



Published in final edited form as:

J Perinatol. 2013 August ; 33(8): 636–641. doi:10.1038/jp.2013.4.

Parental Presence and Holding in the Neonatal Intensive Care Unit and Associations with Early Neurobehavior

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Abstract

Objective—To investigate the effects of parental presence and infant holding in the NICU on neurobehavior at term equivalent.

Study Design—Prospective cohort enrolled 81 infants born <30 weeks gestation. Nurses tracked parent visitation, holding, and skin-to-skin care throughout the NICU hospitalization. At term, the NICU Network Neurobehavioral Scale was administered. Associations between visitation, holding, and early neurobehavior were determined using linear and logistic regression.

Results—The mean hours/week of parent visitation was 21.33±20.88 (median= 13.90; interquartile range 10.10–23.60). Infants were held an average of 2.29±1.47 days/week (median= 2.00; interquartile range 1.20–3.10). Over the admission, visitation hours decreased ($p=0.01$), while holding frequencies increased ($p<0.001$). More visitation was associated with better quality of movement ($p=0.02$), less arousal ($p=0.01$), less excitability ($p=0.03$), more lethargy ($p=0.01$) and more hypotonia ($p<0.01$). More holding was associated with improved quality of movement ($p<0.01$), less stress ($p<0.01$), less arousal ($p=0.04$) and less excitability ($p<0.01$).

Interpretation—Infants of caregivers who were visited and held more often in the NICU had differences in early neurobehavior by term equivalent, which supports increased early parenting in the NICU.

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There are no conflicts of interest to report.

Keywords

Parenting; holding; visitation; premature infant; NICU Network Neurobehavioral Scale (NNS); development; caregiver; skin-to-skin; interaction; attachment

INTRODUCTION

Managing the medical and developmental complications associated with preterm birth is an important public health concern, as approximately 50% of children born very preterm experience a disability (1). Due to the high rates of developmental consequences among prematurely born children, attention is shifting to modifiable aspects of the neonatal intensive care unit (NICU) environment which could optimize developmental outcome (2).

Parenting behavior is believed to be an important mediator between biological risk and developmental outcome. Although the benefits of early parenting can be appreciated, difficulties within the early parent-child relationship have been reported among premature infants. Many parents cope with the enormous stress of premature birth through emotional and sometimes even physical withdrawal, which may be a reflection of anxiety, exhaustion, anger, guilt, or depression (3). Failing to visit and bond with their child interferes with the early attachment process between parent and infant. Low frequency visits between parents and their hospitalized premature infants have been associated with suboptimal outcomes like child abuse and abandonment (4) and adverse emotional functioning (5).

There is a paucity of studies that have investigated visitation trends among parents of premature infants during NICU hospitalization. Because of a new focus on parent empowerment and developmental care in the NICU, visitation frequency is higher now compared to twenty years ago (5–9). European studies have reported that the majority of parents visit almost every day throughout the hospitalization (5–6, 10), and that parent visitation less than every day is a marker for adverse behavioral outcomes (10). However, studies regarding visitation practices in other countries cannot be generalized to the United States, as our culture, demographic make-up, and social policies are not comparable and inevitably lead to differences in parenting practices. One study described visitation practices in the United States, indicating that parents visited 78% of the infant's hospitalization. However, the benefits of parental presence in the NICU, or more importantly the detrimental effects of its absence, remain unclear.

One study investigated the effect of NICU single family rooms, requiring parents to visit 24 hours a day, and concluded that infants demonstrated fewer days of hospitalization when parents were required to stay from admission until discharge (11). While the theoretical benefits of parent involvement in the NICU are compelling, no research to our knowledge has investigated the effect of visitation and holding on early neurobehavior of preterm infants. The objective of the current study was to investigate the effects of parents' visitation and holding frequencies on infant development in the neonatal period.

METHODS

This investigation was a prospective longitudinal cohort study of naturally-occurring parental practices. Study participants were infants born <30 weeks gestation. Infants were enrolled within the first three days of life. Infants with known congenital anomalies and those expected to expire within the first day of life were excluded. This study was approved by the Human Research Protection Office at the study site. The study included serial neuro-imaging and serial neurobehavioral testing during hospitalization.

The study NICU is a 75-bed Level III unit, contained within a 275-bed free-standing children's hospital. It consists of 38 open-bay beds and 36 single-patient rooms, which are assigned by bed and nursing availability. Policies allow for parent visitation 24 hours per day. Visitors are restricted to 2 at the infant bedside. Nurses are available to teach parents basic care tasks, and parents are also provided information about how to interact with their infant in a responsive and developmentally appropriate way. Parents are encouraged to hold their infants when the infant is able to tolerate it, without physiological compromise. This includes holding while intubated, but often does not include time when the infant has physiological fluctuations, is on oscillatory ventilation or has chest tubes in place. Siblings older than 2 years of age are permitted to visit in the NICU.

Visitation and Holding

Recording sheets were delivered to the bedside upon enrollment. A modified version of the Neonatal Infant Stressor Scale (12) was used for all infants admitted to the study. Space was available for nurses to denote who visited and for how long. Holding factors added for documentation include "Infant Received Cuddle" (traditional holding) and "Infant Received Kangaroo Care" (skin-to-skin holding). Nurses recorded visitation and holding factors during each shift from the infant's birth until term equivalent. The completed daily logs were supplemented by documentation in the medical record. When discrepancies occurred, the largest amount of visitation and holding documented in either place was recorded for a given shift.

In order to investigate trends over the hospitalization, data was grouped in accordance with specific timeframes. The average number of hours visited per week over the first two weeks of life, the third and fourth weeks of life, and the fifth week of life through term equivalent (37 weeks estimated gestational age) were calculated. In addition, a summary score representing the average number of hours visited per week from birth through term equivalent was calculated. The average number of days per week that the infant received either traditional holding or skin-to-skin care was calculated over the same timeframes, separately.

Neurobehavioral Assessment

The NICU Network Neurobehavioral Assessment Scale (NNNS) was administered and scored by an occupational therapist certified in its use to provide an assessment of neurological integrity, behavioral functioning, and response to stressors (13). Thirteen summary scores are derived from the NNNS, including habituation, tolerance of handling,

quality of movement, self-regulation skills, non-optimal reflexes, stress signs, arousal, hypertonia, hypotonia, asymmetry, excitability, lethargy, and orientation. Each is a continuous variable on its own scale, and higher scores indicate “more” of the respective construct being present. Each of the summary scores was used as a dependent variable.

Potential Confounders

Several factors affecting developmental outcome were collected and analyzed for potential relationships with neurobehavior. Initial perinatal medical severity score, called the Critical Risk Index for Babies Score (CRIB)(14), was taken from the infant’s medical record. Estimated gestational age at birth, gender, and race were collected, as well as in-utero drug exposure based on maternal toxicology screening at delivery. Additionally, maternal age, marital status, and insurance status (to reflect socioeconomic status) were collected from a questionnaire filled out upon the infant’s discharge. The following additional variables were collected at discharge as other medical or social factors which might have been related to early neurobehavior: number of days the infant was ventilated, number of days on continuous positive airway pressure, whether the infant had sepsis, presence of necrotizing enterocolitis or patent ductus arteriosus, and use of postnatal steroids. Finally infants underwent routine cranial ultrasound at one week and one month of life in addition to magnetic resonance imaging at term equivalent age. Results were interpreted by a single, trained neuroradiologist. Cerebral injury was dichotomized into no significant injury or moderate to severe brain injury, which was defined as any cerebellar hemorrhage, grades 3–4 intraventricular hemorrhage or cystic periventricular leukomalacia. All perinatal and demographic variables were investigated for associations with the independent and dependent variables. To best isolate the effects of parent visitation and holding, those that reached significance ($p < .05$) were further investigated for co-linearity and controlled for in the statistical model. Other variables known to predict function were also included in the model (15–17).

Statistical Analysis

Analyses were conducted using Predictive Analytic SoftWare 18.0. Nonparametrics, via a Wilcoxon Signed Rank test, were used to investigate the association between visitation and holding. Univariate regression analyses were used to investigate the associations between parent visitation and holding on neurobehavioral outcome measures. Multivariate regression analyses were conducted to isolate the effect of parent presence and holding, while controlling for race, cerebral injury, postnatal steroid use, and days of ventilation.

RESULTS

One hundred and twenty infants were recruited for this study. Of those, 16 infants expired prior to NICU discharge, six withdrew, one was transferred to another NICU prior to term equivalence, one was later determined to have a congenital anomaly, and 15 were missing outcome variables. The characteristics of the eighty-one infants represented in the study are summarized in Table 1.

Visitation

Average weekly hours of visitation over the length of stay ranged from 1.80 to 104.07 hours. The mean hours/week of parent visitation was 21.33 ± 20.88 (median= 13.90; interquartile range 10.10–23.60). The distribution of visitation hours by specific time periods within the NICU hospitalization is shown in Table 2 and Figure 1. Visitation hours in the first two weeks was higher than in weeks three and four ($p=0.01$), or from week five through term equivalent age ($p=0.01$). There were no differences between visitation patterns in weeks three and four compared to week five through term equivalent. See Table 3 for associations between parent visitation and neurobehavioral outcome.

Holding

The frequency of holding varied, with average days held per week from birth to term equivalent ranging from 0 to 5.91 days per week (Figure 1). Infants were held an average of 2.29 ± 1.47 days/week (median= 2.00; interquartile range 1.20–3.10) over the length of NICU hospitalization. An increase in number of holds per week was observed as the hospitalization progressed. Thus, infants were less likely to be held in weeks one and two than in weeks three and four ($p<0.01$), or from week five through term equivalent age ($p<0.001$), and between weeks three and four and the rest of the hospitalization ($p<0.001$). See Table 4 for associations between holding and neurobehavioral outcome.

Skin-to-Skin

Skin-to-skin holding was implemented less frequently in our study (Figure 1) with an average number of days per week of skin-to-skin holding being 0.71 ± 0.94 (median= 0.3, interquartile range= 0.10 to 0.90). See Table 2 for data on skin-to-skin rates across hospitalization. There were no significant differences in skin-to-skin holding in weeks 1 to 2, compared to week 3 and 4 ($p=.28$). Significant declines in skin-to-skin were observed from week 3 and 4, compared to week 5 through term equivalent ($p<.01$). See table 5 for associations between skin-to-skin and neurobehavioral outcome.

DISCUSSION

There were two key findings of this study. First, while some infants were visited almost every day, the majority of infants in our study were visited five or fewer days per week during their hospitalization. Second, parent visitation and holding in the NICU had important associations with early neurobehavior in the preterm infant by NICU discharge.

The current study reveals great variation in parent visitation and holding practices. Compared to studies out of Finland (5, 10) and Great Britain (6), in which three-fourths of parents visited every day, the current study showed that less than one-third of the sample was visited six or more days per week. Furthermore, a significant decrease in parent presence was seen as hospitalization progressed. Other studies have also identified higher visitation frequencies during shorter hospitalizations (5, 10). One study in Ohio reported that parents visited 78% of the time that their infants were hospitalized (18). Our rates of visitation (median of 14 hours) are much lower, representing 5% of the time the infant is hospitalized. While parent visitation decreased as the duration of hospitalization increased,

traditional holding frequencies increased. Skin-to-skin care, on the other hand, peaked in the 3rd and 4th week of hospitalization, and then declined. The rates of skin-to-skin (median 0.3 days per week) are significantly lower in this study compared to other reports, which have reported skin-to-skin 24 hour per day 7 days per week in low income settings (19) and for an average of 2 times per week over a 9 week period in an American level III NICU (18). The decline in skin-to-skin care in the final weeks of NICU hospitalization observed in this study have been previously reported (18).

Despite challenges, the importance of parent presence during hospitalization cannot be overemphasized. Research has demonstrated that failure to form an attachment during the first days and months of life and low visitation during hospitalization lead to an increased risk of poor outcome (4, 20). The findings of our study further support the need for parents to be present in the NICU and to engage in the care of their infant due to the defined neurobehavioral differences that exist among infants visited and held more often.

Our study demonstrated that greater visitation and higher holding frequencies were associated with motor patterns of better quality of movements, less hypertonia and more hypotonia. The summary score for quality of movement reflects the smoothness, maturity, and modulation of arm and leg movements, as well as the number of startles and tremors the infant displayed during testing. Higher scores indicate better quality of movement demonstrated by fewer tremors, smooth and fluid movements and average or expected amounts of spontaneous and elicited motor activity (21). High visitation and cuddling frequencies were associated with higher quality of movement scores in the current study.

There were significant associations between visitation and holding and infant tone. More skin-to-skin holding and greater visitation hours were associated with less hypertonia and more hypotonia, respectively. Hypertonia can interfere with the acquisition of movement, inhibit reflexes, and interfere with overall gross motor and fine motor development (22). Hypertonicity has been associated with negative environmental circumstances like intrauterine cocaine (13) and opioid (23) exposure. While both skin-to-skin holding and increased visitation were associated with decreased hypertonia scores, interestingly, visitation was also associated with more hypotonia throughout the arms, legs, and trunk. It is possible that increased stimulation from parents visiting and holding can result in fatigue and infant shut down with associated hypotonia related to state, but it also could indicate that infants who are visited and held more frequently are more relaxed, content and fluid. This finding warrants further investigation, and following up this cohort to document neurodevelopmental outcomes is important.

There were also important associations between visitation and holding with social interaction. Infant holding was associated with less infant stress. High stress scores indicate infant overload (20). Stress may outwardly manifest in color changes, dangerous physiological fluctuations, or facial grimacing. Minimizing infant stress is an important healthcare goal, as an infant being able to modulate their stress level and tolerate the demands of the environment is an important developmental milestone. Holding was also associated with less excitability, which can aid the infant in maintaining the proper state for

movement and interaction. This study provides support for infant holding as a technique which might facilitate modulation of a premature infant's bodily system.

High visitation was associated with lower levels of arousal. Arousal reflects how quickly an infant became irritable upon handling, as well as his or her overall activity level throughout the exam. Higher scores indicate that an infant predominantly fussed and cried during the exam. Lower arousal scores suggest that an infant was calmer when being handled (21). High visitation and holding frequencies were also associated with lower excitability scores. Excitability is a quantification of motor, state, and physiological reactivity (21). Similar to the arousal subscale, it also takes into account how irritable the infant became upon handling. However, excitability includes associated changes in motor activity and physiology, such as color changes or tremors. Further, the infant's response to soothing tactics is considered. Infants with high excitability become very irritated and remain so despite attempts to calm them. Those infants with low excitability scores are less irritable and have fewer state changes and startles (21). Our interaction-related findings, taken together, present a picture of a calmer, more relaxed infant.

In a recent study, Liu and associates (24) categorized infants into behavioral profiles based on the collective picture provided by the infants' NNNS scores. They described those infants with the least optimal conditions as being highly aroused, excitable, and hypertonic, with poor quality of movements and high stress levels. The predictive ability of this developmental profile was supported by strong associations with suboptimal development. Infants in this category had suboptimal Bayley Mental Developmental Index scores at ages one and two years; poorer behavioral regulation at age three; poorer school readiness at age four; and lower cognitive scores than those categorized in other groups at age four and a half. In the current study, those infants who were visited and held more often demonstrated the opposite profile of that which strongly predicted suboptimal outcome by Liu: highly visited and held infants displayed lower arousal and excitability, had better quality of movement, and were less hypertonic and stressed.

The limitations of our study include potential charting inconsistencies among the nursing staff and a failure of the current study to measure the quality of parent-child interactions. In addition, our study lacked norms for comparison of our sample's neurobehavioral performance. Although the NNNS has norms based on healthy full-term infants (25), the research community lacks norms for healthy preterm infants, the development of which would improve the diagnostic usefulness of the exam with the preterm population.

The associations between parent presence and holding in the NICU and differences in outcome as early as term equivalent are reported here for the first time. However, more research on this important area is indicated. Identifying predictors of parent visitation and holding will allow for targeted social interventions that enable parents to overcome barriers associated with interaction in the complex NICU environment. Future studies may benefit from collecting parent visitation practices electronically to reduce variability in nursing documentation; using a quantification system to record the appropriateness of parent-infant interactions; and investigating the trajectory of neurobehavioral change in association with parenting behaviors via serial developmental investigations.

Conclusion

The current study contributes knowledge about preterm infant development and early environmental influences. This study demonstrated that there may be significant benefits of early visitation and holding on the neurobehavior of preterm infants. Visitation and holding may be easily implemented interventions that promote healthy attachment and give preterm infants a developmental advantage. This study provides support for the development of evidence-based social interventions to enable premature infants to undergo optimal neurodevelopmental outcomes.

Acknowledgments

This project was supported by the National Institute of Health (ROI HD 057098), the Doris Duke Charitable Foundation, and the Washington University Intellectual and Developmental Disabilities Research Center.

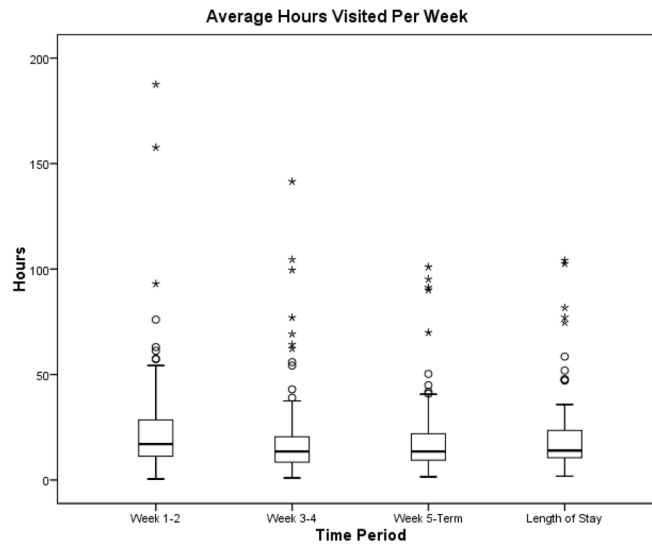
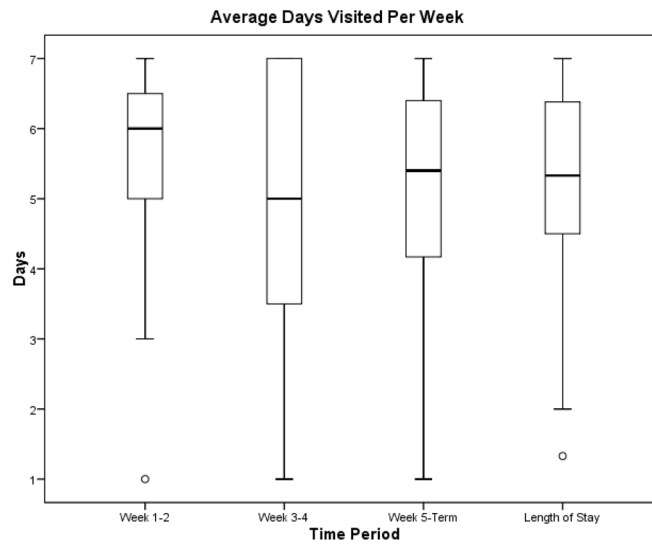
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What This Paper Adds

- While parenting has been linked to developmental outcome, this study investigated the importance of parenting prior to term equivalent in preterm infants.
- Visitation and holding are associated with more mature and fluid motor skills, as well as a calmer, more predictable affect.
- Visitation and holding may be interventions that promote healthy attachment and improve early neurobehavior.



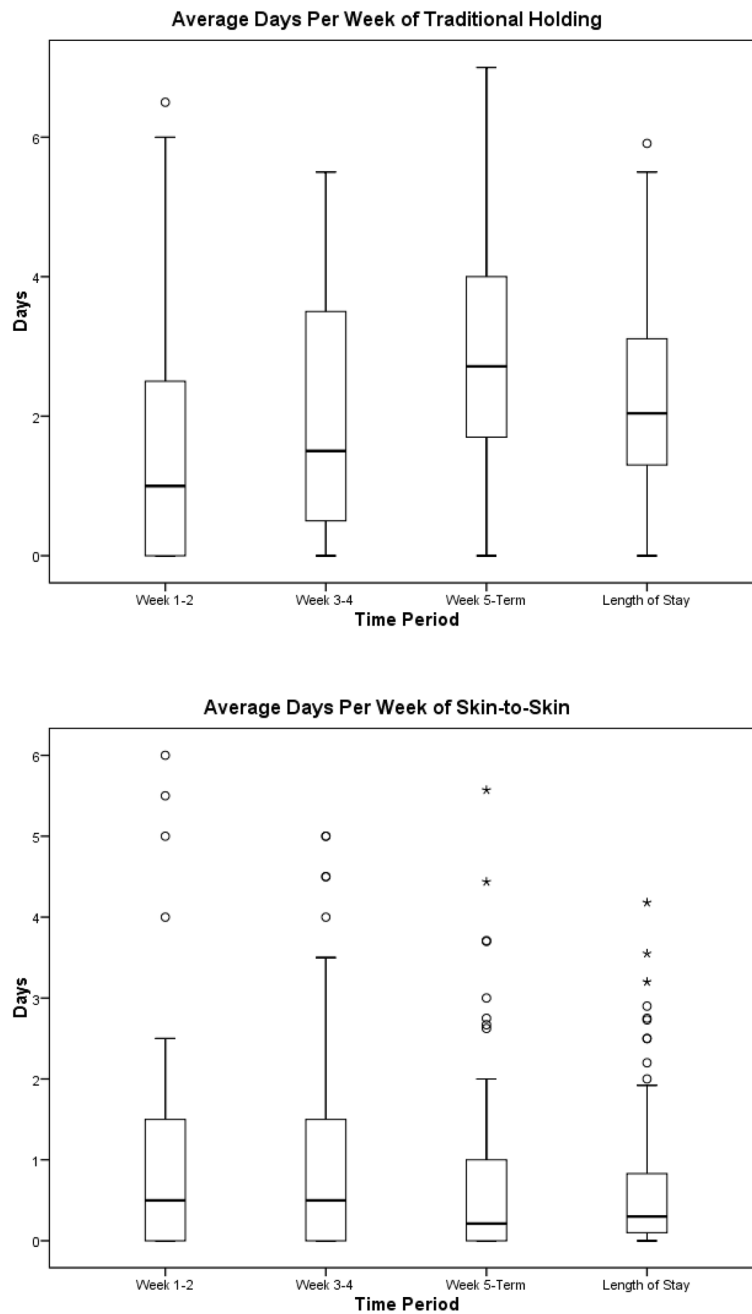


Figure 1. Patterns of Visitation and Holding Across the Length of Stay
 Note: TE=Term equivalent age. The first time point in each plot represents the first two weeks of life; the second time point in each plot represents weeks three and four of life; the third time point represents week five through term-equivalent age; and the final time point represents a summary of what occurred from birth through term-equivalent.

Table 1

Characteristics of the Cohort

Continuous Factors	Mean Or Median	Standard Deviation or Interquartile Range	Range
Gestational Age at Birth	26.6	1.9	23–30
Critical Risk Index for Babies	4.00	3.64	0–14
Length of Stay (Days)	90	32	21–235
Intubation Hours	48	24–504	0–5088
CPAP Hours ¹	72	24–216	0–1632
Total Oxygenation Hours	1512	889–2088	103–5640
Maternal Age	28	8	16–47
Prenatal Care Visits	4.8	2.7	0–10

Categorical Factors	n (%)
Female Gender	41 (51%)
Caucasian Race	39 (48%)
Moderate to Severe Brain Injury	13 (17%)
Use of Postnatal Steroids	25 (31%)
Sepsis	24 (30%)
Patent Ductus Arteriosus	45 (56%)
Necrotizing Enterocolitis	9 (11%)
Married Parents	29 (36%)
Public Insurance Type	40 (70%)
Maternal Drug or Alcohol Use in Pregnancy	9 (11%)

Note. Moderate to severe cerebral injury are defined as any cerebellar hemorrhage, grades 3–4 intraventricular hemorrhage or cystic periventricular leukomalacia

Table 2

Descriptives of independent variables: Patterns of visitation and holding.

	Minimum	Maximum	Mean	Std. Deviation	Median	Interquartile Range
Hours Visited Week 1-2 ¹	0.50	187.50	26.20	29.40	17.00	11.10-28.60
Hours Visited Week 3-4 ¹	1.00	141.50	21.26	24.60	13.50	8.40-20.80
Hours Visited Week 5-Term ¹	1.50	101.00	20.15	20.81	13.50	9.30-22.50
Hours Visited Birth-Term ¹	1.80	104.07	21.33	20.88	13.90	10.10-23.60
Days Visited Week 1-2 ²	1.00	007.00	05.68	01.25	6.00	5.00-6.80
Days Visited Week 3-4 ²	1.00	007.00	05.07	01.64	5.00	3.50-7.00
Days Visited Week 5-Term ²	1.00	007.00	05.08	01.57	5.40	4.20-6.50
Days Visited Birth-Term ²	1.33	7.00	5.24	1.35	5.33	4.30-6.40
Days Cuddled Week 1-2 ³	0.00	006.50	01.60	01.67	1.001.00	0.00-2.60
Days Cuddled Week 3-4 ³	0.00	005.50	02.12	01.75	1.50	0.50-3.50
Days Cuddled Week 5-Term ³	0.00	007.00	02.93	01.68	2.67	1.60-3.90
Days Cuddled Birth-Term ³	0.00	5.91	2.29	1.47	2.00	1.20-3.10
Skin-to-skin Days Week 1-2 ⁴	0.00	006.00	00.94	01.27	0.50	0.00-1.50
Skin-to-skin Days Week 3-4 ⁴	0.00	005.00	01.10	01.38	0.50	0.00-1.50
Skin-to-skin Days Week 5-Term ⁴	0.00	005.57	00.72	01.13	0.21	0.00-1.00
Skin-to-skin Days Birth-Term ⁴	0.00	4.18	0.71	0.94	0.30	0.10-0.90
Day of Life of First Hold ⁵	0.00	76.00	10.30	12.14	5.00	2.00-15.50

Note.

¹ "Hours visited" reflects the average hours per week that a caregiver was present in the infant's room over the given time period.

² "Days visited" reflects average days per week that a caregiver was present in the NICU over the given time period.

³ "Days cuddled" reflects average number of days per week that a caregiver held the clothed child over the given time period.

4. "Skin-to-skin days" reflects average number of days per week that a caregiver held the child kangaroo-style (naked skin to bare chest) over the given time period.

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Table 3

Associations between parent visitation and early neurobehavior.

	Univariate p value	Univariate Beta	Multivariate p value [†]	Multivariate Beta [†]
Quality of Movement	0.02	0.01	0.02	0.01
Arousal	<0.01	-0.01	<0.01	-0.02
Hypotonia	<0.01	0.01	<0.01	0.02
Excitability	<0.01	-0.04	0.03	-0.03
Lethargy	0.09	0.0302727	0.01	0.04

[†] Multivariate analyses controlled for race, cerebral injury, postnatal steroids, and controlled for gestational age at birth, gender, insurance type, cerebral injury, and days of ventilation.

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Table 4

Associations between holding and early neurobehavior.

	Univariate p value	Univariate Beta	Multivariate p value [†]	Multivariate Beta [†]
Quality of Movement	< 0.01	0.18	< 0.01	0.19
Stress	< 0.01	-0.03	< 0.01	-0.03
Arousal	0.10	-0.12	0.04	-0.15
Excitability	0.02	-0.47	< 0.01	-0.54

[†]Multivariate analyses controlled for race, cerebral injury, postnatal steroids, and days of ventilation.

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Table 5

Associations between skin-to-skin and early neurobehavior.

	Univariate p value	Univariate Beta	Multivariate p value [†]	Multivariate Beta [†]
Quality of Movement	0.06	0.18	0.05	0.19
Hypertonia	0.03	-0.32	0.03	-0.32
Arousal	0.06	-0.20	0.03	-0.22
Excitability	0.06	-0.59	0.04	-0.62

[†]Multivariate analyses controlled for race, cerebral injury, postnatal steroids, and days of ventilation.

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