the score the more stress the parent is experiencing. The Cronbach's alpha coefficient for stress occurrence level and overall stress level was calculated to be 0.94 and 0.89 respectively, representing good internal consistency for the entire scale.[42]

Program Evaluation Survey:

A Likert Scale survey created by the PI was administered to assess program accessibility and ease as well as maternal perception of closeness and bonding.

Mean HR and SpO2 Measurements:

The GE B850 Model from Carescape with Neonatal Software was utilized for cardio-pulmonary monitoring. The Masimo Radical 7 co-oximeter was used for pulse oximetry monitoring. Pooled information was transmitted to a central monitoring system that allowed for time specific trending and review. Bed Master software from Excel Medical Electronics, Inc. was utilized to retrieve HR and SpO2 readings 30 minutes before, during (mid-point), and 30 minutes after each reading session.

Data Analysis:

Descriptive and inferential statistical analysis were performed using the IBM Analytics Statistical Package for Social Sciences (SPSS) version 25. Demographic information was assessed for frequency, mean, and median. The Exact Wilcoxon Signed Rank test was used to analyze depression and stress scores. The Sign Test was used to assess interval changes in means of HR and Spo2. Mean HR and SpO2 readings were calculated for each reading time point including 30-35 minutes before and after each reading and one value from mid-reading session. Each infant had a minimum of 12 reading exposures with variable reading times ranging from 2 minutes to 65 minutes per session. A single mean HR and SpO2 was then calculated from the sum of mean values for those reading times and used for analysis. The total number of reading sessions and length of reading time for each session were tracked. The Independent Samples Mann-Whitney U test was used to compare means based of two groups, those who read less than 20 minutes at each session and those who read for greater than 20 minutes.

Mothers of multiples were not excluded from the study. One mother had fraternal twins. Baseline depression and stress scores were elevated but similar to baseline scores for singleton mothers. Since reading to more than one infant had the potential to impact the dose of the intervention and could violate the independence requirement for the proposed analysis, analysis was also done excluding this mother, including the mother with data from one of her infants selected randomly, and including the mother with data from both of her infants.

Results

A total of 14 mothers were initially enrolled, including 15 infants. One mother withdrew two weeks into the intervention leaving 13 mothers for pre and post-test analysis. Data from the reading times of all 15 infants were analyzed. The demographic information for all 14 mothers is displayed in Table 1. Maternal age ranged from a minimum of 20 years to a maximum of 42 years with a mean of 29.43 years (*SD* 5.98). The majority of mothers were Caucasian (71.4%), married (57.1%), and had a high school education (64.3%). Most had no prior history of depression (71.4%). Mothers read a minimum of 12 (with early withdrawal) to a maximum of 47 times during the study period (*M* 20.86, *SD* 11.53). Total reading time over the study period was a minimum of 54 minutes to a maximum of 1239 minutes (*M* 374.07, *SD* 297.04). The characteristics of the infants are displayed in Table 2. The mean birth weight was 1091.87 grams (min 570 gm, max 1718 gm, *SD* 363.9). Mean gestational age at birth was 28.5 weeks (min 24 1/7 weeks, max 32 6/7 weeks, *SD* 2.59) and the mean gestational age at time of consent was 33.3 weeks (min 28 6/7 weeks, max 44 6/7 weeks, *SD* 4.37). The mean CRIB II score was 7.40 (*SD* 4.32). The mean SNAPP II score was 10.93 (*SD* 8.52). On admission to the NICU, 53.3% of the infants were on mechanical ventilation. This declined to 6.7% at the time of consent and for the first reading session. No infants remained on mechanical ventilation at the end of the

intervention with 13.3% on continuous positive airway pressure (CPAP), 20% on nasal cannula, and 66.7% in room air requiring no additional respiratory support. No infants required surgery during the study period. The majority of infants were on caffeine (66.7%) and required no sedation (86.7%) and no cardiovascular medications (93.3%) during the study period.

Depression scores before and after the intervention are summarized in Table 3. Mothers with depression scores greater than or equal to 9 declined from 53.4% pre-intervention to 15.4% post intervention. There was a statistically significant reduction in depression scores following participation in the reading intervention, z =-2.556, p= 0.007. The median score on the EPDS decreased from pre-intervention (Md=9) to post intervention (Md=3) and were almost the same when the mother of twins was omitted.

Stress scores were analyzed based on the four individual domains, an overall scale score, and each mother's self-reported perceived stress score. These results are presented in Table 4. No statistically significant reduction in stress scores in any of the four domains, overall scale score, and self-perceived score pre and post intervention was found when all mothers were included. However, when the mother of fraternal twins was removed, statistical significance between pre and post stress scores in Domain 2 representing infant behaviors and Domain 3 representing parental role alterations (p=0.0498 and p=0.040 respectively) were found. There was also evidence of reduction in overall scale score (p=0.097).

The mean HR for the reading sessions of each infant was obtained for the three-time points of before, during, and after reading (Table 5a). Interval means for before and during reading (p=0.118), during and after reading (p=0.302), and after and before reading (p=0.302) were compared. No statistically significant differences were found (Table 5b). The mean SpO2 for the reading sessions of each infant was obtained in a similar fashion and compared during the

same intervals of before and during reading (p=0.581), during and after reading (p=0.002), and after and before reading (p=0.118). A statistically significant difference was found for mean SpO2 in the interval of during read to after (Table 5b). There was no difference in the distribution of mean scores based on length of reading times less than 20 minutes per session compared to greater than 20 minutes per session as shown in Table 6. When the mother of fraternal twins was removed, there remained statistical significance in mean SpO2 in the interval of during and after reading when including only one twin (p=0.003).

Thirteen mothers completed the 7-item survey. These results are presented in Figure 2. When asked if reading had made them feel closer to their baby, 92.8% agreed or strongly agreed that it did. When asked if they were encouraged to read to their baby during the intervention, 100% agreed or strongly agreed. When asked if they plan to read to their infant after discharge, 100% agreed or strongly agreed. Comments included, “Reading made me feel closer to my baby”, “This was a great program to participate in”, “I am reading more now to my 18-month old at home”, and “I would recommend parents participate in this program and read to their babies”.

Discussion

The majority of women enrolled in the study were Caucasian, high school educated, married, and had no prior history of depression. Of the 57% who scored equal to or greater than 9 on the initial screen, the majority were African American (63%). All 4 women who had a prior history of depression scored over 10 on the screen. These women clearly represented a high-risk category of mothers, emphasizing the need for an accurate prenatal and maternal mental health history to aid in screening. Post-partum depression in the NICU is not well recognized, in part due to lack of adequate screening, the stigmatization associated with depression, and lack of knowledge for both care providers and women on symptom development. The standard

screening mechanism utilized in this NICU prior to this study was a social worker implemented Patient Health Questionnaire-2 (PHQ-2) screen. This study recognized that depression was likely under-identified using the PHQ-2 screen. As a result of this study's intervention, a change in practice occurred and the EPDS is now the standard depression screen instrument in the NICU.

Timing of screening may be important. Three mothers were consented and screened within the first week post-partum. Two of these mothers scored greater than 9 on the pre-intervention screen, one of whom had a prior history of depression, again supporting past history of depression as a risk factor. Of those three women, one mother had a higher post intervention screen of 9 (at 5 weeks postpartum) compared to her pre-intervention screen of 3 (at 1 week postpartum) with no prior history of depression. She was the only mother with an increase in her depression screening score post intervention. The post intervention screen may have been detecting developing depression at 5 weeks. The optimal time to screen for postpartum depression is at the first prenatal visit or 4 to 6 weeks after delivery.[43] The epidemiologic patterns of postpartum depression suggest that the onset is within the first month. The incidences of PPD increase significantly during the first three months with a threefold higher incidence approximately 5 weeks after delivery. [44] There is a decrease in the incidence of PPD at 6 months and no change or increase at one year.[45] The pattern of development suggests that for mothers, who are in the NICU with infants who have prolonged hospitalization, repeat screening during the hospitalization may prove beneficial and reveal symptoms that might have been missed during the initial 2-4 weeks after delivery.

Parental stress is well reported in the NICU. The birth of a sick or premature infant can be a traumatic event.[46] Physical, emotional, and financial stress have been equated with NICU hospitalization. [47-50] Results from the PSS: NICU revealed that the majority of mothers (67%)

perceived their stress to be moderate to high before the intervention. That number was relatively unchanged (64%) after the intervention. The reduction in pre and post scores for infant behavior and appearance and parental role alterations were statistically significant when the mother of the fraternal twins was excluded from analysis supporting the initial hypothesis for mothers of singletons. As the infant's clinical status improves over time and some of the invasive monitoring and physical barriers, such as an endotracheal tube or CPAP mask are removed, the appearance of the infant and how they behave may be perceived as more consistent with a newborn infant. As a mother acclimates to the NICU and begins to identify ways to parent, such as with the reading intervention, the relationship with her infant may evolve. As the infant's clinical status improves and the doubts for survival subside, attachment and relationship development may become more natural. The reading survey revealed that the majority of mothers felt that reading brought them closer to their infant and provided comfort.

During hospitalization, potential triggers such as acute clinical changes, movement to a new or different bed location, changes in parental role expectations, exposure to new care providers, miscommunications, and witnessing clinical situations such as sick admissions, discharges of infants with shorter NICU stays, and the death of pod mates, may create cycles of stress that ebb and flow. Providers must recognize the impact that these triggers have on maternal (and paternal) stress and parenting behaviors.

Total number of reads and reading times varied amongst participants. This was a factor of maternal preference and desire to read, visitation patterns impacting opportunities to read, and dictated by the NICU Reading Garden framework. Reading times were as short as 2 minutes to as long as 65 minutes per reading session. There was no statistically significant reduction in mean HR found when comparing the three-time intervals of before and during, during and after,

and after and before. The mean HR during reading or with maternal voice exposure was not higher suggesting that, although voice exposure may not lead to significant HR reductions, it doesn't appear to lead to HR increases either. This is significant when determining physiologic stability. The mean SpO2 during reading was higher and there was a significant increase during reading when compared to before and after reading. The initial hypothesis that oxygenation improves during maternal voice exposure is supported and auditory stimulation via maternal voice exposure is tolerated.

Study Strengths and Limitations

Using a focused care provision activity to address postpartum depression in the NICU is innovative. No study was found in the literature that evaluated reading to an infant in the NICU as a targeted intervention to reduce maternal stress and depression. The NICU Reading Garden program in itself is unique as no study was found that has utilized a program that was developmentally based. The NICU Reading Garden has been a creative initiative to demonstrate infant developmental maturation and to highlight the effectiveness of reading as a bonding activity to even the smallest of patients.

Another strength of this study was the utilization of theoretical concepts to direct the study interventions. Empowering NICU mothers to provide a focused care provision activity that they alone can offer had merits in promoting maternal self-efficacy. Education about reading benefits, infant development, and stimulation tolerance gave these mothers cognitive and motivational foundations for successful parenting. Staff encouragement, infant response, and progression through the NICU Reading Garden promoted a sense of accomplishment for the mothers, buffering the effect of stress and anxiety while decreasing the perception of depression. Maternal infant attachment was encouraged through the intimate activity of reading. Education

about infant tolerance to stimulation offered the mother a tool to use for instinctive response. Education offered tools that could be used to interpret physiologic parameters and nonverbal cues from the baby that indicated the infant's state of content. This re-enforced the role of mother and offered a mechanism for effective bonding and attachment.

Because of the lack of randomization and a true experimental group, there was a weakening of internal validity of results. Pre-existing factors and co-variants were not taken into account. Mothers who visited frequently had more exposure to the staff and the PI, often translating to more opportunities for encouragement, interaction, and support. This convenience sample had low severity of illness scores, no infants with prolonged ventilation, and no infants with significant clinical deteriorations or surgeries and may not represent the true population of this Level IV NICU, potentially underestimating maternal depression and stress. Although there was no significant difference in mean HR and SpO2 when comparing groups based on reading time greater than or less than 20 minutes, it is unclear if an effect from either total number of reading times or total number of reading minutes was influential on study results.

Nursing Implications and Future Research

Implementation of a reading program can achieve unit goals of family centered care while promoting maternal self-efficacy, maternal infant bonding, and supporting maternal mental health. Screening mothers in the NICU for PPD captures a population of women who based on the evidence, are at even greater risk for depression. Infant physiologic stability does not appear to be negatively impacted by maternal voice exposure and oxygenation levels may actually improve during reading. Previous implementation of noise deprivation in an effort to minimize infant stimulation should be re-evaluated as maternal voice exposure during the NICU hospitalization appears to be beneficial for both mother and infant. Future research should focus

on the diagnosis, treatment, and recognition of the emotional patterns associated with PPD in NICU mothers; cycles and triggers of maternal stress during hospitalization; and how maternal voice exposure in the early neonatal period impacts infant language acquisition long term. The potential physiologic and neurodevelopmental benefits of maternal voice exposure for preterm infants are still being discovered. Nurses play a key role in educating parents about reading benefits and encouraging developmentally focused, family centered interventions that promote attachment and support infant stability.

Conclusion

Women participating in a 4-week reading intervention had a statistically significant reduction in EPDS scores. Women of singletons also had a statistically significant reduction in stress scores associated with infant behavior and parental role alterations. Mean infant SpO2 levels during reading compared to after reading were higher and this was statistically significant. Reading made mothers feel closer to their infants and was an activity that they planned to continue after discharge. Reading in the NICU as an intervention to address maternal depression and stress is feasible and effective. Maternal voice exposure improves infant oxygen saturations during reading and is well tolerated.

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Table 1

Demographics and Characteristics of NICU Mothers (N=14)

Characteristics	Frequency (n)	M (SD)	Minimum	Maximum
Age (years)		29.43 (5.98)	20	42
Race				
Caucasian	71.4% (10)			
African American	21.4% (3)			
Other	7.2% (1)			
Education				
High School	64.3% (9)			
College	28.6% (4)			
Graduate School	7.1% (1)			
Marital Status				
Single	42.9% (6)			
Married	57.1% (8)			
Pregnancy				
Singleton	92.9% (13)			
Multiple	7.1% (1)			
Location of Birth				
Inborn	78.6% (11)			
Outborn	21.4% (3)			
Prior Depression				
Yes	28.6% (4)			
No	71.4% (10)			
Current Depression Medication				
Yes	0% (0)			
No	100% (14)			
Total Number of Readings		20.86 (11.53)	12	47
Total Minutes of Reading		374.07 (297.04)	54	1239

Note: M=mean. SD= standard deviation

Table 2

Infant Characteristics (N=15)

Characteristics	Frequency (n)	Mean (SD)	Minimum	Maximum
Birth Weight (grams)		1091.87 (363.9)	570	1718
Gestational Age of birth (weeks)		28.5 (2.59)	24 1/7	32 6/7
Gestational Age at consent (weeks)		33.3 (4.37)	28 6/7	44 6/7
CRIB II Score		7.4 (4.32)	1	13
SNAPP II Score		10.93 (8.52)	0	28
Diagnoses on Admission				
RDS	100% (15)			
Prematurity	100% (15)			
Observation for Sepsis	100% (15)			
VSD	6.7% (1)			
Respiratory Support on Admit				
Mechanical Vent	53.5% (8)			
CPAP	46.7% (7)			
Nasal Cannula	0 (0)			
Room Air	0 (0)			
Respiratory Support at consent				
Mechanical Vent	6.7% (1)			
CPAP	46.7% (7)			
Nasal Cannula	26.7% (4)			
Room Air	20.0% (3)			
Respiratory Support during study				
Mechanical Vent	6.7% (1)			
CPAP	33.3% (5)			
Nasal Cannula	40.0% (6)			
Room Air	20.0% (3)			
Respiratory Support at End				
Mechanical Vent	0 (0)			
CPAP	13.3% (2)			
Nasal Cannula	20.0% (3)			
Room Air	66.7% (10)			
Surgical Procedure				
Yes	0 (0)			
No	100% (15)			
Caffeine during study				
Yes	66.7% (10)			
No	33.3% (5)			
Sedation during study				
Yes	13.3% (2)			
No	87.7% (13)			
Cardiovascular Medications				
Yes	6.7% (1)			
No	93.3% (14)			

Note: SD= standard deviation. CRIB II= Clinical Risk Index for Babies [6 items scored with weighted sums from 0 to 27 with higher score indicating greater risk for mortality]. SNAPP II= Score for Acute Neonatal Physiology [9 items scored with weighted sums from 0 to 80 with higher scores indicating greater in risk for in hospital mortality]. RDS=respiratory distress syndrome. VSD= ventricular septal defect. CPAP= continuous positive airway pressure

Table 3:

EPDS scores pre and post intervention and exact Wilcoxon Signed Rank Test (N=13)

EPDS	Frequency (n)	Median	*z* score	*p*-value
Pre-Intervention				
Greater than or equal to 9	53.4% (7)	9	-2.556 (-2.450[a])	0.007*, (0.012[a])*
Less than 9	46.6% (6)			
Post Intervention		3		
Greater than or equal to 9	15.4% (2)			
Less than 9	84.6% (11)			

Note: Higher scores represent greater risk for depression.
[a] Results when excluding mother of fraternal twins.
*p <0.05

Table 4:

PSS: NICU scores pre and post intervention and Exact Wilcoxon Signed Rank Test (N=13)

Components	Pre Median	Post Median	*z*-score	*p*-value
Domain 1: Sights and Sounds [6 item subscale: possible range 0-30]	11	8	-1.633 (-1.633[a])	0.107 (0.107[a])
Domain 2: How Baby Looks and Behaves [13 item subscale: possible range 0-65]	25	21	-1.806 (-1.959[a])	0.073 (0.05[a])*
Domain 3: Relationship with Baby [7 item subscale: possible range 0-35]	21	14	-1.689 (-2.047[a])	0.094 (0.040[a])**
Domain 4: Staff behavior/communication [11 item subscale: possible range 0-55]	13	11	-0.140 (-0.339[a])	0.922 (0.813[a])
Overall Scale Total [average of 37 items: range 0-5]	1.9	1.5	-1.415 (-1.693[a])	0.169 (0.10[a])***
Self-Perception of Stress [1 item subscale: possible range 1-5]	3	3	-1.265 (-1.265[a])	0.359 (0.359[a])

Note: Parental Stress Scale: NICU with Likert scale response of 0 (or not applicable) through 5. Value of 1 represents "not at all stressful" and vales 5 represents "extremely stressful". Total scores were used for Domains 1 through 4. Average score for all 37 items was calculated for Overall Scale Total. Higher scores represent greater stress.
[a] Results when excluding mother of fraternal twins.
**p* =0.0498; ***p*< 0.05; ****p*=0.097

Table 5a:

Mean, Median, Minimum, and Maximum HR and SpO2 at three-time points associated with maternal voice exposure (N=15)

Variable	Mean (SD)	Median	Minimum	Maximum
HR before read	158.7 (10.58)	158.33	136	177
HR during read	157.37 (11.59)	160.46	131	171
HR after read	159.13 (10.52)	155.08	142	175
SpO2 before read	96.12 (2.52)	96.38	90	99
SpO2 during read	96.89 (1.48)	96.56	95	99
SpO2 after read	95.76 (2.03)	95.61	93	99

Note: HR= heart rate; SpO2= oxygen saturation.

Table 5b:

Sign Test for change in HR and SpO2 over three-time intervals

Variable	*p*-value
HR before reading compared to during	0.118 (0.180[a])
HR during reading compared to after	0.302 (0.424[a])
HR after reading compared to before	0.302 (0.424[a])
SpO2 before reading compared to during	0.581 (0.774[a])
SpO2 during reading compared to after	0.002* (0.003[a])*
SpO2 after reading compared to before	0.118 (0.180[a])

Note: HR= heart rate. SpO2= oxygen saturation.
[a] Results when excluding mother of fraternal twins.
*p <0.05

Table 6:

Independent Samples Mann-Whitney U test for HR and SpO2 at three time points based on length of reading times—all less than 20 minutes or all greater than 20 minutes (N=15)

Variable	Group 1 (n=6) M (SD), Md	Group 2 (n=9) M (SD), Md	*p*-value
HR before	158.88 (16.83), 160.85	160.06 (15.54), 155.78	0.529
HR during	156.87 (16.37), 156.39	157.14 (15.92), 160.46	0.864
HR after	158.67 (16.86), 154.79	157.05 (17.94), 160.31	1.000
SpO2 before	95.50 (7.07), 95.44	95.95 (4.03), 96.70	0.607
SpO2 during	96.56 (3.12), 96.24	96.79 (3.08), 97.00	0.864
SpO2 after	96.40(4.37), 94.89	95.79 (3.92), 95.61	0.776

Note: HR=heart rate. SpO2= oxygen saturation. M=mean. SD=standard deviation. Md=Median. Reading group 1 includes infants who had all reading times less than 20 minutes; Reading group 2 includes infants who had all reading times greater than 20 minutes.

Figure 1: The NICU Reading Garden Framework

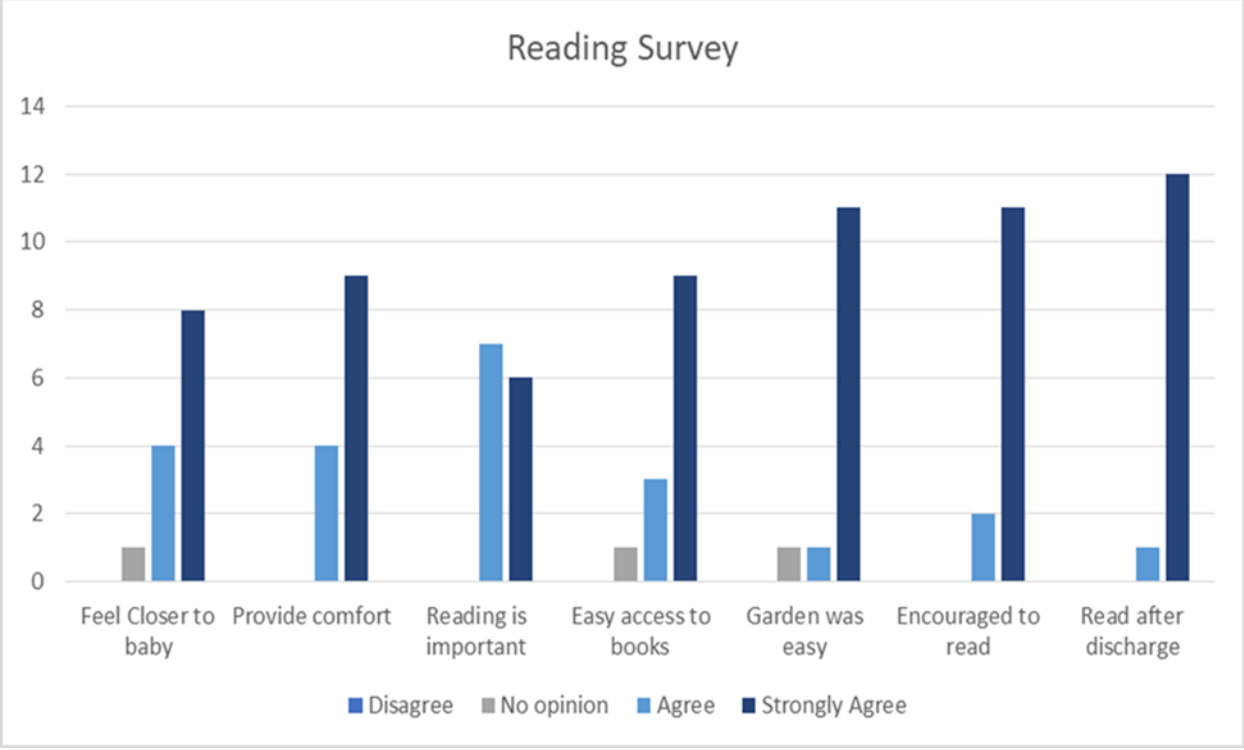

Figure 2: NICU Reading Garden Evaluation with Likert Scale created by primary investigator