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Randomized controlled trial of Family Connects: Effects on child emergency medical care from birth to 24 months

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Abstract

One of Tom Dishion's most significant contributions to prevention science was the development of affordable, ecologically valid interventions, such as the Family Check-Up, that screen for child and family risk factors broadly, but concentrate family-specific interventions on those with greatest potential for population impact. In the spirit of this approach, investigators examined effects of a brief, universal postnatal home visiting program on child emergency medical care and billing costs from birth to age 24 months. Family Connects is a community-wide public health intervention that combines identification and alignment of community services and resources with brief, postpartum nurse home visits designed to assess risk, provide supportive guidance, and connect families with identified risk to community resources. Over 18 months, families of all 4,777 resident Durham County, North Carolina, births were randomly assigned based on even or odd birth date to receive a postnatal nurse home visiting intervention or services as usual (control). Independently, 549 of these families were randomly selected and participated in an impact evaluation study. Families, blind to study goals, provided written consent to access hospital administrative records. Results indicate that children randomly assigned to Family Connects had significantly less total emergency medical care (by 37%) through age 24 months, with results observed across almost all subgroups. Examination of billing records indicate a $3.17 decrease in total billing costs for each $1 in program costs. Overall, results suggest that community-wide postpartum support program can significantly reduce population rates of child emergency medical care through age 24 months while being cost-beneficial to communities.

Keywords

home visiting; population health; prevention; system of care

A significant, enduring legacy of Tom Dishion's numerous contributions to prevention science is the effective translation of basic research on the development of child and

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adolescent problem and risk behavior into effective interventions that screen for child and family difficulties broadly and then concentrate intervention resources to those at greatest risk, with the goal of population impact. Perhaps the most well known of these efforts is the Family Check-Up, a brief, family-centered intervention designed to reduce child and adolescent problem behaviors through the strengthening of family management practices (Dishion & Kavanagh, 2003; Dishion, Nelson, & Kavanagh, 2003). The program was designed to achieve population impact at an affordable cost to communities by engaging and screening all children or adolescents prior to critical transition periods in both social and biological development (e.g., prior to the transition to toddlerhood or early adolescence) within the defined catchment area for risk (e.g., all families of toddler-age boys from a local Women, Infants, and Children program or all students at a middle school), and rapidly triaging and concentrating family management interventions and resources to those families with children deemed at highest risk for poor adjustment outcomes, such as behavior problems, early substance use, or high-risk sexual behavior.

The Family Check-Up begins by briefly screening all children or families across multiple dimensions empirically related to risk for future behavior problems, such as current child conduct problems (e.g., disruptive behavior), family problems (e.g., parent depression or substance use), and socioeconomic risk (e.g., low income or low parent education). Children and families at highest risk are targeted for intervention services that begin with an interview session to explore parent concerns, to learn about parenting and family management practices, and to assess parent motivations for change. The program concludes with an ecologically grounded assessment of family dynamics and stressors resulting in feedback to the family regarding identified needs and intervention services that best address the family's unique needs. After completing feedback sessions, families are encouraged to engage in follow-up intervention sessions, typically focused on factors that can support parenting quality (e.g., parental well-being or social support). A growing body of research identifies multiple positive impacts for children and caregivers throughout early childhood, including reductions in child disruptive behavior and externalizing behavior problems (Dishion et al., 2008; Shaw, Dishion, Supplee, Gardner, & Arnds, 2006); increased child inhibitory control (Chang, Shaw, Dishion, Gardner, & Wilson, 2014); increased caregiver involvement, proactive parenting, and positive parenting (Dishion et al., 2008; Gardner, Shaw, Dishon, Burton, & Supplee, 2007; Shaw et al., 2006); and decreases in caregiver depression (Shaw, Connell, Dishion, Wilson, & Gardner, 2009). Further, multiple studies suggest additional, collateral benefits for children and families, including child school readiness and academic achievement (Brennan, Shaw, Dishion, & Wilson, 2012; Brennan et al., 2013; Lunkenheimer et al., 2008), and caregiver social support and relationship satisfaction (McEachern et al., 2013).

Toward Population Impact for Infants and Young Children: Family Connects

Consistent with the Family Check-Up approach for engaging all families at a critical period in development, identifying family needs, and concentrating intervention resources to those at greatest need, the Family Connects model was designed for population impact for families in the early postpartum period by a brief newborn nurse home visiting program that is universal, manualized, affordable, and also capable of identifying and addressing unique family needs. Results from a randomized controlled trial (RCT) involving every community birth over an 18-month enrollment period (Dodge et al., 2014) demonstrated that the program can be implemented with high quality (nurse protocol adherence = 84%) and population reach (69% of all eligible families completed the program), while successfully connecting families with identified needs to community services for long-term support (79% of families with one or more referrals to community services reported a successful connection within 4 weeks of program completion). Further, independent evaluation with a random, representative subsample of study families indicated that eligibility for Family Connects predicts improved family connections with the community, mothers' self-reported positive parenting (e.g., reading and playing), blinded observer-rated responsive parenting at age 6 months (Dodge et al., 2014), and reduced infant emergency medical care utilization by 50% through age 12 months (i.e., emergency room visits and hospital overnight stays), with effects observed for both high- and low-risk families (Dodge, Goodman, Murphy, O'Donnell, & Sato, 2013a).

Although these findings indicate Family Connects leads to positive infant healthcare outcomes through age 12 months, longer term effects on infant healthcare and costs are unknown. This is an important limitation, as the benefits of numerous early childhood interventions are not sustained over time (Crane & Barg, 2003), and sustained effects are a critical consideration for community investment in any evidence-based program. Furthermore, it is plausible that by reducing emergency medical care in the first year of life, a home visiting program might inadvertently *increase* emergency care in the second year of life if needed medical care has been deferred. The primary goal of the current study is to examine Family Connects effects on child emergency medical care utilization and associated billing costs through age 24 months, well beyond the infancy period. Consistent with previous results, it was hypothesized that Family Connects eligibility would predict overall reductions in child emergency medical care through age 24 months.

Family Connects targets all families of newborns in the community, so a second study goal is to understand whether the program conveys benefits for all groups of families. Many home visiting programs (e.g., Fergusson, Grant, Horwood, & Ridder, 2005; Green, Tarte, Harrison, Nygren, & Sanders, 2014; Olds, Henderon, Chamberlin, & Tatelbaum, 1986) target high-risk (e.g., low-income or single-parent) families exclusively, based on assumptions of greater need, greater impact, and greater cost savings, but it is not clear whether targeting enhances or dilutes impact and savings. During home visits in the Family Connects program, registered nurses rapidly triage families based on individually identified risk and concentrate resources to families with the greatest needs (Dodge, Goodman, Murphy, O'Donnell, & Sato, 2013b). Therefore, it is possible that high-risk families could benefit the most from the program over time. The second goal of this study is to examine whether program impact on child emergency medical care use differs across multiple dimensions of child and demographic characteristics, defined by medical risk at birth, insurance status, minority status, single-parent household, and infant gender. It was hypothesized that moderation analyses would identify effects for all subgroups, but larger effects would be observed for high-risk families because, on average, they were more likely to receive more intensive intervention, including follow-up home visits and nurse-supported connections to community services for long-term support.

The third study goal was to examine Family Connects effects on costs of emergency medical care. Emergency care visits have a wide range of patient severity and costs, and it is plausible that the cases of emergency medical care that are prevented by a home visiting program are those with relatively low cost. A direct assessment of billing costs is necessary to evaluate the benefit-cost ratio of the intervention. A previous evaluation of the Family Connects program showed estimated cost savings based on national cost averages, but without direct examination of actual billing records (Dodge et al., 2014). It is hypothesized that predicted reductions in emergency medical care associated with Family Connects eligibility would also result in lower total emergency medical care billing costs.

Method

The Family Connects model

Family Connects was developed in response to the challenge of improving child health and well-being for an entire community, with the primary goal of reducing community rates of child maltreatment (a full list of primary and secondary objectives can be found on the ClinicalTrials.gov website (https://clinicaltrials.gov/ct2/show/NCT01406184). The model utilizes a public health prevention approach, combining a top-down process of identifying and aligning key community stakeholders and service providers with a bottom-up commitment to engaging all families to identify and address family-specific risk and need. The program was conceptualized through a public-private partnership and piloted for 3 years with iterative improvements in the program model prior to testing by a RCT. More specifically, the Family Connects model seeks population reach and impact with low per-family cost ($700/birth; Dodge et al., 2014) through a process of engaging all families within the community, rapidly triaging families based on identified risk to concentrate resources to families with greater needs, and working collaboratively to connect families with identified needs to matched community programs and services to provide long-term support and to serve as a first step into a broader community system of care.

The Family Connects model begins with a community alignment process, in which staff identify and engage key community stakeholders and agencies providing services to families with infants and young children. This community-level process is a critical first step in implementation, as the short-term design of the intervention necessitates successful linkages into the community system of care in order to promote long-term benefits for families with needs. Key components of the community alignment process include (a) compiling an electronic “directory” of all formal (e.g., Women, Infants, and Children office or mental health clinic) and informal (e.g., local parent support group) services in the community that is utilized by the nurse home visitor to support family referrals to matched community resources; (b) engaging a Community Advisory Board, composed of key community stakeholders, that supports local ownership of the model and supports ongoing community collaboration; and (c) identifying “local champions” to expand community awareness of and support for model implementation. In addition, community alignment staff provide an ongoing link between the intervention and the community, providing ongoing, systematic feedback to the community around service capacity, infrastructure, and gaps in needed services, as well as serving as a direct link with agencies to troubleshoot challenges that may arise in the family referral process.

Assessment and intervention with individual families consists of 4–7 manualized contacts, including (a) an initial contact shortly after birth (in the birthing hospital, ideally) when a staff member communicates the importance of community support for parenting and schedules an initial home visit; (b) 1–3 home visits with a registered nurse, typically between 3 and 12 weeks of infant age, to provide physical assessments for infant and mother, intervention and education, assessment of family-specific needs, and for families with significant nurse- and parent-identified needs, connections to matched community resources for longer term support; (c) 1–2 nurse follow-up contacts with community service providers, as needed, to facilitate successful connections; and (d) a telephone follow-up 1 month after the nurse closes the case to assess family satisfaction and confirm community connection outcomes. With family consent, brief reports summarizing outcomes from the visit(s) are provided to mother and infant healthcare providers to support a strong family connection to their medical home.

During home visits, the nurse engages the mother (and care-giving partner, when possible) to provide brief educational interventions for all families (e.g., appropriate infant feeding and safe sleep practices), to answer family questions and concerns about infant care, and to utilize a high-inference approach to assess family needs across 12 empirically derived factors linked to child health and well-being, inlcuding *healthcare*: parent health, infant health, and healthcare plans; *parenting and childcare*: childcare plans, parent-infant relationship, and management of infant crying; *family material resources and safety*: material supports, family violence, and mother maltreatment history; and *parent well-being*: mental health, substance abuse, and social-emotional support. The nurse rates each of the 12 factors individually and intervenes accordingly. A score of 1 (low *risk)* receives no subsequent intervention. A score of 2 (*moderate risk*) receives short-term, nurse-delivered educational intervention. For a score of 3 (*significant risk*), the nurse works collaboratively with the family to support connections to matched community resources tailored to address that particular need (such as treatment for postpartum depression, a county Department of Social Services social worker for enrollment in Medicaid or food stamps, or a multiyear home visiting program for long-term parent support). The nurse also provides follow-up to help ensure that each connection “sticks,” requiring additional contacts with the family or community agency. A score of 4 (*imminent risk*) receives emergency intervention (<1% of cases). A final contact 4 weeks after case closure ascertains family–consumer satisfaction, outcomes for referrals to community services, and whether further problem solving is needed to address new or existing needs.

Durham Connects RCT implementation

From July 1, 2009 to December 31, 2010, all 4,777 resident births from two Durham County hospitals (one academic tertiary care hospital and one community hospital) were randomized with families assigned a priori to one of two intervention groups based on infant birth date. *Even birth date* families (n = 2,327) were assigned to receive Family Connects and program staff attempted to engage all of these families and schedule a home visit. *Odd birth date* families (n = 2,450) were not offered Family Connects but received other community services as usual and served as the control group (see Figure 1). Although differing from traditional randomization procedures in clinical trials, whereby individuals are randomized after providing informed consent, the a priori randomization procedure utilized in the current trial was necessary to examine program implementation and impact within the full community population (not only those families willing to participate in a randomized trial). This approach allowed for inclusion of all eligible families (i.e., families living in Durham County giving birth at one of the two county hospitals) with experimental rigor, and without exception, but with ethical care for privacy. Hospital discharge records were utilized to confirm eligibility for all families. The Duke School of Medicine Institutional Review Board approved all study implementation and evaluation procedures. Additional information about the intervention protocol is available upon request (ben.goodman@duke.edu).

Previously reported implementation results indicated that 80% of all Family Connects–eligible families (1,863 of 2,327) agreed to participate, and 86% of those families (1,596 of 1,863) successfully completed the program (net completion = 69%; Dodge et al., 2014). Commensurate with community demographics, 40% of participating families were European American, 37% were African American, and 23% were other or multiracial; 26% of families reported Hispanic ethnicity. Sixty-two percent of mothers received Medicaid or had no health insurance at the time of birth; 49% of mothers were married. An independent expert accompanied the nurse on 7% (n =116) of all cases to assess nurse fidelity to the home visit protocol and reliability in rating family risk. Nurse protocol adherence was 84%; interrater agreement on risk across the 12 risk factors (κ = .69) was substantial (Landis & Koch, 1977). Ninety-four percent of all families had one or more nurse-identified risks; 44% had one or more significant risks best addressed by connecting the family to one or more community resources or services. Seventy-nine percent of families receiving one or more nurse referrals reported a successful connection at the time of the follow-up contact 4 weeks after case closure.

Family Connects impact evaluation study participants and design

Completely independent of the Family Connects RCT implementation, a random, representative subsample of 549 families was selected from the full population to conduct an independent impact evaluation beginning at infant age 6 months (initial interviews completed between infant ages 6 and 8 months). Use of random subsamples for evaluation of population-level interventions allows for testing of intervention impact while maintaining feasible evaluation costs (e.g., Moving to Opportunity for Fair Housing intervention; Ludwig et al., 2011). Consistent with this evaluation strategy, 1 family was randomly selected by computer algorithm from public birth records for each of the 549 days of the 18-month Family Connects RCT enrollment period to examine program impact for families enrolled across the entire trial period. Families were selected from the entire population of eligible birth records (i.e., resident Durham County births at one of the two county birthing hospitals) without consideration for intervention participation or adherence. Selected families who declined participation were replaced with a randomly selected family with the same child birth date and race/ethnicity as the original family in order to minimize the possibility of selection bias based on these characteristics. Statistical power was estimated following Cohen (1988) utilizing two-tailed tests with .80 power and a significance level of .05. Using techniques described by Stroup (2012) for power analyses with Poisson distributions, the current study is sufficiently powered to detect a 15% decrease in the outcome variables examined in the current study.

Randomly selected families were contacted by home interviewers and invited to participate in a descriptive research study examining family community service utilization and how such use related to child and family well-being over time. Families were unaware of the primary study goal; research aides conducting home interviews were also unaware of family participation status in the intervention. Overall, 682 families were randomly selected and 549 (81%) participated (n = 269 intervention-eligible families; n = 280 control families). Post hoc comparisons of hospital discharge records and public birth records after all evaluation study consenting and interviews were complete identified 18 participating families who were subsequently declared ineligible due to hospital discharge record error (n =13 families with no hospital discharge record; n = 3 families with child birth date discrepancies; and n = 2 families with address discrepancies affecting Durham County residency), resulting in a final sample of 664 selected families and 531 participating families. The ineligible families (n = 9 Family Connects-eligible families; n = 9 control families) were removed without consideration for intervention adherence or evaluation outcomes; inclusion or exclusion of these families does not alter evaluation results and conclusions presented in this manuscript.

Comparisons of the final evaluation sample revealed no significant difference in participation between Family Connects-eligible (82%) and control (79%) families, and no difference in infant age at the time of the interview, M_C = 6.44, M_I = 6.39, t (1) = 0.89, p = .38. Intervention participation rates for the 260 intervention-eligible families, however, were greater than those for the full population of intervention families (net complete = 78%); χ^2 (1) = 10.78, p < .01, perhaps reflecting a greater willingness on the part of these families to participate in home-based programs and research studies. Thirty-nine participating families moved (n = 21 Durham County-eligible [DC-eligible] families; n = 18 control families) and one participating child died between the initial evaluation interview at age 6 months and age 24 months. These children were retained in the current analyses due to the availability of partial outcome data; inclusion or exclusion of these children does not meaningfully alter evaluation results presented in this manuscript.

Forty-four between-group comparisons were conducted across 11 preintervention infant and demographic characteristics available from hospital discharge records to examine the representativeness of the intervention and evaluation populations and evaluation subsamples. A Holm–Bonferonni sequential correction was applied to account for the increased likelihood of Type I error resulting from the large number of between group tests (Holm, 1979). As shown in Table 1, comparisons of the selected and participating evaluation families, respectively, to all 4,777 RCT families indicated that both subsamples were representative of the entire RCT population. Further, comparisons of the 2,327 DC-eligible families and the 2,450 control families in the full RCT population, as well as the 260 DC-eligible and 271 control evaluation study families revealed only one between-group difference: mothers in the DC-eligible group were more likely to be “Other” race/ethncity compared to control mothers (12.8% vs. 9.4%, $p < .01$; Table 2). As only 1 of 44 tests (2.3%) emerged as statistically significant, it was concluded that the group-level randomization of the full birth population resulted in equivalent intervention and control groups for both the RCT implementation and impact evaluations. Further, it was concluded that (a) the evaluation sample was demographically representative of the broader population and (b) evaluation study participation was not biased between intervention and control groups.

Measures

Hospital emergency department records—Mothers provided written consent during an in-home interview at infant age 6 months to obtain future child hospital administrative records from the two county hospitals. Records were received and coded between birth and child age 24 months (July 1, 2011–December 31, 2012) for the *total number of outpatient emergency room (ER) visits* and the *total number of inpatient overnights* spent in the hospital, excluding care associated with the birthing stay. These two variables were summed to measure *total child emergency medical care* through age 24 months. Further, as a previous Family Connects study reported on program impact on child emergency medical care through age 12 months (Dodge et al., 2013a), *total emergency medical care between 12 and 24 months of age* was also examined to investigate the possibility of additional intervention effects beyond age 12 months.

Hospital and physician billing records were also obtained to conduct a post hoc descriptive examination of how intervention impact on total child emergency medical care was related to total billing costs. All hospital and physician total billing costs were summed to measure *total emergency medical care billing costs* through age 24 months.

Demographic variables—Multiple child and demographic characteristics were examined focused on those that may place families at greater risk for increased emergency medical care utilization or that may otherwise alter intervention impact. Hospital discharge records provided baseline information on *infant cumulative medical risk at birth* (sum score any of the following: infant birth weight <2500 g; infant gestational age <37 weeks; or any other *International Classification of Diseases*, 9th edition [ICD-9] codes indicating birth complications/trauma; range = 0–3; Alonso-Marsden et al., 2013), *mother health insurance status* (0 = *private insurance*; 1 = *Medicaid or no insurance)*, and *infant gender*(0 = *boy*; 1 = *girl)*. Mother reports on *single-parent household status* (0 = *no*; 1 = *yes*) and *mother race/ ethnicity* (0 = *nonminority*; 1 = *minority)* at the 6-month interview were also included.

Statistical analyses

SAS version 9.4 was utilized to conduct two-tailed intent-to-treat analyses estimating the impact of random assignment to Family Connects (or not) on child emergency medical care regardless of intervention participation or adherence. All models utilized multivariate negative binomial regression because the emergency medical care outcomes were count variables with skewed distributions (Coxe, West, & Aiken, 2009). First, main effect models were estimated with mother health insurance status, mother race/ethnicity, single-parent status, infant cumulative birth risk, and infant gender included as covariates. Moderation analyses were estimated to examine whether intervention effects differed based on these five child and demographic characteristics. Moderators were examined individually with all covariates included in the model; a Holm–Bonferonni sequential correction was applied to account for the increased risk of Type I error resulting from 20 individual moderation tests (Holm, 1979). Post hoc tests of significant interactions remaining after the Holm-Bonferonni sequential correction were conducted following Aiken and West (1991). Intervention effect sizes were estimated as the absolute value of $(Mean_{Intervention} - Mean_{Control})$ / Pooled SD. Percentage decreases in emergency medical care were estimated as the absolute value of $(Mean_{Intervention} - Mean_{Control}) / Mean_{Control}$.

Physician billing cost data were missing for instances in which the treating physician had hospital privileges but was not a member of the Duke University Hospital System, which operates both Durham County hospitals. These missing data represented 5.8% of all cost data (n = 245 of 4,248 data points). Consistent with recommendations by Schafer and Graham (2002), missing data were multiply imputed in 20 separate data sets using SAS PROC MI.

Results

Family Connects effects on child emergency medical care

Children in families randomly assigned to intervention (Family Connects families) had 37% less total emergency medical care use than controls, $M_C = 2.41$, $M_I = 1.52$, $p < .001$, effect size = .24, through age 24 months (Table 3). A post hoc examination of ICD-9 codes associated with each emergency medical care episode were conducted to determine the percentage of presentations that were associated with accidents and injuries or child maltreatment. Accidents and injuries included any ICD-9 code associated with accidents, injuries, or poisoning (ICD codes 800–999), while maltreatment-related diagnostic codes were identified using criteria established by Schnitzer, Slusher, Kruse, and Tarleton (2011). Family Connects children had 13% fewer total presentations for accidents and injuries, although this difference was nonsignificant, $M_C = 0.30$, $M_I = 0.27$, $t(1) = 0.76$, $p = .45$, effect size = .07. Family Connects children were also 52% less likely to present multiple times for accidents and injuries compared to children in the control group, a marginal difference, $M_C = 0.06$, $M_I = 0.03$, $\chi^2(1) = 2.71$, $p = .10$. The percentage of children coded for maltreatment-related injuries was low, and no between-group differences were observed, $M_C = 0.02$, $M_I = 0.02$, $\chi^2(1) = 2.38$, $p < .30$.

A previous report documented a significant program effect on reducing child total emergency medical care use through age 12 months (Dodge et al., 2013a), so particular interest here was focused on the effects for the period age 12 months through age 24 months. Family Connects children had 13% less total emergency medical care between 12 and 24 months of age than controls, a difference in the hypothesized direction but not statistically significant, $M_C = 0.84$, $M_I = 0.73$, $p = .73$, effect size = .07, indicating that previously observed intervention effects between birth and infant age 12 months were sustained but did not increase through 24 months of age (Figure 2).

Examining individual components of total child emergency medical care, Family Connects children had 85% fewer inpatient hospital overnights, $M_C = 0.86$, $M_I = 0.13$, $p < .001$, effect size = .24, and 10% fewer outpatient ER visits, $M_C = 1.55$, $M_I = 1.39$, $p = .47$, effect size = .08, through age 24 months, although the latter difference was not statistically significant (Table 3). Post hoc examination of rates of ER visits and hospital overnights between 12 and 24 months of age revealed that children in Family Connects families had a marginally significant 82% reduction in inpatient hospital overnights, $M_C = 0.11$, $M_I = 0.02$, $p = .06$, effect size = .12, but no difference in rates of outpatient ER visits, $M_C = 0.72$, $M_I = 0.71$, $p = .88$, effect size = .01.

Intervention effects across child and demographic subgroups

After applying a Holm-Bonferroni sequential correction to the 20 individual moderation tests, one significant interaction effect was identified for intervention on total child emergency medical care use through age 24 months (Table 3). Specifically, moderation tests identified a significant interaction effect for Intervention × Mother Race/Ethnicity ($b = 1.00$, $p < .01$). Post hoc tests revealed a significant positive impact for children of nonminority mothers, $M_C = 1.80$, $M_I = 0.60$, $p < .01$, effect size = .34, and a smaller, nonsignificant effect (but in the same positive direction) for children of minority mothers, $M_C = 2.61$, $M_I = 1.89$, $p = .29$, effect size = .19. No additional moderation effects were observed for total child emergency medical care between birth and age 24 months. Further, no moderation effects were observed for total child emergency medical care between 12 and 24 months, for total child outpatient ER visits, or for inpatient hospital overnights through age 24 months.

Associations between reduced emergency medical care and total billing costs

In light of predictive analyses suggesting random assignment to Family Connects reduces total child emergency medical care, post hoc descriptive analyses were used to test how these reductions were related to average per-child billing costs (average total of all hospital and physician billing charges). Results indicate total child emergency medical care billing costs were lower by $2,217 per child between birth and age 24 months (M_C = $3,459, M_I = $1,242). To understand more fully emergency medical care cost savings that accrue relative to program implementation costs, a benefit-cost ratio was calculated as $BCR_{\mathrm{FC}} = (EMCC_C - EMCC_I) / (IC_I - IC_C)$ (Drummond, O’Brien, Stoddart, & Torrance, 1997), where BCR_{FC} represents the benefit–cost ratio of random assignment to Family Connects, $EMCC_C$ and $EMCC_I$ represent the average total emergency medical care billing costs per child from birth to age 24 months for control and intervention families, respectively, and IC_I and IC_C represent the total per-family intervention costs for Family Connects–eligible ($700) and control ($0) families, respectively. Accounting for total billing and intervention costs, the benefit–cost ratio was 3.17, meaning that each $1.00 in Family Connects implementation costs was associated with $3.17 in savings through reductions in total child emergency medical care billing costs through age 24 months.

Discussion

Overall, results of the current study indicate that random assignment to the Family Connects program was associated with a 37% reduction in total child emergency medical care utilization and a 64% reduction in emergency medical care billing costs during the period from postbirth hospital release through child age 24 months. The previously reported reductions in child emergency medical care between birth and age 12 months (Dodge et al., 2013a) were sustained through age 24 months, although no additional intervention effects were observed during the second year of the child's life. Important for a community-wide program, these findings held across the majority of child and demographic subgroups examined, although there is evidence suggesting that benefits for minority families may decrease beyond the infancy period. Overall, the absence of consistent moderating effects suggests that both high- and low-risk families may benefit from universal, postpartum home visiting interventions. Some families benefit from reengagement over time to access newly emerging needs during the transition to toddlerhood. New innovations focused on building a continuum of support for families, such as an integration of Family Connects in infancy with Family Check-Up in toddlerhood, present a promising possibility for supporting sustained population impact throughout early childhood and into the transition to kindergarten.

Observed intervention effects on child emergency medical care utilization were also associated with a reduction in total emergency medical care billing costs by an average of $2,217 per case. This decrease resulted in an estimated $3.17 in savings for each $1.00 in program costs. These results are consistent with previously reported effects of Family Connects on estimates of total billing costs during infancy ($3.02 in savings for each $1.00 in program costs; Dodge et al., 2014) but extend and enhance prior findings by utilizing actual hospital billing records rather than cost estimates based on national averages per case and by measuring costs through child age 24 months. Collectively, these results indicate that a modest economic investment in a short-term, postpartum, universal home visiting program like Family Connects ($700/birth) could produce positive, sustained returns for communities over time through reductions in child emergency medical care utilization.

It should be noted that the higher rate of program completion among Family Connects–eligible families participating in the evaluation study compared to Family Connects–eligible families in the full population (78% vs. 69%) suggests that the current results may represent a high-end estimate of program effects in the full population. In addition, while previous results suggest Family Connects benefits accrued to all intervention group families during infancy (Dodge et al. 2013a, 2014), the current findings provide some evidence suggesting that differential program effects may begin to emerge beyond infancy. Specifically, program effects on total child emergency medical care through 24 months were greater for nonminority families, relative to minority families, a finding inconsistent with our initial hypothesis. Minority families in the Durham community were significantly more likely to experience socioeconomic disadvantage (as defined by Medicaid and Children's Health Insurance program participation at infant age 6 months), $\chi^2(1) = 192.45$, $p < .001$. It is plausible that brief, community-wide programs like Family Connects offered during infancy are less effective at addressing the needs of these families over longer periods of time or that differing needs emerge for these families beyond infancy. Future research will explore additional child and family outcomes beyond infancy, as well as examine mechanisms of Family Connects impact, in order to understand how families may benefit from program participation over time, as well as the specific pathways associated with improved child health and well-being across these subgroups.

It should also be noted that while the current findings may generalize to communities similar to Durham, North Carolina (i.e., moderate-sized urban communities with a relatively high rate of socioeconomic disadvantage), the extent to which these findings generalize to communities with meaningfully different population, geographic, and/or socioeconomic profiles requires further investigation. Results from a recent quasi-experimental evaluation of Family Connects in four low-income, rural counties in eastern North Carolina are consistent with reductions in infant emergency medical care through age 6 months (Dodge & Goodman, 2019), although longer term impacts have not been tested. A second randomized trial in Durham found mixed results, with observed reductions in ER visits in the first year of life but an adverse effect on hospital overnights (Dodge & Goodman, 2019; Dodge, Goodman, Bai, O'Donnell, & Murphy, 2019). As the Family Connects model is disseminated to other communities throughout the United States, new opportunities for independent impact evaluation are being pursued. Collectively, these efforts will support a more complete understanding of the generalizability of the current results over time and across diverse communities.

Finally, the processes linked with decreases in child emergency medical care utilization in the intervention group are still under investigation. For example, because the intervention provided additional support for infant health and emphasized strong connections to a primary medical home, decreases in emergency medical care may represent better overall infant health and more appropriate utilization of infant primary healthcare. Further, a more comprehensive economic analysis is required in order to more fully understand the patterns of healthcare utilization, as well as the potential for cost avoidance, across a broader range of domains related to the intervention. Although considerable efforts were made to account for nonintervention factors that might account for differences in child utilization of emergency medical care, it is possible that additional unmeasured factors, such as mother or child genetic risk, were associated with assignment to condition and may contribute to observed group differences. Future research is needed to test how genetic risk and other factors may moderate Family Connects' impact on child health and well-being.

Conclusions

A brief, postpartum nurse home visiting program delivered with high-quality and community-wide reach can significantly reduce population rates of child emergency medical care utilization through age 24 months, with the potential for meaningful cost savings to communities. These findings further indicate that such a public health prevention approach has benefits to families and communities that are sustained beyond infancy, improving early child health and reducing emergency medical care costs, making such programs a worthy community investment.

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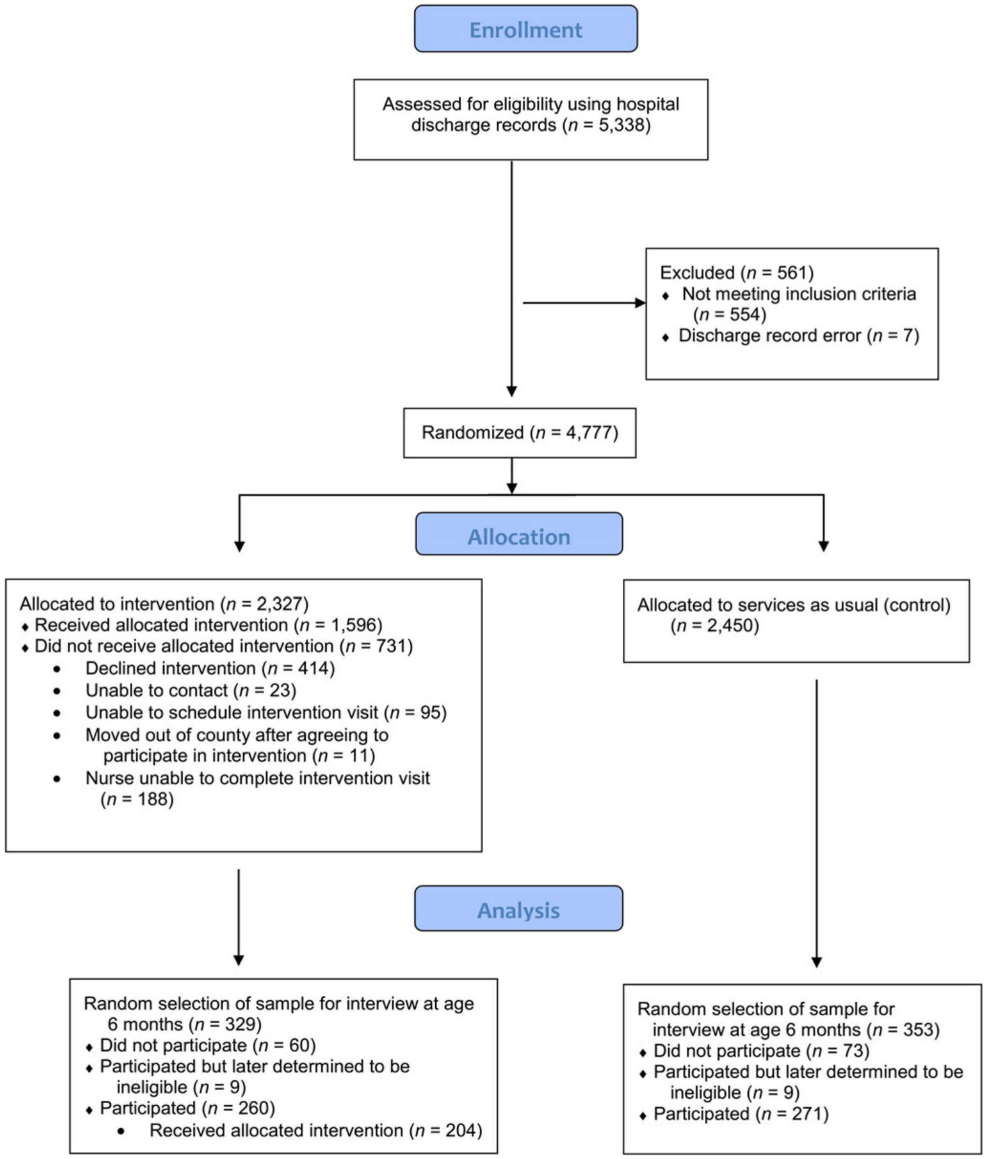

Figure 1.
CONSORT 2010 flow diagram for Family Connects RCT implementation and evaluation.

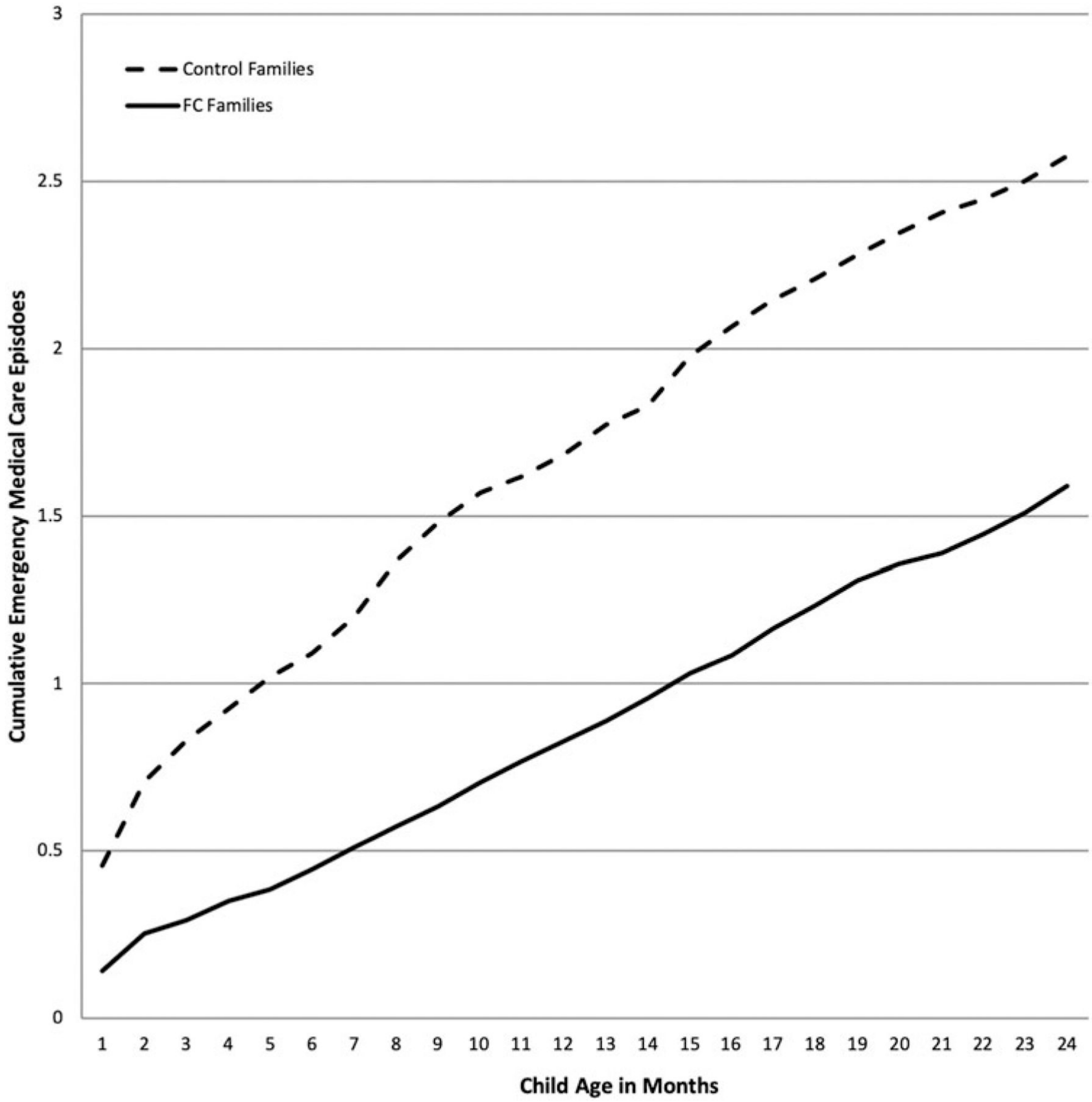

Figure 2.

Mean cumulative number of emergency medical care episodes from birth to 24 months, by intervention group ($n = 531$).

Table 1.

Comparisons of preintervention sample characteristics for the RCT population and selected and participating evaluation subsamples

	RCT population versus selected and interviewed evaluation subsamples		
Variable	**RCT population (n = 4,777)**	**Selected evaluation subsample (n = 664)**	**Participating evaluation subsample (n = 531)**
% Participation of selected			80.0
Infant cumulative birth risk			
% Low birth weight	10.0	9.1 ($p = .50$)	8.9 ($p = .45$)
% Gestation <37 weeks	8.2	6.7 ($p = .17$)	6.3 ($p = .12$)
% Any birth complications	7.4	5.8 ($p = .13$)	6.1 ($p = .26$)
% Cesarean section birth	30.6	31.6 ($p = .59$)	31.8 ($p = .56$)
% Medicaid/no insurance	60.8	63.1 ($p = .26$)	65.5 ($p = .04$)
Mother age (mean, years)	28.5	28.5 ($p = .84$)	28.3 ($p = .58$)
Mother race/ethnicity			
%White, non-Hispanic	29.7	29.2 ($p = .80$)	26.6 ($p = .13$)
% Black	36.7	38.0 ($p = .54$)	39.4 ($p = .23$)
% Hispanic	22.6	23.2 ($p = .71$)	24.7 ($p = .27$)
% Other	11.1	9.6 ($p = .27$)	9.4 ($p = .25$)
% Infant female	49.8	54.7 ($p < .01$)	53.5 ($p = .11$)

Note: Column 2 and Column 3 are contrasted with Column 1, with significance level in parentheses. A Holm–Bonferroni sequential correction was applied to account for multiple tests of between-group differences. No moderation terms remained statistically significant after applying a Holm-Bonferroni sequential correction.

Table 2.

Comparisons of preintervention sample characteristics for RCT intervention and control populations and for intervention and evaluation subsamples

Variable	RCT intervention population (n = 2,327)	RCT control population (n = 2,450)	Intervention evaluation subsample (n = 260)	Control evaluation subsample (n = 271)
% Participation of selected			81.3	78.8 (p = .43)
Infant cumulative birth risk				
% Low birth weight	10.1	9.8 (p = .77)	7.8	10.0 (p = .39)
% Gestation <37 weeks	7.9	8.5 (p = .49)	4.7	7.8 (p = .15)
% Any birth complications	7.3	7.5 (p = .76)	3.9	8.1 (p < .05)
% Cesarean section birth	30.9	30.3 (p = .66)	32.4	31.3 (p = .82)
% Medicaid/no insurance	60.4	61.2 (p = .55)	63.3	67.5 (p = .31)
Mother age (mean, years)	28.5	28.5 (p = .72)	28.2	28.4 (p = .66)
Mother race/ethnicity				
% White, non-Hispanic	29.5	29.9 (p = .76)	28.5	24.7 (p = .33)
% Black	35.8	37.6 (p = .20)	36.5	42.1 (p = .19)
% Hispanic	21.9	23.1 (p = .31)	25.0	24.4 (p = .86)
% Other	**12.8**	**9.4 (p < .01)**	10.0	9.9 (p = .65)
% Infant female	48.9	50.8 (p = .19)	50.8	56.1 (p = .22)

Note: Column 2 is contrasted with Column 1, and Column 4 is contrasted with Column 3, with significance level in parentheses. A Holm–Bonferroni sequential correction was applied to account for multiple tests of between-group differences. Bold font denotes moderation term remained statistically significant after applying a Holm-Bonferroni sequential correction.

Table 3.

Main effect and moderation analyses examining Family Connects impact on child emergency medical care utilization through age 24 months (n = 531)

	Birth to 24-month total ED care		12-month to 24-month total ED care		Birth to 24-month total ER visits		Birth to 24-month total hospital overnights	
Variable	***b***	**95% CI**	***b***	**95% CI**	***b***	**95% CI**	***b***	**95% CI**
Infant cumulative birth risk	0.45***	[0.27, 0.63]	0.12	[−0.08, 0.31]	0.09	[−0.08, 0.25]	1.21***	[0.38, 2.03]
Medicaid/no insurance at birth[a]	0.99***	[0.64, 1.35]	0.94***	[0.52, 1.36]	1.17***	[0.84, 1.51]	0.90	[−1.06, 2.86]
Mother minority status[b]	−0.10	[−0.47, 0.27]	0.20	[−0.23, 0.63]	0.17	[−0.18, 0.51]	−1.07	[−3.07, 0.92]
Mother single-parent status[c]	0.49***	[0.22, 0.76]	0.62***	[0.33, 0.92]	0.50***	[0.27, 0.74]	0.57	[−0.67, 1.82]
Infant gender[d]	−0.42***	[−0.67, −0.17]	−0.45***	[−0.73, −0.17]	−0.31**	[−0.54, −0.08]	−0.68	[−1.87, 0.51]
Treatment[e]	−0.35***	[−0.60, −0.10]	−0.05	[−0.34, 0.23]	−0.08	[−0.31, 0.15]	−1.66**	[−2.70, −0.63]
Treatment × Infant Birth Risk	−0.16	[−0.55, 0.24]	−0.44†	[−0.92, 0.04]	−0.16	[−0.54, 0.22]	0.62	[−1.03, 2.26]
Treatment × Medicaid/No Insurance	0.74*	[1.07, 1.61]	0.55	[−0.18, 1.28]	0.43	[−0.15, 1.01]	1.71	[−1.01, 4.43]
Treatment × Minority Status	**1.00****	**[0.40, 1.61]**	0.40	[−0.35, 1.15]	0.51†	[−0.09, 1.11]	2.58†	[−0.11, 5.28]
Treatment × Single-Parent Status	0.05	[−0.44, 0.55]	−0.59*	[−1.15, −0.02]	−0.10	[−0.56, 0.35]	0.45	[−1.76, 2.66]
Treatment × Infant Gender	−0.04	[−0.53, 0.46]	−0.24	[−0.80, 0.33]	−0.26	[−0.72, 0.19]	0.03	[−2.11, 2.18]

Note: AH interaction terms were examined individually; a Holm-Bonferroni sequential correction was applied to account for multiple tests of moderation. Bold font denotes moderation term remained statistically significant after applying a Holm–Bonferroni sequential correction.

[a] Medicaid/no insurance at birth: 0= *no*, 1 = *yes*.

[b] Mother minority status: 0 = *nonminority*, 1 = *minority*.

[c] Mother single parent status: 0= *no*, 1 = yes.

[d] Infant gender: 0 = *boy*, 1 = *girl*.

[e] Treatment: 0 = *control*, 1 = *Family Connects-eligible*.

† $p < .10$.

* $p < .05$.

** $p < .01$.

*** $p < .001$.