A Neurobehavioral Intervention Incorporated into a State Early Intervention Program is Associated with Higher Perceived Quality of Care Among Parents of High-Risk Newborns

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Abstract

The purpose of this study is to compare two models of early intervention (EI) service delivery—a neurobehavioral intervention and usual care—on parents' perceived quality of EI service delivery. Families of newborns referred to EI were randomly assigned to a neurobehavioral intervention or usual care group and followed until the infant was 12 weeks corrected gestational age. The intervention group (n= 25) received a weekly neurobehavioral intervention. The usual care group (n= 13) received standard weekly home visits. Mothers completed the Home Visiting Index (HVI) measuring the quality of EI service delivery. Mixed linear regression was used to examine group differences in quality scores. The intervention group reported higher quality of care related to facilitating optimal parent–infant social interaction (mean difference= 2.17, 95% CI: 0.41, 3.92).A neurobehavioral model of service delivery can be successfully integrated into EI programming and appears to be associated with higher parent-reported perceived quality.

The Individuals with Disabilities Education Act (IDEA), Part C, mandates that states provide early intervention (EI) services to infants and toddlers with or who are at risk for developmental difficulties.[1] While neurodevelopmental and parental mental health consequences of the birth of a high-risk newborn have been well-established,[2–4] less is known about the quality of population-

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based interventions (e.g., EI) to address these needs. Currently, EI programs are facing financial crises.[5] Increasing numbers of young children with developmental delays are overwhelming the system. Thus, it is imperative to understand more about the quality of developmental services for high-risk infants and their families. A mechanism to achieve this objective is comparative effectiveness research (CER).

CER compares models of health care delivery to facilitate informed decision-making by clinicians and consumers with the ultimate goal of improving patient and population health. Specific CER research priorities include birth and developmental disorders and support services for families discharged from the neonatal intensive care unit (NICU).[6] State EI programming is one health/developmental services sector to address these priorities; however, conducting CER in EI presents a number of challenges.

First, states have flexibility in establishing eligibility criteria [7] resulting in some states providing EI services for children with a host of biological and/or social risk factors. Thus, under a traditional EI model, heterogeneity of need can complicate comparisons of quality between models of service delivery where the most appropriate interventions may vary across families. However, despite disparate birth and social histories, neurobehavioral theory[8] suggests that developmental difficulties of the high-risk newborn center around one main task—self-regulation. Self-regulation can be described as the successful integration of four neurobehavioral subsystems: autonomic (e.g., heart rate and respiratory rate), motor (e.g., muscle tone and movement patterns), state (e.g., sleep/awake), and social interaction.[8,9] Self-regulation is an ongoing, dynamic neurodevelopmental task,[10] a complexity which can challenge early attachment and social interaction. Self-regulation is the foundation for optimal social interaction skills, and a neurobehavioral model (i.e., that fosters self-regulation) should be the cornerstone (i.e., a metric of access to quality developmental care) of neurodevelopmental interventions in the newborn period.[11]

Second, neurodevelopmental vulnerability is frequently associated with negative consequences for parents.[12,13] Parental psychosocial distress, initiated by a NICU hospitalization, is further complicated by the complexity of self-regulation,[9,10] which can result in attachment and social interactional difficulties.[14] Thus, interventions targeted at high risk infants should also address parental psychosocial needs. This dynamic and dual nature of families' needs further challenges CER. A neurobehavioral model—which addresses self-regulation within the context of the parent–infant dyad—might be expected to be associated with more optimal perceptions from parents about the quality of interventions to facilitate appropriate social interactions with their high-risk newborn. This may have important implications for supporting parents in the short-term and facilitating more optimal social–emotional trajectories for infants.

Third, there is limited research to endorse specific population level evidence-based interventions for high-risk newborns, which can exacerbate comparative analysis challenges. Previous intervention studies of the birth to three populations have included either low birth weight[15] or low income[16] infants and toddlers. The results of these studies[17] suggest that comprehensive, high quality early education programs are associated with improved cognitive function. That is, EI programs are efficacious, but when programs are brought to scale in everyday Part C EI programming, their effectiveness is unclear. Moreover, these previous EI studies have not addressed the unique needs of the high-risk newborn. Indeed, other studies[18–20] have appropriately addressed (i.e., implementing a neurobehavioral intervention framework) the unique needs of medically fragile and developmentally vulnerable newborns. This body of research[18–20] suggests that a neurobehavioral model is associated with positive effects on parental anxiety and depression and infant neurodevelopment. However, these studies are limited to hospital-based interventions, with few studies following infants through the newborn period. Thus, the perceived quality of a population-based, posthospital neurobehavioral model of service delivery is still unknown. This uncertainty is further complicated by limited training received by EI providers in newborn neurodevelopment and a current model of service delivery most appropriate for older infants and

toddlers.[11,21] The dichotomy between EI service delivery and the needs of the high-risk infant and parent fosters inappropriate assessment and intervention strategies for high-risk infants. As a result, parents are minimally engaged in EI service delivery and do not receive individualized anticipatory guidance.[21] A neurobehavioral model of service delivery might be expected to positively influence parents' perceptions of the quality of EI service delivery, that is, that their EI service provider engages and supports them and offers useful guidance. However, no published studies have previously investigated this.

The purpose of this paper is to compare two models of EI home visit service delivery—a neurobehavioral intervention and usual care—on parents' perceived quality of EI service delivery. In particular, it is hypothesized that EI parents who participate in a neurobehavioral intervention will report higher perceived quality of three aspects of EI service delivery: (1) their EI service provider's ability to engage and support them, (2) the usefulness of their EI service provider's anticipatory guidance, and (3) their own ability to socially interact with their high-risk newborn compared to similar families receiving usual care.

Methods

Participants

All infants at risk for developmental delay who were referred to one of three EI programs in one state between January and August 2004 and (1) were less than 12 weeks corrected age, (2) for whom the parent was the infants' primary caregiver, and (3) whose parents were fluent in English were eligible to participate. All eligible parents received Institutional Review Board approved material about the study from their EI service provider. Parents who agreed to participate completed written informed consent and were recruited from the three EI programs.

Design and procedures

Study participants were then randomly assigned to either the neurobehavioral intervention or usual care group using simple randomization procedures. In accordance with EI federal mandates,[1] all participants received the following home-based EI services: (1) an initial developmental assessment (week 1), (2) creation of an individualized family service plan (IFSP)—a document describing parent's priorities and concerns, developmental assessment results, goals, and strategies for intervention (week 2), and (3) weekly intervention by a consistent EI service provider (weeks 3–7). For both the intervention and usual care groups, all visits occurred at the infant's home and services were delivered by a consistent EI provider assigned to the family.

Intervention group

Infants in the intervention group received home visits from an EI provider certified in the Newborn Observational (NBO) System.[9] The NBO is an 18-item neurobehavioral intervention that includes both observation and elicited maneuvers with the purpose of (1) identifying infant neurobehaviors, (2) interpreting these neurobehaviors in the context of the parent–infant interaction, with the goal of enhancing the parent–infant relationship. The NBO was incorporated into all aspects of the procedural mandates listed above. A detailed description of the study protocol is available from the first author upon request. Briefly, the intervention group received seven home visits from an NBO-certified EI service provider. The content of neurobehavioral intervention home visits consisted of intervention strategies guided by the NBO. Specifically, at each home visit, the EI service provider administered the NBO with the parents and discussed (1) the infant's self-regulation and (2) how these self-regulation behaviors contributed to the parent–infant social interactional strengths and difficulties. Thus, the NBO served as a supplement to the initial assessment, informed the writing of the IFSP goals and intervention strategies, and was an

intervention tool during home visits. The experimental group received the neurobehavioral intervention during their weekly home visit for seven successive weeks. The final visit took place no later than the end of the 12th week of the infant's life, when the infant was 3 months of age, adjusted age.

Usual care group

The usual group received traditional EI home-based service delivery, that is, the procedural mandates listed above. The usual care group received seven home visits from an EI provider not certified in the NBO. The content of usual care group home visits consisted of therapeutic and developmental activities deemed appropriate for the infant's adjusted age and included visual tracking, reaching and grasping toys of a variety of textures, and tolerance of developmental play. The usual care group received weekly EI services throughout the study.

At the end of the third month, at the scheduled home visit, all mothers completed a measure of the quality of EI service delivery (described below in "Measures"). Of the 41 infants recruited for this study, three were not followed due to inability to contact the family after initial referral. The final sample included 38 infants (intervention group=25 and control group=13).

The years of service for all EI service providers averaged 5.5 years and ranged from 2 to 20 years, and there was no discernible difference between the EI service providers in the intervention or usual care groups.[22] For example, the distribution of disciplines within both the intervention and control groups was identical. The majority of study service providers were physical therapists (55.6%), followed by social workers (33.3%), and then developmental specialist/early childhood educator (11.1%). About 75% of study providers in both groups had Master's degree education and 25% had a Bachelor's degree. There was no turnover within two years in the three programs.

Measures

The Home Visiting Index (HVI) is a 25-item scale that asks parents to rate, on a four-point scale (1=strongly agree and 4=strongly disagree) their degree of agreement with statements about the quality of EI service delivery.[23] The anticipatory guidance subscale contains 12 items including, "My home visitor gave me good advice about feeding," "My home visitor gave me good advice about caring for my baby," and "My home visitor told me what behavioral changes I could expect to see each week in my baby." The parental engagement and support subscale contains seven items including "My home visitor listened carefully to what I had to say about my baby," "My home visitor encouraged me to talk about the problems that I have with my baby," and "I developed a warm relationship with my home visitor." The parent–infant social interaction subscale contains six items including "My home visitor helped me understand my baby," "I have learned to see small behavior changes in my baby," and "I am confident that I can teach my baby things." The internal consistency overall ($\alpha=0.90$) within each subscale—anticipatory guidance ($\alpha=0.85$), parental engagement and support ($\alpha=0.88$), and parent–infant social interaction ($\alpha=0.81$)—was deemed acceptable.[24] HVI summary and subscale scores were summed and reverse coded so that higher scores indicate higher perceived quality of service delivery.

Data analysis approach

Mixed linear models were used to test the effect of the intervention on (1) summary HVI score, (2) anticipatory guidance score, (3) parental engagement and support score, and (4) parent–infant social interaction score. Mixed models allowed for adjustment of the nonindependence that arises from the fact that infants within the same EI program are more alike than infants in different EI

programs. For each model, the mean difference (and 95% confidence interval) in score for the intervention versus the usual care group was reported. To assess the clinical significance of statistically significant mean differences in HVI scores, effect sizes were calculated and previously published criteria [25] were used to differentiate effect sizes as small (0.20), medium (0.50), and large (0.80). All analyses were conducted in SAS v9.2.[26]

Results

The final sample included 38 infants (intervention group=25 and control group=13). Characteristics of the whole cohort are presented in Table 1. The randomization procedures were successful, and the control and intervention groups did not differ on medical or sociodemographic characteristics (Table 2).

Scores on the Home Visiting Index for the whole sample, as well as for the control and experimental groups separately, are presented in Table 3. Model 3 (Table 4) indicates that compared to parents of infants in the usual care group, parents of infants in the intervention group reported higher perceived quality of EI service delivery related to promoting parent–infant interaction (mean difference=2.17, 95% CI: 0.41, 3.92). This difference reached statistical significance ($p=.02$) and had a small to moderate effect size (0.33).

Discussion

This study compares two models of EI service delivery, a neurobehavioral model and usual care, among families of newborns with biological and social risk for developmental difficulties. The results suggest that incorporating an NBO-based neurobehavioral model into EI may be associated with higher perceived quality and content of the service delivery. In particular, parents participating

Table 1

Characteristics of study sample of families ($n=38$) with a high-risk infant

Characteristic	Whole sample n(%)
Race and ethnicity	
White, non-Hispanic	30 (73.9)
Minority	8 (21.1)
Mother's education	
High school (HS) or less	16 (42.1)
Some college	7 (18.4)
College	15 (39.5)
Mother's employment status	
Full-time	6 (15.8)
Part-time	9 (23.7)
Unemployed	13 (34.2)
Stay at home mother/homemaker	10 (26.3)
Child's gender	
Male	23 (60.5)
Female	15 (39.5)
Low birth weight	20 (52.6)
Child in the NICU	27 (71.1)
Child has chronic feeding difficulties	8 (21.1)
Family lacks social supports	12 (31.6)

Table 2

Differences in characteristics between control and experimental groups

Characteristic	Control (*n*=13)	Experimental (*n*=25)	*p*
	N (%)		
Race and ethnicity			.83
White, non-Hispanic	10 (76.9)	20 (80.0)	
Minority	3 (23.1)	5 (20.0)	
Mother's education			.84
Less than high school (HS)	4 (30.8)	12 (48.0)	
Some college	2 (15.4)	5 (20.0)	
College	7 (53.8)	8 (32.0)	
Mother's employment status			.57
Full-time	1 (7.7)	5 (20.0)	
Part-time	3 (23.1)	6 (24.0)	
Unemployed	4 (30.8)	9 (36.0)	
Stay at home mother/homemaker	5 (38.5)	5 (20.0)	
Child's gender			.18
Male	6 (46.2)	17 (68.0)	
Female	7 (53.8)	8 (32.0)	
Low birth weight	7 (53.8)	14 (56.0)	.57
Child in the NICU	9 (69.2)	18 (72.0)	.86
Child has chronic feeding difficulties	2 (15.4)	6 (24.0)	.56
Family lacks social supports	5 (38.5)	7 (28.0)	.51

in the neurobehavioral intervention are more likely to report that EI service delivery promoted parent–infant social interaction but not anticipatory guidance or parental engagement and support.

Previous hospital and postpartum neurobehavioral interventions[17–19,27] demonstrate a positive influence on parent–infant social interaction. However, previous postpartum studies are limited by a lack of randomization and standardized intervention protocol.[28] This appears to be the first multisite randomized controlled trial of a systematic, standardized neurobehavioral intervention delivered weekly to high-risk infants and their families throughout the newborn period. The results of the current study have important implications for understanding quality of service delivery for

Table 3

Differences in mean summary and subscale scores of the Home Visiting Index for whole study cohort and experimental and control groups

	Whole sample	Control group	Experimental group
	Mean (SD), range		
Home Visiting Index score			
Total	12.67 (8.71), 0–28	9.76 (9.92), 0–28	14.34 (7.64), 3–28
Anticipatory guidance	10.01 (5.12), 0–20	8.74 (5.62). 2–19	10.74 (4.77), 0–20
Engagement and support	5.36 (3.13), 0–14	4.99 (3.33), 0–12	5.58 (3.06), 1–14
Parent–infant social interaction	6.65 (2.63), 0–11	5.39 (2.78), 0–10	7.38 (2.29), 4–11

Table 4

Mean difference and 95% confidence interval in Home Visiting Index (HVI) total and subscale scores from mixed linear regression models testing the effect of a neurobehavioral intervention among 38 families (25 intervention and 13 control) with a high-risk newborn

	Intercept	Mean difference between groups	p
Model 1			
Anticipatory guidance sub-scale	6.25 (−6.98, 19.48)	2.34 (−1.16, 5.84)	.18
Model 2			
Engagement/support subscale	4.84 (−3.18, 12.86)	0.38 (−1.81, 2.58)	.73
Model 3			
Parent–infant social interaction subscale	3.14 (−3.26, 9.55)	2.17 (0.41, 3.92)	.02
Model 4			
Total HVI score	4.64 (−17.36, 26.65)	4.98 (−0.86, 10.82)	.09

families of high-risk infants. Given the potential fragility of the parent–infant attachment in the context of parenting a high-risk infant,[29,30] intervention programs that are associated with higher perceived quality of care germane to determinants of parent–infant social interaction may have the potential to facilitate optimal patterns of attachment and social interaction and perhaps lay the foundation for later social–emotional development.[10,27,31]

This is the first study to incorporate a neurobehavioral intervention into a state EI program curriculum. Previous research[11,21] suggests that the traditional implementation of federal EI mandates by state EI programs is limited in its ability to adequately meet the needs of families of high-risk infants. The results of the current study suggest that a neurobehavioral approach can be successfully and effectively incorporated into traditional public health programming. This has important programs and policy interventions for not only promoting future population-based pediatric CER but also for assisting state Part C coordinators, lead agencies that oversee training of EI providers, and EI program directors in developing practice guidelines for families of high-risk infants. Furthermore, given the current fiscal crisis of EI,[5] there is a focus on maximizing efficiency and effectiveness in population-based EI service delivery. There continues to be an increase in the number of infants born with biological and/or social risk. Establishing an intervention model associated with higher perceived quality of service delivery may support the unique needs of these newborns and their parents and contribute to the limited literature regarding efficacy and best practice for EI.

A priori, it was hypothesized that the neurobehavioral intervention would positively influence parents' perceptions about the quality of the anticipatory guidance and support they received; however the results provide no evidence of this. The results of the current study are consistent with previous evaluations of EI[32–34] where parents perceive their EI service provider to be a good listener, respectful of the family's needs and priorities, and partner with the family in decisions about the developmental care of the child. Thus, the particular strength of the neurobehavioral intervention in the present study is its ability to build upon existing well-functioning parent–provider relationships in order to promote early parent–infant interaction and social–emotional development.

This study has limitations. The overall sample size was small, which contributed to imbalance between the intervention and usual care groups. For example, with small sample sizes, simple

randomization procedures can lead to an imbalance between groups.[35] Moreover, while no discernible differences between groups on measured sociodemographic and medical characteristic were found, this does not rule out the possibility of qualitative differences. For example, over half (53.8%) of the control group mothers were college educated, whereas less than one-third (32.0%) of the mothers in the intervention group were college educated. Thus, this difference, although not statistically significant, may be clinically relevant. However, given the positive association[35] between maternal education and receipt of quality early health and education services and infant neurodevelopment, the bias was likely to be in the direction of not finding an intervention effect. The results should, therefore, be interpreted with caution and future studies should include larger sample sizes. While the HVI has not been previously validated, the underlying theoretical framework was strong and internal consistency of the overall scale and subscales was excellent, which contributes to the outcome measure's utility. However, future research should replicate these results with larger, more diverse samples, which would allow for a more extensive assessment of the psychometric properties of the scale, including validity, to capture true differences in service delivery quality.

Implications for Behavioral Health

These results suggest that a neurobehavioral model can be successfully incorporated into population-based programming for high-risk families. Moreover, an NBO-based neurobehavioral model appears to be associated with higher parent perceived quality of EI service delivery related to promoting parent–infant interaction. However, this was a small study of three EI programs in one state. Future research should replicate these results with larger, more diverse samples.

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Conflict of Interest Statement Both authors disclose their affiliation with the Brazelton Institute, Department of Newborn Medicine, Children's Hospital Boston. In the particular, the second author is Director of the Brazelton Institute and assisted in the design of the neurobehavioral intervention under study.

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