Family Mediators and Moderators of Treatment Outcomes Among Youths with Poorly Controlled Type 1 Diabetes: Results From a Randomized Controlled Trial

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Objective To determine whether multisystemic therapy (MST) improved family relationships among youths with poorly controlled type 1 diabetes and whether these changes mediated MST effects on health outcomes. The moderating effect of family demographics on study outcomes was also assessed. **Methods** A randomized controlled trial was conducted with 127 youths. Changes in general family relationships and caregiver support for diabetes care from baseline to treatment completion were assessed. Structural equation modeling (SEM) was used to test whether changes in family relations mediated improvements in frequency of blood glucose testing (BGT) and metabolic control. **Results** MST increased support for diabetes care from both primary and secondary caregivers in two-parent but not in single-parent families. However, MST had the strongest effects on BGT and metabolic control in single-parent families. SEM did not support family relations as the mediator of improved BGT or metabolic control. Rather, MST had a direct effect on BGT for all participants. BGT mediated improvements in metabolic control among single-parent families. **Conclusions** MST improved family relationships for youths with diabetes in two-parent but not in single-parent families. Objective outcomes related to diabetes were strongest for single-parent families. Other processes such as increased parental monitoring may have been responsible for improved health outcomes among these families.

Key words diabetes; family functioning; multisystemic therapy.

Family relationships play an important role in the development of good illness management skills among children with chronic illnesses such as type 1 diabetes. Multiple studies suggest that children with diabetes who come from families with maladaptive interactional patterns such as high levels of conflict or low levels of cohesion have poorer adherence and health outcomes (Cohen, Lumley, Naar-King, Partridge, & Cakan, 2004; Hanson, Henggeler, & Burghen, 1987; Hauser et al., 1990; Jacobson et al., 1994). Daily family interactions that take place around diabetes care, such as parental support for diabetes care, have also been found to be related to adherence and metabolic control (Anderson, Auslander, Jung, Miller, & Santiago, 1990; Hanson, Deguire, Schinkel, & Henggeler, 1992).

Because family relationships appear to influence children's ability to adhere to their medical regimen, intervention trials with children with type 1 diabetes have often used a family approach (Delamater et al., 2001). Both general family relations (Wysocki et al.,

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2000; Wysocki, Greco, Harris, Bubb, & White, 2001) and family support for diabetes care (Anderson, Brackett, Ho, & Laffel, 1999; Laffel et al., 2003) have been targeted for change, with the assumption that improvements in these areas would result in improved adherence behavior and metabolic control. However, some family therapy interventions that were successful in improving family relationships did not have the desired effect on health outcomes (Wysocki et al., 2000). Other studies that successfully used family intervention techniques to improve health outcomes did not find the expected changes in family relationships (Satin, LaGreca, Zigo, & Skyler, 1989). In still others, where the effect of the intervention on both family variables and health outcomes was established, formal tests of mediation were not conducted (Anderson et al., 1999). This leaves it unclear whether changes in family relationship were responsible for improvements in adherence or metabolic control.

Our research group has recently investigated the effectiveness of multisystemic therapy (MST) for the treatment of youths with poorly controlled type 1 diabetes. MST is an intensive, home- and community-based family therapy originally used with youths presenting with serious antisocial behavior and their families (Henggeler, Schoenwald, Borduin, Rowland, & Cunningham, 1998). Youths with poor metabolic control and their families are characterized by high rates of psychiatric co-morbidity (Kovacs, Goldston, Obrosky, & Iyengar, 1992), family psychopathology (Liss et al., 1998), and poor interface with health care providers (Jacobson et al., 1997; Kaufman, Halvorson, & Carpenter, 1999). The MST treatment approach is an excellent fit with the known etiology of poor metabolic control, because the scope of MST interventions encompasses the individual youth, the family system, and the broader community systems within which the family operates (i.e., school and health care system).

Results of our prior studies have shown MST to be effective in improving regimen adherence and metabolic control, decreasing diabetes-related stress, and reducing hospital admissions for diabetic ketoacidosis (DKA) for youths with poor metabolic control (Ellis, Frey, et al., 2005a, 2005b). Prior trials of MST with delinquent youths found that families receiving MST reported improvements in family relationships (Borduin et al., 1995; Henggeler, Melton, & Smith, 1992). Therefore, the primary purpose of the present study was to determine whether youths with type 1 diabetes who received MST and their families would report improvements in either general or in diabetes-specific family relationships such as caregiver support for diabetes care. A secondary aim was to determine whether any changes in family relationships that occurred as a result of the intervention would mediate the intervention's effect on a specific aspect of adherence, frequency of blood glucose testing (BGT), and metabolic control.

The final aim was to investigate whether family demographic characteristics such as the number of parents in the home would moderate the effects of MST on treatment outcomes. Minority and single-parent families are overrepresented among children with poor metabolic control (Delamater et al., 1999; Palta et al., 1997; Thompson, Auslander, & White, 2001). Such families may face unique challenges in coping with chronic illnesses, such as more limited resources for completing the medical regimen. However, prior trials of family interventions for youths with diabetes have enrolled low numbers of single-parent households. It was hypothesized that MST would be significantly more effective in improving family relationships than standard medical care and that MST would be equally effective for single-parent and two-parent families given its original development for high-risk families.

Methods

Participants

Youths and their families were recruited from an endocrinology clinic within a tertiary care children's hospital located in a major Midwestern metropolitan area. Inclusion criteria were (a) those diagnosed with type 1 diabetes for at least 1 year, (b) an average glycated hemoglobin (HbA1c) of 8% or higher during the year prior to study entry as well as the most recent HbA1c $\geq$ 8%, (c) between 10 years, 0 months and 17 years, 0 months of age, and (d) sufficient mastery of English to communicate with therapists and complete study measures. The only study exclusion criteria were moderate or severe mental retardation or psychosis.

Of the 182 families eligible for participation, 33 families (18%) refused to participate. Reasons for the lack of participation included parent or youth belief that the youth could improve their diabetes care without intervention, parental disinterest in home-based services, and family report that they were too busy to participate. Five families (3%) indicated an interest in participating but asked to be re-contacted later, and 17 families (9%) consented to participate but had not completed baseline data collection when study enrollment was closed and were not randomized. The final sample consisted of 127 youths and their families (70% of eligible families).

Sixty-four participants were assigned to MST and 63 to the control condition. Nine of the 127 families (7%) dropped out of the study before completing follow-up data collection and another 8 (6%) did not complete data collection within the specified window (87% completion rate). Seven of the 17 were in the MST condition and 10 in the control condition; there was no suggestion of differential loss to follow-up between the groups. One additional family could not be included in this study, as the parent did not report marital status on demographic questionnaires. Nine additional families were excluded from the analyses involving BGT only because of missing data from blood glucose meters. The study had sufficient power (.80) to detect a medium-sized difference (.5 *SD*) between MST and standard care control condition (SC), assuming two-tail $\alpha = .05$.

Consistent with the demographics of the clinic where participants were recruited and the known over-representation of minorities among the population of youth with poor metabolic control (CMPC), 63% of the sample were African American. Twenty-six percent were white, and the remaining 11% were of other ethnicity. Fifty-one percent were female. Mean youth age was 13.2 (*SD* = 1.9). Forty-nine percent of youths resided in a single-parent household (two-parent households included parents who identified themselves as single but living with a partner). Mean annual family income was $27,950 (*SD* = $17,951). The majority of youths participating in the study (92%) were managed with injected insulin, whereas 8% used an insulin pump. Mean length of time since diagnosis was 4.9 years (*SD* = 3.0). The mean HbA1c of youths at study entry was 11.3% (*SD* = 2.3%), confirming that youths in the sample were in poor metabolic control.

Procedures

The study was a randomized controlled trial with a repeated measures design. Families randomized to MST treatment received approximately 6 months of home- and community-based psychotherapy plus standard medical care, whereas families randomized to the control condition received standard care only. Randomization to treatment condition was completed immediately after baseline data collection by the project statistician. To ensure equivalence across treatment condition, we stratified randomization by the level of HbA1c at the baseline visit (high ≥ 10.5; low < 10.5). Data were collected at 7, 12, 18, and 24 months after baseline data collection. Questionnaires were completed by the youth and the youth's primary caregiver. In 88% of cases, the primary caregiver was a female. Families were reimbursed for data collection sessions. This study reports on data from the 7-month post-test (immediately after the conclusion of the intervention for families randomized to MST).

Intervention Condition

Youths assigned to the intervention condition received MST plus standard medical care (described in Standard Care Control Condition subsection). MST is an intensive, family-centered, community-based treatment originally designed for use with youth presenting with serious antisocial behavior (Henggeler et al., 1998). As MST is designed to target the multiple systems within which youth with serious problems are embedded, it does not follow a session-by-session treatment protocol. Rather, MST is specified through nine treatment principles that operationalize the parameters for designing and implementing interventions (Ellis, Naar-King, et al., 2005) and a treatment manual focusing on the application of these principles (Henggeler, Melton, Brondino, Scherer, & Hanley, 1997; Henggeler, Schoenwald, Liao, Letourneau, & Edwards, 2002; Huey, Henggeler, Brondino, & Pickrel, 2000, for an extensive discussion of the MST treatment principles and treatment fidelity). Three therapists provided treatment in this study. Therapists and their supervisor received a formal, 5-day training in MST techniques. MST interventions were also monitored for treatment fidelity using state-of-the-art quality assurance protocols, including weekly on-site clinical supervision and weekly telephone consultation with an MST expert consultant. All therapists participating in the trial met expected standards for treatment fidelity as assessed by standardized questionnaires and session audiotape coding.

Therapists began treatment by gathering data from multiple sources across multiple informants (family members, peers, school personnel, and medical treatment team) regarding the most salient factors associated with the youth's poor metabolic control. Once this assessment was completed, treatment goals and interventions were individually tailored for each family to treat the identified causes. Therapists met with families a minimum of two to three times per week at the beginning of treatment and then reduced the frequency of contact over time based on clinical need. The mean length of treatment in the study was 5.7 months, which is consistent with previous MST trials. Twenty-five percent (16/64) of treatment families did not complete a full course of therapy. The mean number of treatment sessions was 48 (*SD* = 19; range = 11–91) for treatment completers and 9 (*SD* = 8; range = 0–25) for dropouts.

MST interventions targeted adherence-related problems within the family system, peer network, and the broader community systems within which the family was embedded. Therapists drew on a menu of evidence-based intervention techniques that included cognitive–behavioral therapy, parent training, and behavioral family system therapy. For example, individual interventions carried out in this study included cognitive–behavioral therapy with depressed youth. Family interventions included introducing systematic monitoring, reward, and discipline systems to decrease parental disengagement from the diabetes regimen and teaching caregivers to communicate effectively with each other about the youth's medical regimen. School interventions included improving family–school communication about the youth's diabetes care needs and adherence behaviors (e.g., having school personnel report blood glucose readings from school meter to parents weekly). Peer interventions included enlisting the active support of peers regarding regimen adherence.

Community-level interventions included developing strategies to monitor and promote the youth's diabetes care while participating in extracurricular activities. Interventions within the health care system included helping the family resolve barriers to keeping appointments and working with the family and the diabetes treatment team to promote a positive working relationship. For example, therapists were required to accompany families to their medical appointments to assist the family and members of the medical team to problem-solve ways to improve regimen adherence.

Standard Care Control Condition

Youths randomized to the control condition received standard medical care. Standard care at the hospital where youths were cared for consisted of quarterly medical visits with a multidisciplinary medical team composed of an endocrinologist, a nurse, a dietician, a social worker, and a psychologist.

Measures

Family Relationships

Family relationships were measured by two methods. Diabetes-specific family relationships, operationalized as caregiver support for diabetes care, were measured by the supportive subscale of the Diabetes Family Behavior Checklist (DFBC; Schafer, McCaul, & Glasgow, 1986). Caregivers were asked to rate their supportive behaviors toward the youth. Youths were asked to rate supportive behaviors by the primary caregiver. When the youth resided in a two-parent home, they were also asked to rate supportive behavior by their other caregiver. Higher scores on the instrument indicate more support. Internal consistency in the current sample was .80 for parents and .82 for youths.

General family relationships were measured by the Family Relationship Index (FRI) of the Family Environment Scale (FES; Moos & Moos, 1994). The FRI consists of three FES subscales (expressiveness, cohesion, and conflict) and is calculated by adding the expressiveness and cohesion subscales and subtracting the conflict subscale. Higher scores indicate better family functioning (high expressiveness, high cohesion, and low conflict). Internal consistency in the current sample was .73 for parents and .78 for youths.

Adherence

Adherence to a single aspect of the diabetes regimen, frequency of BGT, was obtained directly from the youth's blood glucose meter. Obtaining data from the meter instead of by self-report provided the most objective information possible. The frequency of testing during the 14-day period immediately preceding data collection was recorded, and an average daily testing frequency was subsequently calculated. Although diabetes self-care includes the completion of insulin administration and management of diet, BGT is the regimen adherence behavior that has been most closely linked to metabolic control in pediatric populations (Levine et al., 2001).

Metabolic Control

For the majority of participants, HbA1c (reference range = 4–6.4%) was calculated by the medical center laboratory from a total glycated hemoglobin (GHb). This approach was taken by the laboratory because of the high prevalence rate of abnormal hemoglobin variant carriers in the population served, which is primarily African American. GHb was analyzed by boronate-affinity chromatography using a glycated hemoglobin and protein analyzer Model CLC385 (Primus Corporation, Kansas City, MO). However, 5.5% of HbA1c values were calculated during a medical appointment in the diabetes clinic with a DCA 2000 system (Bayer, Elkhart, IN) which uses an immunoglobulin-agglutination methodology. DCA results were used when youths were seen for a clinical appointment on the day of a research visit and refused a venipuncture, or when families missed the study visit but completed their clinical visit. Higher levels of HbA1c indicate worse metabolic control.

Results

Analytic Approach

To simplify data presentation and decrease the complexity of the analyses and the likelihood of Type I error because of multiple comparisons, we first conducted data reduction by averaging parent and youth report for the FRI and for DFBC ratings of primary caregiver support. As the youth alone rated support from the secondary caregiver, the DFBC secondary caregiver score represented youth ratings only. To ensure that a simple summative score was capturing the reliable common variance for the combined measures, we first calculated internal consistencies. Second, following Holmbeck, Li, Schurman, Friedman, & Coakley (2002), an unrestricted principal component factor analysis was performed on each aggregated measure to examine the contribution of youth and parent components to the primary unrotated factor as judged by the sum of the squared factor loadings of the items onto the factor. This provides an estimate of the common variance accounted for in the factor by the items. For the FRI combined measure, the α coefficient was .81. The parent items accounted for 16% of the variance in the primary factor and the youth items for 18% of the variance, suggesting that each respondent version contributed equally to the combined measure. For the DFBC combined measure, the α coefficient was .84. The parent items accounted for 12% of the variance in the primary factor and the youth items for 16% of the common variance, suggesting that parent and youth items contributed equally to this instrument also.

The hypothesis that the MST group would have improved outcomes relative to the SC group was tested using intent-to-treat analyses. Non-completers of the post-test data collection (7 MST and 10 controls) were treated conservatively as if no change occurred and the participant's baseline score for each outcome variable was forwarded to the follow-up point. Comparisons of families with missing data on any variable with those who completed all data points were conducted using Student's t test for continuous variables and Fisher's exact test for categorical variables. No differences were found on HbA1c at study entry, $t(125) = -.56$, *ns*, nor on child age, $t(125) = 1.18$, *ns*, illness duration, $t(118) = 1.14$, *ns*, gender, $\chi^2(1)=1.00$, *ns*, ethnicity, $\chi^2(1)=.31$, *ns*, or number of parents in the home, $\chi^2(1)=.80$, *ns*. There were also no significant differences for either the parent or the teen report version of the FRI or DFBC between the two groups at study entry.

Change in family functioning, BGT, and HbA1c was calculated by subtracting baseline values from 7-month follow-up values. Therefore, positive change scores for the FRI, DFBC, and BGT represented improved functioning, and negative change scores for HbA1c indicated improved functioning. Separate analyses of variance (ANOVAs) were then conducted with FRI, DFBC, BGT, and HbA1c change scores serving as the dependent variables and treatment assignment as the independent variable. The hypothesis that changes in family relationships would mediate improvements in the frequency of BGT and metabolic control was tested via structural equation modeling (SEM) using AMOS Version 5.0.

To test for the moderation of treatment effects, family composition (one- or two-parent household) was added separately to the ANOVA as a factor. Family composition was coded without regard to whether caregivers were related biologically to the child or not; therefore, two-parent homes included two biological parents, a biological parent and stepparent, two foster parents, and two extended family members (i.e., two grandparents). Single parents with live-in partners were also coded as two–parent homes. Interaction effects were not tested for the DFBC secondary caregiver variable because of sample size constraints that would have resulted in inadequate power and the confounding of the measure with family composition (i.e., only youths in two-parent homes rated the secondary caregiver's support).

Although at least one study that has disentangled the effects of ethnicity and family composition has found that single-parent status accounts for the majority of the variance in metabolic control (Harris, Greco, Wysocki, Elder-Danda, & White, 1999), the degree of association between family composition and family ethnicity was also assessed to ensure that family composition was not a proxy for family ethnicity. Ethnicity was transformed into a categorical variable with two levels (African American and other). Chi–square tests of association showed that in the present urban sample, family composition and family ethnicity were not significantly associated, $\chi^2(1) = 2.42$, *ns*. Because ethnicity could not have accounted for a significant amount of the variance in outcome measures explained by family composition, it was not included further in the analyses. Family income was significantly related to single-parent status ($r = -.37$, $p < .01$). Analyses for moderation were also repeated using family income as the moderator. However, family income did not function as a moderator of intervention effects for any outcome variable.

Baseline Comparisons

Table I summarizes baseline descriptive statistics for treatment outcome variables by treatment assignment and family composition. There were no significant differences between the MST and SC groups at baseline on any outcome variable, nor between single- and two-parent families. In addition, there were no significant differences

Table I. Baseline Scores for Family Variables and Outcome Variables by Group Assignment, Ethnicity, and Family Composition

	M (*SD*)			
	MST (*N* = 64)	SC (*N* = 63)	Single-parent (*N* = 65)	Two-parent (*N* = 61)
DFBC primary caregiver	27.52 (7.05)	28.44 (5.86)	28.07 (6.96)	28.02 (6.00)
DFBC secondary caregiver[a]	22.63 (7.80)	25.83 (9.22)		
FRI	8.87 (3.27)	8.69 (3.31)	9.01 (3.39)	8.60 (3.20)
HbA1c	11.40 (2.25)	11.29 (2.34)	11.69 (2.27)	11.03 (2.28)
BGT frequency	1.82 (1.15)	2.17 (1.33)	1.94 (1.28)	2.05 (1.24)

BGT, blood glucose testing; DFBC, Diabetes Family Behavior Checklist; FRI, Family Relationship Index; HbA1c, average glycated hemoglobin; MST, multisystemic therapy; SC, standard care.

[a]Variable not measured for adolescents in single-parent families.

between the MST and control groups on the majority of demographic variable such as regimen type, child or parent age, ethnicity, or family composition. However, significantly more males were randomized to MST.

Family Relationship Outcomes

It was predicted that MST would improve family relations as compared with standard care. However, as summarized in Table II, the main effect of treatment condition on primary caregiver support for diabetes care was not significant, $F(1, 126) = .01$, *ns*. On the contrary, a significant main effect of treatment condition was found for secondary caregiver support. Youths residing in two-parent families who received MST reported significant increases in support from their secondary caregiver as compared with controls in two-parent households, who reported decreased support over time ($t = 2.67$, $p < .05$). There was no significant main effect of treatment condition on FRI, $F(1, 126) = .55$, *ns*, as both MST and SC families reported small improvements in general family relationships (Table II).

When interaction effects were considered, a very different picture of change in family relations emerged. Figure 1 shows change in primary caregiver support (DFBC primary caregiver) for diabetes care and change in general family relations (FRI) for single-parent and two-parent families in the MST and control conditions. A significant Treatment × Family Composition effect was found for DFBC primary caregiver, $F(1, 126) = 3.75$, $p \leq .05$, and for FRI, $F(1, 126) = 4.90$, $p < .05$. Follow-up with simple effects tests indicated that there was no significant change in primary caregiver support for diabetes care for single ($p = .96$) or two-parent SC families ($p = .48$). However, in the MST condition, two-parent families reported increased support for diabetes care from the primary caregiver ($p = .01$), whereas single-parent families reported no significant change in support ($p = .18$). A similar pattern of effects was found for FRI (Fig. 1); however, none of the simple effects tests were significant.

Table II. Change Scores for Family, Adherence, and Metabolic Control Variables for Multisystemic Therapy (MST) and Standard Medical Care (SC) Conditions

	M (*SD*)		
	MST	SC	F
DFBC primary	.47 (4.02)	–.18 (4.73)	.55
DFBC secondary[a]	3.32 (7.93)	–1.63 (5.25)	7.13**
FRI	.16 (2.79)	.09 (2.89)	.01
HbA1c	–.68 (1.68)	.09 (1.66)	3.00*
BGT frequency	.71 (1.08)**	–.16 (1.28)	16.35**

BGT, blood glucose testing; DFBC, Diabetes Family Behavior Checklist; FRI, Family Relationship Index; HbA1c, average glycated hemoglobin.

[a]DFBC secondary caregiver analyses conducted with two-parent families only.

*$p < .10$. **$p < .05$.

Adherence and Metabolic Control Outcomes

A significant main effect of treatment condition was found for BGT, $F(1, 116) = 16.35$, $p < .001$. Youths who received MST showed significant improvement in the frequency of BGT as compared with youths receiving standard care, who were less adherent over time (Table II). A trend to significant main effect was found for HbA1c, with youths receiving MST showing improvements in metabolic control, $F(1, 126) = 3.00$, $p < .10$.

There were no significant Treatment × Family Composition effects for BGT, $F(1, 116) = 1.12$, *ns*. However, a trend toward significant effect of Group × Family Composition was found for HbA1c, $F(1, 126) = 3.20$, $p < .10$ (Fig. 1). Simple effects test indicated that significant change occurred only for youths in single-parent homes assigned to MST ($p = .003$); HbA1c decreased .92% for this group.

Structural Equation Modeling

Model Specification and Testing

As bivariate analyses showed a significant interaction between family composition and changes in family relationship variables (FRI and primary caregiver DFBC),

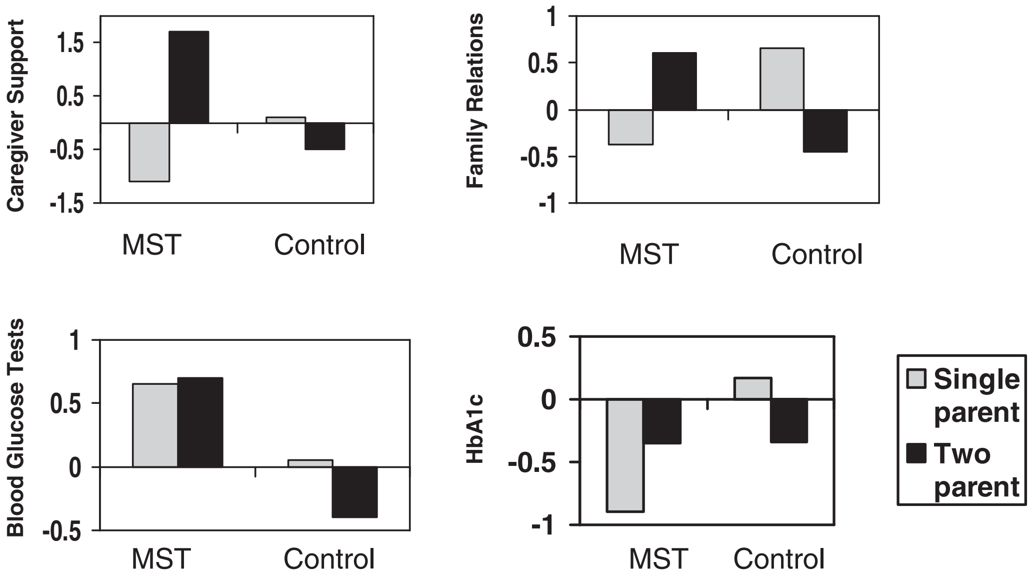

Figure 1. Changes in proposed family mediators and treatment outcome variables for single- and two-parent families in Multisystemic Therapy (MST) and Standard Medical Care (SC) conditions.

multigroup SEM was used to test for mediation with family composition defining the two groups. The purpose of this analysis was not to formally test the hypothesis that a two-group solution was preferable but simply to conduct tests for mediation by group given prior findings of differences between single- and two-parent families. The general conceptual model that was tested included one exogenous variable (treatment condition: MST or SC control) and four endogenous variables (i.e., FRI, primary caregiver DFBC, BGT, and HbA1c). As MST was expected to improve adherence behavior both directly and indirectly via improved family functioning, direct paths from MST to BGT and indirect paths from MST to BGT through family variables were both included.

A recursive model with four correlated equations was tested using the covariance matrix for each group. No parameters were constrained to be equal across groups. Therefore, all parameters could be estimated with ordinary least squares regression. Estimating the model in this way does not provide the customary model fit indices. Therefore, full information maximum likelihood (ML) estimation followed by a parametric bootstrap was used to estimate model parameters and standard errors. The parametric bootstrap is considered more appropriate for small samples, particularly when testing mediation (Shrout & Bolger, 2002).

SEM Results

Figure 2 shows the results of the multigroup SEM. The overall fit of the model was satisfactory (χ^2 = 10.01, p = .18, *CFI* = .91, and *RMSEA* = .06). Examination of the standardized path coefficients showed that MST improved primary caregiver support for diabetes care for youths in two-parent families but not for youths in single-parent families. This was expected based on the bivariate analyses presented previously. Primary caregiver support, however, did not mediate the effect of MST on BGT as expected. Neither FRI nor DFBC primary caregiver was significantly related to BGT frequency in either group. Frequency of BGT was found to mediate the effect of MST on HbA1c for youths in single- but not two-parent families (p = .04). An alternative model with direct paths from FRI and DFBC primary caregiver to HbA1c was also tested. However, paths from FRI and DFBC to HbA1c were of low order and nonsignificant, and the model fit statistics were not significantly improved with these paths in the model.

Analyses of family variables were also repeated using the parent and youth report versions of the DFBC and FRI rather than the aggregated variables. In these analyses, a significant Treatment x Family Composition effect was found for DFBC parent report [F = 5.41, p <. 05] and for FRI parent report [F = 5.46, p < .05], replicating the findings for the aggregated DFBC and FRI variables. The direction of the means for youth report on the FRI and DFBC was the same as for parent report but was nonsignificant. SEM models were also run separately using first parent- and then youth-reported family variables. For two-parent families, results obtained using parent and youth report were virtually identical to one another with no difference in the

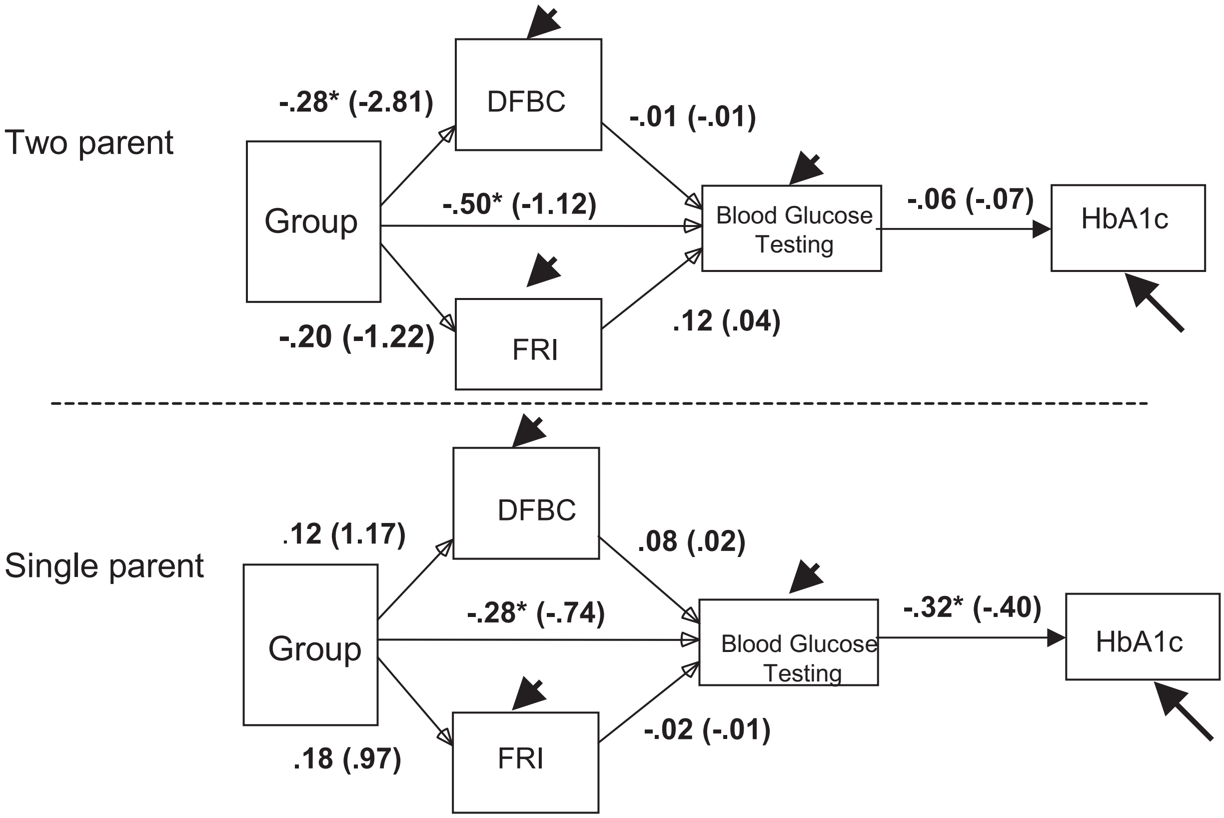

Figure 2. Standardized path coefficients from multigroup structural equation modeling (SEM). Multisystemic therapy (MST) = 1; standard medical care (SC)=2. Residuals between Diabetes Family Behavior Checklist (DFBC) and Family Relationship Index (FRI) are positively correlated ($r = .22$) in the two-parent group but are not shown in the diagram. *$p < .05$.

significance level of any standardized path coefficient and the largest difference in magnitude being less than .10. For single-parent families, the negative effect of MST on DFBC shown in the aggregated model became significant when parent report alone was used [$\alpha = .35$, $p < .05$], whereas youth report alone was nonsignificant [$\alpha = .10$, *ns*]. Single parents in MST thus reported decreased support over time, although this was not reported by the youth. The single-parent model was otherwise alike regardless of whether the parent or the youth report of DFBC and FRI was used.

Discussion

Family-based approaches have often been used to improve adherence behavior and metabolic control among youths with type 1 diabetes. The primary purpose of this study was to investigate the effects of MST on general and diabetes-specific family relationships among youths with poor metabolic control and to determine whether family demographic characteristics such as the number of parents in the home moderated the effects of MST on treatment outcomes. A secondary purpose was to determine whether changes in family relationships would mediate any improvements in adherence (frequency of BGT) and metabolic control that occurred as a result of MST.

Significant improvements in family relationships as a result of MST were found only for two-parent families. For these families, MST significantly increased support for diabetes management from both the primary and the secondary caregiver over the course of the study. Improved support from the secondary caregiver is particularly important in light of the common findings that secondary caregivers (often fathers) have low levels of involvement in the care of chronically ill children (Wysocki & Gavin, 2004) and the nature of the MST intervention, which targeted the entire family.

Although changes in general family relationships were in the same direction as those found for diabetes-specific relationships, improvements in general family relationships for two-parent MST families were not statistically significant. Reports from prior trials of MST for delinquent youth (Borduin et al., 1995; Henggeler et al., 1992) show that in families of antisocial youth, MST was able to improve general family relations. However, the current adaptation focused most strongly on family interactions related to diabetes care. Some studies have also suggested that diabetes–specific interactions may be more closely linked to health-related outcomes than general family relations (Hanson et al., 1992).

Findings regarding changes in family relationships for single-parent families were in significant contrast with those for two-parent families. No improvements were found for either general family relationships or diabetes-specific caregiver support for those single-parent families assigned to MST. The broader family and adolescent risk literature may help explain why single-parent families did not report improvements in diabetes-related support. Other studies of low-income, urban families suggest that economic disadvantage is a stressor which places single parents at high risk of psychological distress and poor parenting practices (Brody & Flor, 1997; Mistry, Vandewater, Huston, & McLoyd, 2002). Thus, the multiple demands faced by single parents may have made increasing their day-to-day support to youths for diabetes care more difficult than for two-parent families. Social support has been proposed as a protective factor for single parents that is related to more effective and nurturant parenting (Ceballo & McLoyd, 2002). To increase diabetes support from parents in single-parent families where parents are already taxed by work and family demands, clinicians may need to seek increased support for parents in the natural social ecology, such as from extended family members or friends who could encourage and support more active parenting

The finding that single-parent families perceived no improvement in family relationships is particularly striking in light of the health-related outcomes for these families. Youths in single-parent families assigned to MST had significant improvements in frequency of BGT, one aspect of adherence to the diabetes regimen, and were the only group to show significant improvement in HbA1c. Moreover, the mean reduction in HbA1c for youths in single-parent families was .92%, a reduction that is both clinically meaningful and in the range associated with reductions in rates of diabetes complications (The Diabetes Control and Complications Trial/Epidemiology of Diabetes Interventions and Complications Research Group, 2000). Youths in two-parent families had significant improvements in BGT frequency but not in metabolic control. A possible explanation is the relatively higher HbA1c of youths in single-parent families at study entry. Although these differences were not statistically significant, youths with higher HbA1cs at study entry may have had more opportunity to improve. The possibility of confounding variables such as more insulin resistance among two-parent families because of earlier Tanner stage, higher rates of obesity, or other physiological factors also cannot be ruled out.

When the effects of changes in family relationships on changes in BGT were investigated through SEM, little support was found for mediation. Assignment to MST was strongly associated with improved BGT for two-parent families and modestly associated with improved BGT for single-parent families. These changes in BGT were also significantly related to changes in metabolic control for single-parent families. However, the improvements in support for diabetes care found among two-parent families were not related to changes in BGT. Longitudinal studies have provided mixed support for the hypothesis that family environment at the time of diagnosis predicts later adherence and metabolic control (Hauser et al., 1990; Jacobson et al., 1994). For instance, it has previously been suggested that family conflict may be an outcome, not a predictor, of poor adherence (Hanson, 1990). If so, then reductions in family conflict or increases in support might not necessarily result in improved adherence.

An alternative explanation for our findings that changes in family support were not related to changes in BGT is that MST affected family processes, such as parental supervision and monitoring of youth diabetes care, that were not adequately measured in this study and that increased monitoring was responsible for improved BGT. These processes have been shown to be critical in other risky behaviors such as early sexual initiation (French & Dishion, 2003), delinquency and substance use/abuse (Forehand, Miller, Dutra, & Chance, 1997; Simons-Morton & Chen, 2005), and academic failure (Anderson, Lindner, & Bennion, 1992). Poor adherence may be yet another of this constellation of risk behaviors that is relevant to the subset of youths who have a chronic illness. Measures of parental monitoring of diabetes management, as a parenting behavior that is discrete from support, have not been well developed but may be particularly important to predicting the outcomes of youth with poor metabolic control.

Limitations of this study include the use of self-report data to measure family relations and inclusion of only a single aspect of regimen adherence (BGT). Although the measure was chosen because of its close association with metabolic control in prior studies (Levine et al., 2001), it is possible that family support may have been more strongly related to other aspects of regimen adherence such as insulin administration, diet, or exercise. In addition, this study reports only on outcomes at treatment termination. Additional follow-up of the sample is needed to assess whether there were stable changes in family relationships. The relatively broad age of the sample and different expectations for parental support for diabetes care for younger and older youth may also have affected study findings. This study used a standard care control condition; therefore, it is not possible to rule out the effects of attention versus specific intervention content in participant improvement. Finally, the effects of various aspects of treatment implementation such as the dose of treatment received and the location of treatment (i.e., home, school or medical clinic) were not investigated in this study and should be considered in future work.

In summary, the results of this study support the effectiveness of intensive, home-based family therapy for improving diabetes-specific family relations in a subset of youth with type 1 diabetes and poor metabolic control. This study further highlights the importance of developing evidence-based interventions for chronically ill youth, particularly those that show potential for wide-scale adoption in real-world, community settings. Further research is needed to better understand those family processes that are most crucial for improving adherence behavior in urban, socially disadvantaged youth, particularly those youth from single-parent families.

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