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Addressing the Psychosocial Risk Factors Affecting the Developing Brain of the High-Risk Infant

Cynthia Rogers, MD*

“We’re mirrors for infants that tell them who they are, and we’re also windows that let them know what to expect.”

-Adapted from Jeree Pawl, 2001

This quote brilliantly captures the role of the primary caregiver for an infant and how influential infant-caregiver interactions are for subsequent brain development. This sentiment also highlights the importance of the caregiver’s own functioning to the child’s development. The caregiver-infant dyad is based on reciprocal interactions, but it is the caregiver who sets the stage for how these interactions will evolve. The extent to which the caregiver-infant interaction reflects to the infant (like a mirror) that the infant is worthy of love and support through the caregiver’s responses, and the extent to which the infant sees through these interactions (like a window) that the world is a safe and loving environment, powerfully impacts how that infant’s brain develops during a time of rapid brain development.

The psychological and socio-demographic characteristics of the caregiver, commonly referred to as psychosocial factors, are highly critical in shaping an infant’s brain development as they often influence the caregiver’s emotional state, stress responses, and overall mental health.¹ Poverty is one of the most potent of these psychosocial factors. Poverty is associated with myriad other deleterious exposures and behaviors known to affect caregiver-infant interactions such as parental stress, psychiatric

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1. See Claudia M. Klier et al., *A Multirisk Approach to Predicting Chronicity of Postpartum Depression Symptoms*, 25 *DEPRESSION & ANXIETY* 718 (2008); Catherine Monk et al., *Linking Prenatal Maternal Adversity to Development Outcomes in Infants: The Role of Epigenetic Pathways*, 24 *DEVELOPMENTAL PSYCHOPATHOLOGY* 1361 (2012); Curt A. Sandman et al., *Exposure to Prenatal Psychobiological Stress Exerts Programming Influences on the Mother and Her Fetus*, 95 *NEUROENDOCRINOLOGY* 8 (2012).

illnesses, and substance abuse.² These psychosocial stressors are experienced during both the prenatal and postnatal period and are often interconnected. When these stressors are experienced during pregnancy they work together to impact the development of the fetal brain. After birth, the neonatal brain continues to mature and is further impacted by the postnatal environment,³ which often includes continued exposure to a caregiver with these same psychosocial risks. The goal of this Article is to examine how exposure to these prenatal and postnatal stressors can lead to impaired development in children and how changes in our support of young infants and their caregivers during this period could help mitigate the risk of these adverse outcomes.

Poverty can be viewed as the hub of the wheel of many different stressors that a pregnant woman can experience both during her pregnancy and afterward. While there are almost innumerable adversities related to experiencing poverty that can impact a developing child, the primary focus of this Article will be on maternal mental health and substance use disorders. While these illnesses are prevalent across all socio-demographic strata, they are unfortunately more common among those in poverty, who often have the greatest barriers to access available treatment services.⁴ These illnesses are modifiable: evidence-based treatments exist that can improve maternal functioning and infant outcomes. However, if these factors remain unaddressed and/or current policies continue to inhibit access to these treatments, the results can be highly deleterious to infant outcomes due to direct exposures to the developing brain in utero. In addition, this Article argues the relationship that maternal mental health and substance use have on the development of dysfunctional parenting styles can continue to alter the brain of infants after birth. There is

2. See Magdalena Cerda et al., *Lifetime Income Patterns and Alcohol Consumption: Investigating the Association Between Long- and Short-term Income Trajectories and Drinking*, 73 SOC. SCI. & MED. 1178 (2011); Rebecca P. Newland et al., *The Family Model Stress and Maternal Psychological Symptoms: Mediated Pathways From Economic Hardship to Parenting*, 27 J. FAM. PSYCHOL. 96 (2013); Janet W. Rich-Edwards et al., *Sociodemographic Predictors of Antenatal and Postpartum Depressive Symptoms Among Women in a Medical Group Practice*, 60 J. EPIDEMIOLOG. COMMUNITY HEALTH 221 (2006).

3. Rebecca C. Knickmeyer et al., *A Structural MRI Study of Human Brain Development from Birth to 2 Years*, 27 J. NEUROSCIENCE 12176 (2008).

4. Ronald C. Kessler et al., *Prevalence, Severity, and Comorbidity of 12-month DSM-IV Disorders in the National Comorbidity Survey Replication*, 62 ARCH. GEN. PSYCHIATRY 617 (2005).

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burgeoning evidence that both these direct in utero mechanisms and postnatal exposures may act to alter the trajectory of typical brain development.⁵

While many negative outcomes for the mother and the fetus can result from these psychosocial stressors, preterm delivery is one of the most significant.⁶ Overwhelming evidence indicates that maternal substance abuse is a significant risk for multiple obstetric complications including preterm delivery.⁷ We also know that maternal mental health illnesses like depression, anxiety, and bipolar disorder increase the risk of preterm birth to approximately 1.5 to 2 times that of women without these disorders.⁸ Even in populations such as African-American women that are known to be at high risk for preterm delivery,⁹ evidence suggests that maternal depression independently predicts preterm birth.¹⁰

To understand how we can lessen the risks to the developing brain, we must clarify the mechanism(s) by which maternal mental health leads to

5. See Beata Napiorkowski et al., *Effects of in Utero Substance Exposure on Infant Neurobehavior*, 98 PEDIATRICS 71 (1996); Joan L. Luby et al., *Maternal Support in Early Childhood Predicts Larger Hippocampal Volumes at School Age*, 109 PROC. NAT'L ACAD. SCI. 2854 (2012); Torill S. Siveland et al., *Patterns of Mother-infant Interaction From 3 to 12 Months Among Dyads With Substance Abuse and Psychiatric Problems*, 37 INFANT BEHAV. & DEV. 772 (2014); Tiffany Field, *Postpartum Depression Effects on Early Interactions, Parenting, and Safety Practices: a Review*, 33 INFANT BEHAV. & DEV. 1 (2010); Anne Rifkin-Graboi, *Prenatal Maternal Depression Associates with Microstructure of Right Amygdala in Neonates at Birth*, 74 BIOLOGICAL PSYCHOL. 837 (2013); Catherine Lebel et al., *Prepartum and Postpartum Maternal Depressive Symptoms Are Related to Children's Brain Structure in Preschool*, 80 BIOLOGICAL PSYCHIATRY 859 (2016); Michael Rivkin et al., *Volumetric MRI Study of Brain in Children with Intrauterine Exposure to Cocaine, Alcohol, Tobacco, and Marijuana*, 121 PEDIATRICS 741 (2008).

6. Preterm delivery is defined as birth before the thirty-seventh week of pregnancy.

7. See Andreea A. Creanga et al., *Maternal Drug Use and Its Effect on Neonates: a Population-Based Study in Washington State*, 119 OBSTETRICS & GYNECOLOGY 924 (2012); Suezanne T. Orr et al., *Maternal Health Prior to Pregnancy and Preterm Birth Among Urban, Low Income Black Women in Baltimore: The Baltimore Preterm Birth Study*, 22 ETHNICITY & DISEASE 85 (2012).

8. See Tuija Männistö et al., *Maternal Psychiatric Disorders and Risk of Preterm Birth*, 26 ANNALS EPIDEMIOLOGY 14 (2016); Alexander Jarde et al., *Neonatal Outcomes in Women with Untreated Antenatal Depression Compared with Women Without Depression: A Systematic Review and Meta-analysis*, 73 JAMA PSYCHIATRY 826 (2016).

9. Joyce A. Martin et al., NAT'L CTR. HEALTH STAT., BIRTHS IN THE UNITED STATES 2016, NCHS DATA BRIEF NO. 287 (Sept. 2017), <https://www.cdc.gov/nchs/data/databriefs/db287.pdf> (finding African-American women are approximately fifty percent more likely to deliver preterm).

10. Suezanne T. Orr et al., *Maternal Prenatal Depressive Symptoms and Spontaneous Preterm Births Among African-American Women in Baltimore, Maryland*, 156 AM. J. EPIDEMIOLOGY 797 (2002).

preterm delivery. One obvious path linking maternal mental health to preterm delivery is poor adherence to prenatal care.¹¹ As depression is often manifested by a lack of self-care, poor appetite, and fatigue, it is not surprising that women suffering from depression may fail to attend prenatal medical visits and may not have adequate nutrition during pregnancy, thereby increasing the risk of preterm delivery.¹² Further, there's a significant relationship between mental health disorders during pregnancy and the use of illicit substances, which themselves increase the risk of preterm delivery.¹³ Additionally, there is a relationship between depression, anxiety, bipolar disorder and other negative pregnancy complications that heighten risk for preterm delivery including gestational hypertension and pre-eclampsia.¹⁴ Premature birth, which is once again increasing in the United States, affects approximately 400,000 newborns in this country each year, occurring in approximately ten percent of all births in 2016.¹⁵ Preterm birth remains a leading cause of neurological disabilities in children.¹⁶ Children born prematurely have a range of impairments including cognitive, motor, language and psychiatric impairments and unfortunately, a third of these children have impairments across multiple domains.¹⁷

11. H. G. Kim et al., *Antenatal Psychiatric Illness and Adequacy of Prenatal Care in an Ethnically Diverse Inner-city Obstetric Population*, 9 ARCHIVES WOMEN'S MENTAL HEALTH 103 (2006).

12. Shelia M. Marcus, *Depression During Pregnancy: Rates, Risks and Consequences*, 16 CAN. J. CLINICAL PHARMACOLOGY 15 (2009).

13. *Id.*

14. Tapio Kurki et al., *Depression and Anxiety in Early Pregnancy and Risk for Preeclampsia*, 95 OBSTETRICS & GYNECOLOGY 487 (2000) (studying effects of depression and anxiety); Fiona Judd et al., *Adverse Obstetric and Neonatal Outcomes in Women with Severe Mental Illness: To What Extent Can They Be Prevented?*, 157 SCHIZOPHRENIC RES. 305 (2014) (studying effects of schizophrenia and bipolar disorder).

15. Joyce A. Martin et. al., *Births: Final Data for 2016*, NAT'L VITAL STAT. REPS., Jan. 31, 2018, at 1, 8.

16. Michael K. Mwanikiki et al., *Long-term Neurodevelopmental Outcomes After Intrauterine and Neonatal Insults: A Systematic Review*, 379 LANCET 445 (2012).

17. See Peter Anderson & Lex W. Doyle, *Neurobehavioral Outcomes of School-age Children Born Extremely Low Birth Weight or Very Preterm in the 1990s*, 289 J. AM. MED. ASS'N 3264 (2003); Glen P. Aylward, *Cognitive and Neuropsychological Outcomes: More Than IQ Scores*, 8 MRDD RES. REV. 234 (2002); Samantha Johnson et al., *Psychiatric Disorders in Extremely Preterm Children: Longitudinal Finding at Age 11 Years in the EPICure Study*, 49 J. AM. ACAD. CHILD & ADOLESCENT PSYCHIATRY 453 (2010); Neil Marlow et al., *Neurologic and Developmental Disability at Six Years of Age After Extremely Preterm Birth*, 352 New Eng. J. Med. 9 (2005); Gerry H. Taylor et al., *Verbal*

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Preterm infants are a useful representative group to study when interested in how psychosocial risk impacts the developing brain because they are at an elevated risk for these psychosocial exposures. For instance, preterm infants are disproportionately born into socially disadvantaged families that have elevated rates of maternal depression, high parenting stress, and unsupportive maternal-child interactions.¹⁸ My colleagues and I have begun studying the impact of preterm birth and these other psychosocial risk factors on the developing brain in a cohort of preterm children enriched for social disadvantage. The infants we studied were born at less than thirty weeks gestational age. During their hospitalization in the neonatal intensive care unit (NICU) we obtained up to four magnetic resonance imaging (MRI) scans of their brains, as well as assessments of familial psychosocial risk factors like socioeconomic status, maternal stress and psychiatric symptoms.¹⁹ These children and their families returned at ages two and five for developmental follow-up

Memory Deficits in Children With Less Than 750g Birth Weight, 6 CHILD NEUROPSYCHOLOGY 49 (2000); L. J. Woodward et al., *Very Preterm Children Show Impairments Across Multiple Neurodevelopmental Domains by Age 4 Years*, 94 ARCH DISEASE CHILDHOOD FETAL NEONATAL ED. 339 (2009).

18. H. L. Brumberg & S. I. Shah, *Born Early and Born Poor: An Eco-bio-developmental Model for Poverty and Preterm Birth*, 8 J. NEONATAL-PERINATAL MED. 179 (2015) (noting high rate of preterm births among impoverished families); Tracy A. Manuck, *Racial and Ethnic Differences in Preterm Birth: A Complex, Multifactorial Problem*, 41 SEMINARS PERINATOLOGY 511 (2017) (linking poverty and preterm birth); *Prevalence of Self-Reported Postpartum Depressive Symptoms--17 states, 2004-2005*, MORBIDITY AND MORTALITY WKLY REP. (Apr. 11, 2008), <https://www.cdc.gov/mmwr/preview>

[/mmwrhtml/mm5714a1.htm?s_cid=mm5714a1_e](https://www.cdc.gov/mmwr/html/mm5714a1.htm?s_cid=mm5714a1_e) (linking postpartum depression and emotional stress); Margaret S. Miles et al., *Depressive Symptoms in Mothers of Prematurely Born Infants*, 28 J. DEVELOPMENTAL & BEHAV. PEDIATRICS 36 (2007) (linking depression and preterm birth); Lynn T. Singer et al., *Maternal Psychological Distress and Parenting Stress After the Birth of a Very Low-Birth-Weight Infant*, 281 J. AM. MED. ASS'N 799 (1999); Peter H. Gray et al., *Parenting Stress in Mothers of Very Preterm Infants - Influence of Development, Temperament and Maternal Depression*, 89 EARLY HUM. DEV. 625 (2013) (liking depression and preterm birth); Ruth Feldman, *Parent-infant Synchrony and the Construction of Shared Timing: Physiological Precursors, Developmental Outcomes, and Risk Conditions*, 48 J. CHILD PSYCHOL. & PSYCHIATRY 329 (2007) (linking stressful parental interactions); Caron A. C. Clark et al., *Development of Emotional and Behavioral Regulation in Children Born Extremely Preterm and Very Preterm: Biological and Social Influences*, 79 CHILD DEV. 1444 (2008) (linking poverty to various risks associated with preterm birth); Rosario Montirosso et al., *A Comparison of Dyadic Interactions and Coping with Still-face in Healthy Pre-term and Full-term Infants*, 28 BRIT. J. DEVELOPMENTAL PSYCHOL. 347 (2010) (comparing caregiver-infant dyad in full-term and pre-term births).

19. Cynthia E. Rogers et al., *Regional White Matter Development in Very Preterm Infants: Perinatal Predictors and Early Developmental Outcomes*, 79 PEDIATRIC RES. 87 (2015).

assessments. We also evaluated these familial psychosocial risk factors and observed parent-child interactions. The children will return at ages nine or ten for follow-up assessments and MRI scans.²⁰ This data collection will allow us to assess how prematurity affects early brain development and subsequent developmental outcomes in these children.

To understand how the developing brain may be impacted by these psychosocial factors, it is important to note the dramatic brain development that typically occurs *in utero* during the third trimester of pregnancy. There are several developmental processes that happen during this time, including neurons, the major brain cells, migrating to their programmed destinations and forming connections with each other that allow for information flow.²¹ Additionally, the brain not only grows in volume, but the cortex, the outer layer of the brain, also transitions from a very smooth to a complexly folded surface.²² Thus, preterm infants, particularly those born before thirty weeks gestation, experience this time of rapid and critical brain development outside of the womb rendering them particularly vulnerable to postnatal psychosocial stressors. These infants are also at greater risk for medical complications associated with preterm birth,²³ which may further heighten their vulnerability to additional stress. The cumulative impact that the psychosocial stressors can have on the developing brain over time can be even more considerable. This results in significant variability in the brain, and increased risk for the variety of developmental disorders that preterm children exhibit. Questions remain as to whether this variability in brain development of preterm infants predicts the outcomes that they have later in childhood and how susceptible their brains are to subsequent exposures to psychosocial risk factors.

A few studies we have conducted recently have been aimed at answering these questions by assessing early variability in brain development and relating this to early childhood outcomes. First, we measured how different areas of the brain's white matter, the parts of the

20. Rachel E. Lean et al., *Maternal Intelligence Quotient (IQ) Predicts IQ and Language in Very Preterm Children at Age 5 Years*, 59 J. CHILD PSYCHOL. PSYCHIATRY 150 (2017).

21. Irina Bystron et al., *Development of the Human Cerebral Cortex: Boulder Committee Revisited*, 9 NAT. REV. NEUROSCIENCE 110 (2008).

22. *Id.*

23. M.J. Platt, *Outcomes in Preterm Infants*, 128 PUB. HEALTH 399 (2014).

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neurons responsible for sending information to neighboring brain cells, mature during the NICU hospitalization.²⁴ Not only did we find, similar to other researchers,²⁵ that different regions of the brain develop at differential rates, but also that individual infants had varying trajectories of regional white matter development²⁶ Further, we also demonstrated that the measures of maturation of white matter of particular brain regions as neonates related to motor and social emotional development during early childhood.²⁷ We have also assessed how the function of particular brain regions and coordinated activity between brain regions varies and how that relates to later child development.²⁸ For example, preterm infants in our cohort demonstrated detectable differences in brain function in many regions compared to infants born full term.²⁹ We have also found that variability in regional brain function among these infants relates to their social-emotional development at age two, particularly to symptoms of anxiety.³⁰ We are seeing evidence that variability in neonatal brain development in these high-risk infant samples relates to how they are functioning later in childhood. Our work adds to the large body of literature indicating that prematurity, a known deleterious outcome of psychosocial risks experienced during pregnancy, can significantly alter the developing brain.

This line of research will enable continued examination of developmental outcomes at age five as well as help determine how longitudinal exposure to psychosocial risk factors interact with neonatal brain changes to potentially increase the risk of developmental

24. Rogers et al., *supra* note 19.

25. See e.g., Vann Chau et al., *Abnormal Brain Maturation in Preterm Neonates Associated with Adverse Developmental Outcomes*, 81 *NEUROLOGY* 2082 (2013); Susanne Brummelte et al., *Procedural Pain and Brain Development in Premature Newborns*, 71 *ANNALS NEUROLOGY* 385 (2012).

26. Karina J. Kersbergen et al., *Microstructural Brain Development Between 30 and 40 Weeks Corrected Age in a Longitudinal Cohort of Extremely Preterm Infants*, 103 *NEUROIMAGE* 214 (2014).

27. *Id.*

28. *Id.*

29. Cynthia E. Rogers et al., *Neonatal Amygdala Functional Connectivity at Rest in Healthy and Preterm Infants and Early Internalizing Symptoms*, 56 *J. AM. ACAD. CHILD ADOLESCENT PSYCHIATRY* 157 (2017); Christopher D. Smyser et al., *Resting-State Network Complexity and Magnitude Are Reduced in Prematurely Born Infants*, 26 *CEREBRAL CORTEX* 322 (2016).

30. Rogers et al., *supra* note 19; Chad M. Sylvester et al., *Cortical Functional Connectivity Evident After Birth and Behavioral Inhibition at Age 2*, 175 *AM. J. PSYCHIATRY* 180 (2017).

impairments. We also will be able to assess how psychosocial risk alters brain development across childhood.

As noted previously, the parent-child interaction is likely one key mechanism by which psychosocial stressors alter the trajectory of child brain development. Infants are highly dependent on their caregiver, not only to soothe their distress but also to learn whether this is a trusting world, if their caregiver is there to help and support them. If infants do not find that emotional support from their caregiver they are at higher risk for significant adverse development in social-emotional and cognitive development.³¹ The mental health of the caregiver is a crucial influence on how the caregiver will interact with their child. One of the most common and most studied mental health disorders in this context, postpartum depression, is unfortunately associated with impaired and dysfunctional maternal-infant interactions. Preterm infants once again represent an at risk group for this association as women who have infants that are born preterm or are in the NICU have a rate of postpartum depression that is about two to three times that of the general population.³² We also found in families from our research that forty percent of the mothers who had moderate to severe postpartum anxiety symptoms at the time they were taking their baby home from the NICU, which is higher than the published rates of postpartum anxiety in the general population.³³ The trauma experienced by parents in the NICU has been well-described, including in the lay press.³⁴ One can imagine that having your infant in the NICU for three to four months and being constantly in fear of whether or not your infant is going to survive is extremely traumatic.³⁵ Given the frequent, recurrent life-threatening events that often characterize a NICU

31. Rachel E. Lean et al., *supra* note 20; Laura Hubbs-Tait et al., *Relation of Maternal Cognitive Stimulation, Emotional Support, and Intrusive Behavior During Head Start to Children's Kindergarten Cognitive Abilities*, 73 CHILD DEV. 110 (2002).

32. Simon N. Vigod et al., *Prevalence and Risk Factors for Postpartum Depression Among Women with Preterm and Low-Birth-Weight Infants: A Systematic Review*, 117 BJOG INT'L J. OBSTETRICS & GYNAECOLOGY 540 (2010).

33. Cynthia E. Rogers et al., *Identifying Mothers of Very Preterm Infants At-Risk for Postpartum Depression and Anxiety Before Discharge*, 33 J. PERINATOL. 171 (2013).

34. See e.g., Laurie Tarkan, *For Parents on NICU, Trauma May Last*, N.Y. TIMES, (Aug. 24, 2009), <http://www.nytimes.com/2009/08/25/health/25trau.html>.

35. Alexandra Sawyer et al., *Providing Immediate Neonatal Care and Resuscitation at Birth Beside the Mother: Parents' Views, a Qualitative Study*, 5 BMJ OPEN 1 (2015).

hospitalization, it is not surprising that these parents can often end up with posttraumatic stress disorder symptoms both acutely and chronically for months after the hospital stay.³⁶ Approximately thirty-five percent of mothers and twenty-four percent of fathers experience Acute Stress Disorder days after infant hospitalization, with fifteen percent of these mothers and eight percent of these fathers having continuing Post Traumatic Stress Disorder symptoms.³⁷ Thus, preterm infants are exposed to caregivers with higher rates of several different mental health disorders.

The consequences of postpartum mental health symptoms like depression on maternal infant interactions can be pervasive. Mothers with postpartum depression have difficulty breastfeeding and are more likely to cease breastfeeding their infants much sooner than those not suffering from depression.³⁸ They are less affectionate and more hostile, and engage in less cooing, singing and reading to their infants, which can be critical for child language development.³⁹ Most concerning, mothers with postpartum depression are also at greater risk of abusing their infants.⁴⁰ The largest group of children that is a victim of child abuse is infants under the age of twelve months.⁴¹ Women with postpartum depression are not only at higher risk for physical child abuse but also for harsh punishment and having thoughts of harming their infant.⁴² Furthermore, preterm infants are more likely to experience these abusive behaviors, suggested by the fact that a significant proportion of infants in foster care

36. Michelle M. Greene et al., *Depressive, Anxious and Perinatal Post-Traumatic Distress in Mothers of Very Low Birth Weight Infants in the NICU*, 36 J. DEV. BEHAV. PEDIATRICS 362 (2015). See also Rogers et al., *supra* note 29.

37. Debra S. Lefkowitz et. al., *Prevalence and Correlates of Posttraumatic Stress and Postpartum Depression in Parents of Infants in the Neonatal Intensive Care Unit*, 17 J. CLINICAL PSYCHOL. MED. SETTINGS 230 (2010).

38. Claudia Castro Dias & Barbara Figueiredo, *Breastfeeding and Depression: A Systematic Review of the Literature*, 171 J. AFFECTIVE DISORDERS 142 (2015).

39. Field, *supra* note 5; L. A. Quevedo et al., *The Impact of Maternal Post-Partum Depression on the Language Development of Children at 12 Months*, 38 CHILD CARE HEALTH DEV. 420 (2012). Alan Stein et al., *The Influence of Maternal Depression, Caregiving, and Socioeconomic Status in the Post-Natal Year on Children's Language Development*, 34 CHILD CARE HEALTH DEV. 603 (2008).

40. Dominic T. Plant et al., *Maternal Depression During Pregnancy and Offspring Depression in Adulthood: Role of Child Maltreatment*, 207 BR. J. PSYCHIATRY 213 (2015).

41. U.S. DEPT. OF HEALTH & HUMAN SERV., ADMIN. FOR CHILDREN, YOUTH & FAMILIES, CHILD MALTREATMENT 2015 (2017).

42. Field, *supra* note 5; Kay Donahue Jennings et al., *Thoughts of Harming Infants in Depressed and Nondepressed Mothers*, 54 J. AFFECTIVE DISORDERS 21 (1999).

are born preterm.⁴³ Thus, with an elevated rate of child abuse as well as a greater frequency of mothers who have psychiatric disorders, these preterm infants, with a brain already vulnerable at birth, potentially endure additional adverse exposures to risks that further alter their brain development during later infancy.

While evidence supports that poor parental mental health disrupts parent-infant bonding in the NICU and early infancy, there is also a large body of research indicating that parental mental health across early childhood impacts parenting and multiple child developmental domains.⁴⁴ The dysfunctional parent-child interactions that occur beyond the early postpartum period likely impact these developmental outcomes, as there are still significant changes that happen within the developing brain during the first few years of life. For example, while the brain at birth is twenty-five percent of the volume of an adult brain, by age one the brain is seventy percent the size of adult size and by age two it is eighty percent the size of an adult brain.⁴⁵ There are several different processes that occur during this time period that are responsible for this rapid change, including further growth and connections between neurons, refinement of brain circuits, and more myelination (insulation) of axons to facilitate faster information transfer.⁴⁶ When infants are exposed to significant stressors during a time of such tremendous transformation, very deleterious effects on their brain, cognitive, and social-emotional development may result.⁴⁷

Given that there is substantial research highlighting the impact of

43. SHERYL DICKER & ELYSA GORDON, ZERO TO THREE POL'Y CTR., ENSURING THE HEALTHY DEVELOPMENT OF INFANTS IN FOSTER CARE: A GUIDE FOR JUDGES, ADVOCATES AND CHILD WELFARE PROFESSIONALS (2004) (finding forty percent of infants in foster care are born preterm).

44. S. Dubber et al., *Postpartum Bonding: The Role of Perinatal Depression, Anxiety and Maternal-Fetal Bonding During Pregnancy*, 18 ARCHIVES WOMENS MENTAL HEALTH 187 (2015); M. Christine Lovejoy et al., *Maternal Depression and Parenting Behavior: A Meta-Analytic Review*, 20 CLINICAL PSYCHOL. REV. 561 (2000); Field, *supra* note 5; Susan B. Campbell et al., *The Course of Maternal Depressive Symptoms and Maternal Sensitivity as Predictors of Attachment Security at 36 Months*, 16 DEV. PSYCHOPATHOLOGY 231 (2004); Sherryl H. Goodman & Ian H. Gotlib, *Risk for Psychopathology in the Children of Depressed Mothers: A Developmental Model for Understanding Mechanisms of Transmission*, 106 PSYCHOL. REV. 458 (1999); S. L. Grace, *The Effect of Postpartum Depression on Child Cognitive Development and Behavior: A Review and Critical Analysis of the Literature*, 6 ARCHIVES WOMEN'S MENTAL HEALTH 263 (2003).

45. Knickmeyer et al., *supra* note 3.

46. Joan Stiles & Terry L. Jernigan, *The Basics of Brain Development*, 20 NEUROPSYCHOLOGY REV. 327 (2010).

47. *See supra* note 1 and accompanying text.

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preterm birth and other psychosocial risks, particularly parental mental health, on the developing brain and child outcomes, supporting effective interventions targeted at improving parental mental health is critical to optimizing early brain development. In fact, lines of research exist supporting the positive role of these interventions on parental functioning and early parent-child interactions.⁴⁸ At Washington University School of Medicine, we established the Perinatal Behavioral Health Service (hereinafter “the Service”) with the goal to improve maternal mental health and thereby optimize child outcomes.⁴⁹ The staff of the Service conduct mental health screenings on pregnant and postpartum women for perinatal mental health disorders in outpatient and inpatient settings. One of the Service’s primary clinical areas is our local NICU where staff are embedded within the NICU, which allows for close collaboration between our staff and the physicians, nurses, and social workers who serve these families. The Service also provides education about perinatal mental health disorders to women with infants in the NICU, not only about the symptoms that they may or may not be experiencing but also describing coping techniques that they can utilize even before symptoms develop. For women with psychosocial needs, the Service coordinates referrals for substance abuse treatment, nurse home visitation, parent education, legal services, and other social service agencies. Additionally, the Service has incorporated mental health treatment provided to women in other areas of our medical center. It offers psychiatric care in its perinatal behavioral health clinic and also has co-located psychotherapy counseling within the NICU setting so those mothers do not have to leave the medical center for treatment. The Service has similarly incorporated treatment in other outpatient settings for pregnant and postpartum women.

With a staff of psychiatrists, psychologists, licensed professional

48. Ruth Feldman et. al., *Comparison of Skin-to-Skin (Kangaroo) and Traditional Care: Parenting Outcomes and Preterm Infant Development*, 110 *Pediatrics* 16 (2002); Diane Holditch-Davis et al., *Maternally Administered Interventions for Preterm Infants in the NICU: Effects on Maternal Psychological Distress and Mother-Infant Relationship*, 37 *INFANT BEHAV. & DEV.* 695 (2014); Bernadette Mazurek Melnyk et al., *Reducing Premature Infants’ Length of Stay and Improving Parents’ Mental Health Outcomes with the Creating Opportunities for Parent Empowerment (COPE) Neonatal Intensive Care Unit Program: A Randomized Controlled Trial*, 118 *PEDIATRICS* 1414 (2006); Richard J. Shaw et al., *Prevention of Traumatic Stress in Mothers With Preterm Infants: A Randomized Controlled Trial*, 132 *PEDIATRICS* e886, e886 (2013).

49. PERINATAL BEHAV. HEALTH SERV., pbhs.wustl.edu (last visited April 13, 2018).

counselors and social workers, this clinical program is able to provide comprehensive mental health care for the parents of high-risk infants. Over the last five years we have screened over 1200 women. About 400 of those women had clinically-elevated levels of depression and anxiety. This represents approximately twice the rate typically reported in the general population, which is likely attributable to the demographics at our medical center including more high-risk women.⁵⁰ We have also made hundreds of referrals to outside agencies to provide care closer to home for our families that are from more remote locations. Over 200 women have been treated by our psychiatrists and/or therapists, and among those that are engaged in treatment with our service, a clinically significant reduction in their depression symptoms ranging from thirty to forty percent was detected. We believe providing these treatment services in an accessible way through co-location with a multidisciplinary team will enable the Service to provide more care to those populations with the greatest psychosocial risk.

While our own research into the impact of the Perinatal Behavioral Health Service is ongoing, others have engaged in research evaluating what impact these types of interventions have on infant brain development. For instance, the Family Nurture Intervention embedded nurses in the NICU who were providing similar strategies by assisting women in methods that would enable them to feel more connected to their infants, ultimately reducing symptoms of depression and anxiety.⁵¹ This intervention demonstrated that at the time of discharge from NICU, the women that had been randomized to the intervention compared to mothers who did not receive it were displaying more sensitive parenting with their infants, and when evaluated four months later displayed fewer symptoms of anxiety and depression.⁵² While the research into the impact on neonatal brain development of these interventions is a bit sparse, what exists indicates that these methods may lead to more optimal brain development.

50. Jean Y. Ko et al., CTR. FOR DISEASE CONTROL & PREVENTION, *Trends in Postpartum Depressive Symptoms — 27 States, 2004, 2008, and 2012*, 66 MORBIDITY AND MORTALITY WKLY REP. 153 (2017).

51. Martha G. Welch et al., *Depression and Anxiety Symptoms of Mothers of Preterm Infants Are Decreased at 4 Months Corrected Age with Family Nurture Intervention in the NICU*, 19 ARCHIVES WOMENS, MENTAL HEALTH 51 (2015).

52. *Id.*

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One intervention that evaluated early parent-infant interactions, found that just eight weeks of skin-to-skin care, which involves placing the naked infant directly on the caregivers chest, increased a measure of preterm infants' brain activity to more closely resemble that of term infants.⁵³ The Family Nurse Intervention noted above also assessed brain activity and measured it over the course of several weeks. This study found that those preterm children in the family nurse intervention group had improved brain activity over time compared to those preterm children whose families did not receive the intervention.⁵⁴ Importantly, they also reported that, at eighteen months of age, the preterm infants who were in the intervention group had improved cognitive skills, fewer attention problems and had a lower risk of autism symptoms.⁵⁵ Overall, these studies point to what benefits these kinds of interventions targeting maternal depression, anxiety and parenting styles can have on later infant brain development. More research is needed to replicate this finding and determine which aspects of this type of intervention are most impactful.

As we have evidence that treatment interventions can have a positive impact on maternal mental health, and we have evidence that these interventions may be positively influencing the neonatal brain, we must encourage policies that promote these interventions. If we cannot improve access to this care by trained mental health providers when it is needed, we cannot deliver these interventions and ultimately promote optimal infant brain development. One of the policy issues that is complicating the ability to deliver mental health treatment to these mothers of at-risk infants is access to postpartum health insurance coverage, particularly in states without Medicaid expansion. For example, pregnant women with incomes up to 201 percent of the poverty line qualify for Medicaid in Missouri, which is three percent of all the Medicaid recipients.⁵⁶ In 2014, coverage

53. F. Kaffashi et al., *An Analysis of the Kangaroo Care Intervention Using Neonatal EEG Complexity: A Preliminary Study*, 124 CLINICAL NEUROPHYSIOLOGY 238 (2013).

54. Martha G. Welch et al., *Family Nurture Intervention in Preterm Infants Increases Early Development of Cortical Activity and Independence of Regional Power Trajectories*, 106 ACTA PAEDIATRICA 1952 (2017).

55. Martha G. Welch et al., *Family Nurture Intervention in the Neonatal Intensive Care Unit Improves Social-Relatedness, Attention, and Neurodevelopment of Preterm Infants at 18 Months in a Randomized Controlled Trial*, 56 J. CHILD PSYCHOL. & PSYCHIATRY 1202 (2015).

56. Alexandra Dansicker, *Missouri Medicaid Basics*, MO. FOUND. FOR HEALTH (Spring 2017), <https://mffh.org/wordpress/wp-content/uploads/2017/03/MedicaidBasics2017.pdf>.

was expanded to cover those with incomes at a higher percent of the Federal poverty level.⁵⁷ Nevertheless, the challenge to treatment delivery is that this Medicaid for pregnant women only includes sixty days of postpartum insurance coverage. Nationally, especially in states that did not expand Medicaid, over fifty percent of women lose their coverage at sixty days postpartum and in some states that is as high as seventy percent.⁵⁸ This loss of coverage means these women have no mental health insurance benefits and no benefits for substance abuse treatment at a time when this coverage is crucial to improve maternal and infant outcomes. The major risk of perinatal mental health disorders is suicide, particularly for those with postpartum depression and bipolar disorder, and, as the American College of Obstetrics and Gynecology indicates, maternal suicide exceeds the other common causes of maternal mortality, such as hemorrhage and preeclampsia, in terms of the overall risk of mortality for women.⁵⁹ Further, evidence suggests that the risk of suicide is highest in the late postpartum period, beyond six weeks, at a time when these women are losing their healthcare coverage.⁶⁰ Thus, there has been increasing advocacy by interested stakeholders to expand this postpartum coverage for women beyond sixty days so that we can continue to provide care to these women when they most need it, and when both they and their infants are at greater risk for the deleterious effects of these disorders.⁶¹

It will take advocacy and collaboration like this across multiple disciplines to address the needs of these at-risk families. The evidence strongly suggests that maternal mental health is a critical psychosocial

57. *Id.*

58. Kay Johnson, *Addressing Women's Health Needs and Improving Birth Outcomes: Results from a Peer-to-Peer State Medicaid Learning Project*, 21 THE COMMONWEALTH FUND 1 (2012).

59. Committee Opinion No. 630, *Screening for Perinatal Depression*, in THE AM. COLLEGE OF OBSTETRICIANS & GYNECOLOGISTS, COMMITTEE ON OBSTETRIC PRAC., 2, 1-4 (Feb. 2010).

60. Maeve E. Wallace et al., *Pregnancy-Associated Homicide and Suicide in 37 US States with Enhanced Pregnancy Surveillance*, 215 AM. J. OBSTETRICS & GYNECOLOGY 364.e1 (2016).

61. *See e.g.*, MARCH OF DIMES, MOVING MISSOURI TO ACTION ADDRESSING MATERNAL BEHAVIORAL HEALTH (June 2016). The March of Dimes in the state of Missouri has been one of these advocates, and our Perinatal Behavioral Health Service was engaged as one of the many stakeholders working together to deliver strategies to increase access to care. The March of Dimes in Missouri reported being alarmed by the statistics that of the one in seven moms that had these symptoms, only fifteen percent were receiving treatment. The March of Dimes partners with other allies like the American College of Obstetrics and Gynecology to promote legislation that will increase access to treatment and to raise awareness and support needed to increase screening and treatment. *Id.*

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stressor impacting the developing brain, and that those born preterm are particularly vulnerable. Efforts aimed at addressing psychosocial risk factors prenatally and prior to conception would have an immense impact on reducing the risk not only for preterm birth but also in the adverse exposures to these risks that happen after birth. There are evidence-based interventions available that can optimize maternal mental health both before and after birth to mitigate risk and optimize brain development. Effective utilization of these interventions will require changes in policy that will enable increased access to care for our highest risk families.