Multisystemic Treatment of Poorly Controlled Type 1 Diabetes: Effects on Medical Resource Utilization

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Objective To determine whether multisystemic therapy (MST), an intensive, home-based psychotherapy, could decrease rates of hospital utilization and related costs of care among adolescents with poorly controlled type diabetes. **Methods** Thirty-one adolescents were randomly assigned to receive either MST or standard care. MST lasted approximately 6 months, and all participants were followed for 9 months. Rates of inpatient admissions and emergency room (ER) visits were calculated for a 9-month prestudy period and during the 9 months of study participation. The relationship between changes in inpatient admissions and changes in metabolic control was also investigated. **Results** Intervention participants had a decreasing number of inpatient admissions from the baseline period to the end of the study, whereas the number of inpatient admissions increased for controls. Use of the emergency room did not differ. Related medical charges and direct care costs were significantly lower for adolescents receiving MST. Correlational analyses conducted with a subset of participants indicated that decreases in inpatient admissions were associated with improved metabolic control for MST but not control participants. **Conclusions** Findings suggest that MST has the potential to decrease inpatient admissions among adolescents with poorly controlled type 1 diabetes.

Key words diabetes; ketoacidosis; multisystemic therapy.

The management of adolescents with type 1 diabetes and chronically poor metabolic control presents a number of challenges to health care professionals. Although physiological factors such as insulin resistance can result in inadequately controlled diabetes, poor completion of diabetes self-care tasks is also related to poor metabolic control (Anderson, Ho, Brackett, Finkelstein, & Laffel, 1997; Glasgow et al., 1999; Morris et al., 1997). Behavioral risk factors that have been linked to suboptimal health outcomes for adolescents with diabetes are also more prevalent among adolescents with poorly controlled diabetes. Adolescents in poor metabolic control have been reported to have higher rates of behavioral or emotional problems and psychiatric disorders (Leonard, Jang, Savik, Plumbo, & Christensen, 2002; Orr, Golden, Myers, & Marrero, 1983), and more family relationship problems than adolescents whose diabetes is well controlled (Dumont et al., 1995; Liss et al.; 1998). Excessive school absence beyond that accounted for by hospital stays has also been described (Orr et al., 1983). Finally, such adolescents are disproportionately likely to be from disadvantaged groups such as those of lower socioeconomic status and minority groups (Delamater et al., 1999; Harris & Mertlich, 2003).

Taken together, the descriptive studies of adolescents with chronic poor metabolic control suggest that such teens are embedded within problematic family, school and community contexts which provide inadequate

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support for good diabetes management. The growing literature on intervention strategies for multiproblem youth and families suggests that family-based, comprehensive therapy approaches may be a viable way to successfully engage and treat difficult adolescents (Borduin, Schaeffer, & Ronis, 2003; Liddle & Hogue, 2000; Szapocznik & Williams, 2000). The following article reports findings from a randomized, controlled trial that used multisystemic therapy (MST), an intensive, home-based family therapy, as a treatment to improve regimen adherence and glycemic control among adolescents with poorly controlled type 1 diabetes. MST was originally developed for use with delinquent youth and their families (Henggeler, Schoenwald, Borduin, Rowland, & Cunningham, 1998). Several randomized clinical trials have documented its utility for treating highly difficult populations including youths presenting with delinquency (Borduin et al., 1995; Henggeler, Melton, & Smith, 1992), substance abuse (Henggeler, Clingempeel, Brondino, & Pickrel, 2002) and psychiatric emergencies (Henggeler et al., 1999; Schoenwald, Ward, Henggeler, & Rowland, 2000). The treatment theory underlying MST draws upon social-ecological and family systems theories of behavior. As a result, MST interventions are directed toward adolescents and their families, peers, and schools. Because of its comprehensive, family-based treatment approach, MST is conceptually an excellent fit for the treatment of poorly controlled diabetes.

Preliminary work by our group has provided data to support the transportability of MST to the treatment of adolescents with chronic illness and suggests that MST has the potential to improve the glycemic control of adolescents with chronically poor control (Ellis, Naar-King, Frey, Rowland, & Greger, 2003). Another health-related outcome of interest is MST's ability to decrease rates of hospital utilization for complications of diabetes. Poor metabolic control is associated with higher rates of hospital admissions for diabetic ketoacidosis (DKA) (Dumont et al., 1995; Levine et al., 2001; Liss et al., 1998; Rewers et al., 2002), a serious and potentially life-threatening condition. This may be because the compromised health status of children in poor control makes them more vulnerable to metabolic instability in the face of acute illness or infection or because of the problematic adherence behaviors found in this population, as most DKA admissions in the postdiagnostic period occur because of omitted insulin (Smith, Firth, Bennett, Howard, & Chisholm, 1998). In addition to the threats to health posed by DKA, DKA-related costs have been estimated to represent 1 in 4 health care dollars spent on direct medical care for persons with diabetes (Javor et al., 1997) and those whose DKA admissions are caused by regimen noncompliance represent the most expensive group to treat (Maldonado, Chong, Oehl, & Balasubramanyam, 2003).

The purpose of this study was to determine whether MST could reduce rates of emergency room (ER) use and hospital admissions for adolescents in poor metabolic control. A secondary goal was to determine whether there would be related reductions in the costs of diabetes care for such adolescents. We hypothesized that adolescents who received MST would have significantly lower hospital utilization rates than adolescents who received traditional medical management and that therefore, the related costs of their care would be lower as well.

Method

Participants

Adolescents and their families were participants in a larger clinical trial investigating the effectiveness of MST for improving health outcomes among adolescents with poorly controlled type 1 diabetes. They were recruited from an endocrinology clinic within a tertiary care children's hospital located in a major metropolitan area. To be eligible for the study, participants had to be diagnosed with type 1 diabetes for at least 1 year and to have a glycohemoglobin (GHb) of 13% or higher. Several prior studies have used the benchmark of GHb greater than 10% (Delamater, Albrecht, Postellon, & Gutai, 1991; Wysocki et al., 2000) to distinguish between adequate and inadequate control based on recommendations from the American Diabetes Association. However, there are no research guidelines for defining very poor control. Therefore, 13% was chosen because it marked approximately the 75th percentile of the distribution of GHb for children seen in the clinic from which participants were recruited. It should be noted that metabolic control is a health outcome and therefore should not be viewed as synonymous with a behavioral variable such as poor adherence (Glasgow & Anderson, 1995). However, given the difficulty of obtaining valid self-report of poor regimen adherence (Burkhardt, Dunbar-Jacob, & Rohay, 2001), and the substantial literature supporting links between poor control and inadequate diabetes management (Anderson et al., 1997; Morris et al., 1997), poor metabolic control was used as a proxy variable for poor treatment adherence. Participants were required to have a Tanner stage of II or above to be certain that they had already entered puberty, as the transition to puberty and ensuing hormonal changes can

adversely affect metabolic control, and we wished to exclude adolescents with transitory control problems secondary to biological factors. Adolescents older than 16 were excluded from the study, as it was felt that family therapy might be less appropriate for older youth. No child psychiatric diagnoses were exclusionary with the exception of moderate or severe mental retardation or psychosis. This was important in light of the previously discussed finding that children with chronically poorly controlled type 1 diabetes have higher rates of psychiatric comorbidity. Minimizing such exclusion criteria increased the likelihood that the sample would be similar to those adolescents encountered in the real world of clinical practice.

The initial subject pool consisted of forty-seven eligible adolescents whose families were contacted about the study (Figure 1). The final sample consisted of 31 adolescents and their families. Sixteen of the participants received MST and 15 participants were controls. Five of the 16 treatment families dropped out of treatment before completion of the therapy protocol; however, data from all 31 families were included in the analyses. Three dropouts occurred after families had received three to five sessions of treatment and represented a failure to adequately engage the family in treatment. Two dropouts occurred later in treatment after families had received 16–24 sessions of treatment. These reflected disagreement between the therapist and the family regarding the direction and nature of treatment (e.g., one parent wanted to pursue individual therapy for the adolescent). For correlational analyses, data were available on only 23 participants because of study dropouts and inability to schedule participants for data collection.

Table I presents information on sample demographics. The insulin management of the adolescents participating in the study consisted of a regimen of two to four insulin injections per day; no adolescent was using an insulin pump. Adolescents were also required to test their blood sugar a minimum of 3–4 times per day and

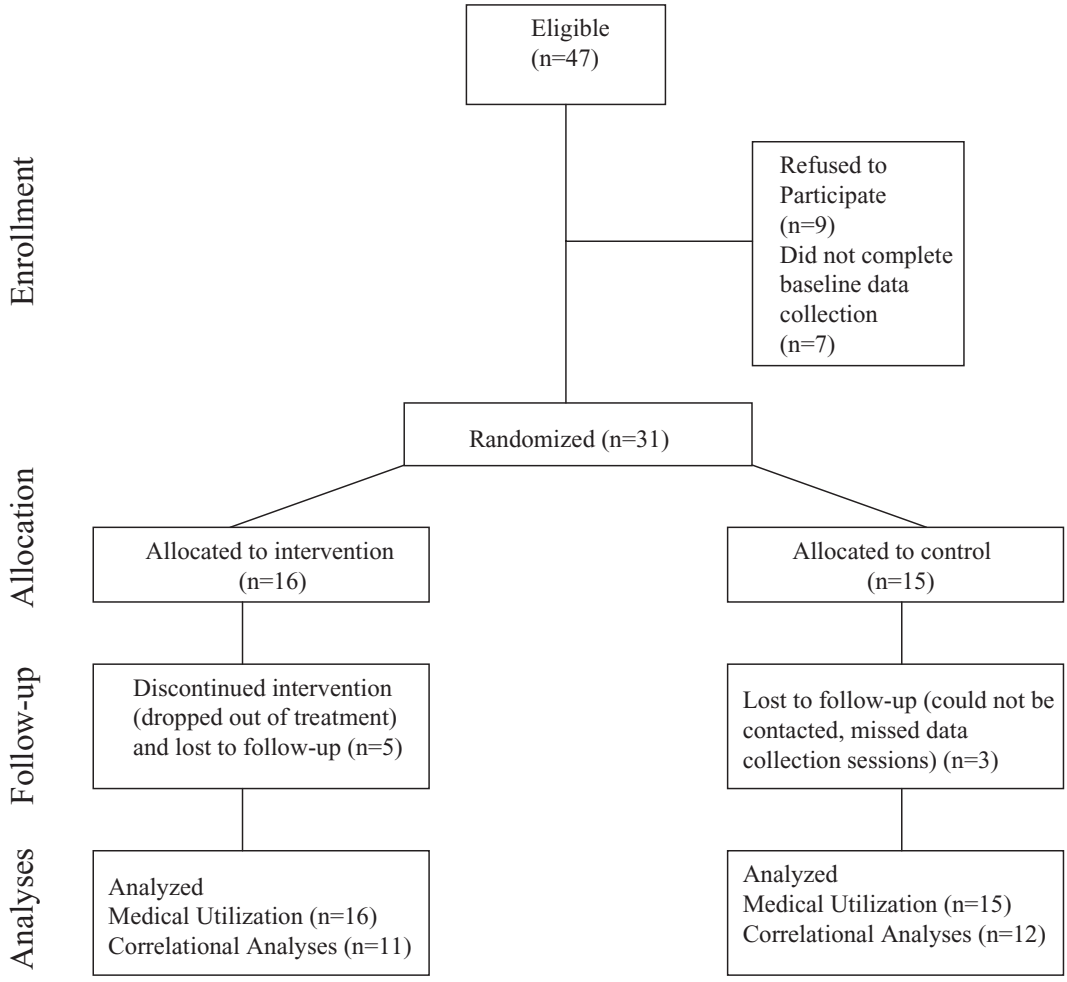

Figure 1. Study sample overview using Consolidated Standards of Reporting Trials guidelines for randomized clinical trials.

Table I. Demographic Characteristics of Adolescents and Their Families Multisystemic Therapy (MST) Vs. Standard Care

	MST	Standard care
Child age	14.19 (1.42)	13.47 (1.68)
Parent age	37.81 (6.26)	38.43 (7.76)
Family income	$26,437 ($16,655)	$31,666 ($17,338)
GHb	17.0% (2.8%)	17.4% (3.9%)
Child gender		
% Male	44	40
% Female	56	60
Number of parents in home		
% Two parents[a]	56	67
% Single parent	44	33
Child ethnicity		
% African American	75	46
% Caucasian	19	46
% Other[b]	6	7

[a]Two parents indicates biological parents or stepparents.
[b]Other included one adolescent who was biracial and one who was Hispanic.

follow a standard American Diabetes Association (ADA) diet plan for children with type 1 diabetes.

Procedure

Eligible adolescents and their parents were contacted about the study by letter followed either by a telephone call or by a personal contact at the time of a hospital clinic visit if no home telephone number was available. The research was approved by the Human Investigation Committee of the university affiliated with the hospital where the adolescents were seen for medical care. All participants and their parents provided informed consent and assent to participate.

The design of the parent study from which data for this study was drawn was a randomized controlled trial of MST. Families randomized to treatment received approximately 6 months of home-based psychotherapy in addition to their standard medical care, whereas families randomized to the control condition received standard care alone. A posttest was also conducted 9 months after study entry to assess maintenance of treatment effects during the 3 months after therapy was terminated. Randomization to treatment or control group was completed by the project statistician immediately after initial data collection (i.e., questionnaires, interviews) was completed.

Intervention Condition

Adolescents assigned to the intervention condition received MST plus standard medical care (described below). Treatment was provided by three therapists with varied backgrounds (i.e., one graduate student in clinical psychology, one bachelor's level mental health worker, one nurse with a child mental health specialization). MST is an intensive, family centered, community based treatment originally designed for use with adolescents presenting with serious antisocial behavior (Henggeler, 1999). As MST is designed to target the multiple systems within which youth with serious problems and their families are embedded, it is not amenable to detailed session by session treatment specification. Rather, MST is broadly specified through nine treatment principles, a treatment manual focusing on the application of these principles (Henggeler et al., 1998), and manuals specifying supervisor and consultant protocols (Henggeler & Schoenwald, 1998; Schoenwald, 1998). Therapists begin by conducting a multisystemic assessment of the strengths and weaknesses of the family, then based upon this assessment tailor treatment goals and interventions to each family to best treat the adherence problem. In the current study, therapists were expected to meet with families a minimum of 2 to 3 times per week at the beginning of treatment. Treatment was terminated when treatment goals were met rather than when a set number of sessions were completed. However, based on previous MST trials and our own prior experience with the model (Ellis et al., 2003), treatment was planned to last for approximately 6 months. Mean length of treatment in the study was in fact 6.5 months.

MST interventions targeted adherence-related problems within the family system, peer network, and the broader community systems within which the family was involved. Therapists drew upon a menu of evidence-based intervention techniques that included cognitive-behavioral therapy, parent training and behavioral family

Table II. Multisystemic Therapy (MST) Principles

(1)	The primary purpose of assessment is to understand the "fit" between the identified problems and their broader systemic context.
(2)	Therapeutic contacts should emphasize the positive and should use systemic strengths as levers for change.
(3)	Interventions should be designed to promote responsible behavior and decrease irresponsible behavior among family members.
(4)	Interventions should be present focused and action oriented, targeting specific and well-defined problems.
(5)	Interventions should target sequences of behavior within or between multiple systems that maintain the identified problems.
(6)	Interventions should be developmentally appropriate and fit the developmental needs of the youth.
(7)	Interventions should be designed to require daily or weekly effort by family members.
(8)	Intervention efficacy is evaluated continuously from multiple perspectives with providers assuming accountability for overcoming barriers to successful outcomes.
(9)	Interventions should be designed to promote treatment generalization and long-term maintenance of therapeutic change by empowering caregivers to address family members' needs across multiple systemic contexts.

systems therapy. For example, family interventions carried out in this study included introducing systematic monitoring, reward, and discipline systems to decrease parental disengagement from the diabetic regimen; developing family organizational routines such as regular meal times; prompting caregivers to communicate effectively with each other about the adolescent's medical regimen; teaching strategies for problem-solving day-to-day conflicts; and developing indigenous social support networks to assist parents with monitoring of diabetes care. Peer interventions included assisting adolescents with disclosure of their medical condition to peers and enlisting the active support and encouragement of peers regarding regimen adherence.

At the community level, interventions included developing strategies to monitor and promote the youth's diabetes care while in school or other settings (i.e., extracurricular activities). Interventions within the health care system were considered to be a crucial community-level intervention and developing a collaborative relationship between the family and their medical providers was paramount. Interventions included helping the family resolve barriers to keeping appointments, developing a system of regular family contact with the nurse educator who provided insulin adjustments between medical appointments, and working with the family and the diabetes treatment team to promote a positive working relationship. For example, at the initiation of treatment, the therapist met with medical providers to assist in the development of a treatment plan so that the family and the medical team were working on the same goals. Therapists also routinely accompanied families to their medical appointments. Diabetes-specific interventions such as providing diabetes education sessions to address knowledge deficits identified during treatment were also included as intervention choices. Such education was provided by the nursing and dietary staff that worked in the diabetes clinic.

Treatment Fidelity. To promote treatment fidelity, therapists and their supervisor received a formal, week long training in MST techniques. Because the types of interventions that are provided vary across each family, treatment fidelity in MST is assessed via fidelity to nine treatment principles (Table II). These principles serve to operationalize MST, and evaluations of treatment fidelity are based on therapist adherence to these principles. Treatment fidelity was monitored through weekly supervision with the on-site supervisor and weekly telephone consultation with an MST expert consultant. The Therapist Adherence Measure (TAM) (Henggeler & Borduin, 1992) was also completed on a monthly basis by caregivers and therapists for as long as each family remained in treatment. Scores on the adherence scale of this instrument were reviewed by the supervisor and expert consultant to ensure adequate treatment fidelity. Item response on the TAM is from 1 ("Not At All") to 5 ("Very Much"). On the caregiver version of the TAM, the mean score across all therapists on the Adherence Scale was 4.28 (SD = .55). On the therapist version, the mean score across all therapists was 4.21 (SD = .35).

Control Condition

Adolescents randomized to the control condition received standard medical care. Standard care at the hospital where adolescents were cared for consisted of management by a multidisciplinary medical team comprised of an endocrinologist, nurse, dietician, social worker, and psychologist. Adolescents were scheduled for visits with the team every 3 months. No restrictions were placed on receipt of mental health services such as outpatient psychotherapy or psychiatric management during study participation for those adolescents randomized to standard care. However, only one child randomized to the control condition received such services during the course of the study.

Measures

Rates of Inpatient Hospitalization and ER Use

All participants enrolled in the study obtained their diabetes care from a single children's hospital facility. Utilization data for the study was obtained from the hospital's computerized hospital medical information system, which provided information regarding the date of the visit, the setting in which the service was provided (ER vs. inpatient) and the International Classification of Diseases, Ninth Revision (ICD-9) diagnostic code(s) associated with the visit. The hospital finance department provided information on charges, costs, and revenue associated with each hospital contact.

Information regarding the number of hospitalizations and ER visits was requested for each participant from the medical information system for the 9 month window before study entry and the 9 months during which the participant participated in the study. This approach was taken to allow a baseline rate of utilization to be calculated and to ensure equivalence of the two time periods being compared. All records were reviewed by an endocrinologist who was blind to the adolescent's randomization status and were coded as diabetes related or not. Only visits that were related to diabetes were included in the present analyses. Examples of nondiabetes-related utilization included an ER visit for bronchitis and an inpatient admission for testicular torsion. If a participant was admitted to an inpatient unit from the ER, the visit was coded only as an admission for the purpose of calculating rate of utilization, but all charges were included in the estimations of cost.

Cost of Medical Utilization

Costs of medical utilization were assessed from several different perspectives (Stone, Curran, & Bakken, 2002). All data used in cost analyses were obtained from the hospital financial database. To estimate the costs of participants' ER and inpatient utilization to the hospital where care was provided, information on the direct costs associated with the ER and inpatient services utilized by each participant was obtained. Although hospital charges typically overstate true organizational (i.e., hospital) costs, information on charges was obtained as well.

To assess the costs of the participants' ER use and inpatient admissions from a third-party payor (i.e., insurance) standpoint, information on hospital revenues associated with each hospital charge was obtained. Revenue provided an estimate of the average third-party payor cost of hospital utilization, because it reflected reimbursements from private insurances, health maintenance organizations (HMOs), and Medicaid. In the present sample, 14% of participants held private insurance, 43% had HMO insurance plans, and 43% had Medicaid.

Metabolic Control

Metabolic control was measured via total glycosylated hemoglobin (GHb). GHb is an indirect and retrospective measure of average blood glucose over the previous 2 to 3 month period. It measures total GHb as compared to other commonly used measures of metabolic control such as hemoglobin A1C. The normal range for persons who do not have diabetes is 4–7% and higher levels of GHb indicate poorer metabolic control. GHb was calculated using a saline incubated sample with automated high performance liquid chromatography. GHb was collected as part of the battery of research measures at the time of study visits (i.e., study entry, 6 and 9 month posttests). However, if a participant had had a clinical blood draw to obtain a GHb within 30 days of their study visit, this information was used and an additional research blood draw was not obtained.

Results

Baseline Rates of Hospital Utilization

High hospital utilization rates were demonstrated during the baseline period. 16.1% of participants made an ER visit during the 9 month prestudy baseline period and 25.8% had an inpatient admission. Eighty-eight percent of these inpatient admissions were associated with a primary ICD-9 code of DKA. For the remaining 12%, all had a secondary diagnosis suggestive of DKA (i.e., acetonuria, hypovolemia). Among the 25.8% of the sample who had an inpatient admission, approximately half (12.9% of the total sample) had multiple admissions. No baseline ER visit was associated with an ICD-9 code of DKA, although all were associated with a primary diagnosis of diabetes mellitus and 40% were associated with a secondary diagnostic code suggestive of DKA (i.e., vomiting, hypovolemia).

Intent to Treat Analyses

As previously noted, all participants randomized to treatment were included in utilization and cost analyses, although five participants dropped out of treatment before the completion of therapy and three of these received a minimal dose of treatment (i.e., 3–5 sessions). There were no significant differences between the MST and control groups on study entry GHb, nor on any demographic variable such as gender, age, family composition, or income (Table I). Utilization rates for the MST and control groups during the prestudy and 9-month study follow-up period are presented in Table III to show mean number of ER visits and admissions as well

Table III. Medical Utilization Rates for Multisystemic Therapy (MST) vs. Standard Care

	MST				Standard care			
	M	*SD*	Range	%	*M*	*SD*	Range	%
Baseline								
ER visits	0.06	0.25	0–1		0.27	0.46	0–1	
Admissions	0.56	1.03	0–3		0.47	1.13	0–4	
No admissions				68.7				80.0
Single admission				18.8				6.7
Multiple admissions				12.5				13.3
Study								
Mean ER visits	0.13	0.34	0–1		0.47	0.64	0–2	
Mean admissions	0.13	0.34	0–1		1.00	2.14	0–7	
No admissions				87.5				73.3
Single admission				12.5				6.7
Multiple admissions				0.0				20.0

as percentages of the groups who had no admissions, one admission or multiple admissions during the pre-study baseline and the 9-month study periods.

The change in total number of ER visits and hospital admissions for each participant was calculated by subtracting the number of visits during the baseline period from the number of visits during the study period. A negative number therefore reflected a declining number of visits and a declining rate of hospital utilization. An independent sample *t*-test was conducted on the change scores for the MST and control groups. The MST group had fewer inpatient admissions ($M = -.43$, $SD = .96$), whereas the control group had more inpatient admissions ($M = .53$, $SD = 1.46$); this difference was significant ($t = -2.201$, $p < .01$). The effect size of .80 associated with change in number of admissions was moderately large. There was no significant difference in change in number of ER visits between the groups (MST $M = .06$, $SD = .44$; control $M = .20$, $SD = .77$).

Correlational Analyses

It was of interest to investigate whether changes in number of hospital admissions were associated with changes in metabolic control during the 9-month study period. Data was available for a subset of 23 families (11 MST, 12 controls) who completed the 9-month study termination visit. There were no significant differences on any study entry demographic variable or on GHb between the 8 families for whom data was incomplete and the 23 who completed the 9-month posttest. Changes in GHb were calculated by subtracting GHb at study entry from GHb at study completion. Because lower GHb indicates better metabolic control, a negative change score indicated improved metabolic control during the study period. For the MST group, hospital admission change scores were significantly and positively associated with changes in GHb. Participants who had a decreasing number of hospital admissions also had decreased GHb and therefore improved metabolic control ($r = 0.58$, $p < .05$). There was no significant association between metabolic control and changes in number of admissions for controls ($r = -0.15$, *ns*).

Cost Data

Charges and costs associated with the inpatient admissions and ER visits during the baseline and 9 month study period are presented in Table IV. Repeated measures (analysis of variance) ANOVAs were conducted using hospital charges, hospital costs and insurance costs as dependent variables and group assignment as the independent variable. A significant group by time interaction was found for hospital charges and hospital costs. Charges for adolescents receiving MST decreased significantly from the prestudy baseline period to the 9 month study period as compared to the control group for whom charges increased ($F = 2.87$, $p \leq .05$) (Table IV). Similarly, direct hospital costs decreased by 68% for adolescents receiving MST; this represented a significant reduction as compared to controls for whom costs approximately doubled ($F = 2.81$, $p \leq .05$). A marginally significant group by time interaction was found for third-party payor costs ($F = 2.39$, $p = .07$) with costs decreasing for adolescents with MST and increasing for control adolescents (Table IV). The effect sizes associated with the changes in charges, direct hospital costs and third-party payor costs were .64, .63, and .62, respectively.

Discussion

The primary aims of the study were to determine whether intensive, home-based family therapy could reduce rates of

Table IV. ER and Inpatient Admission Costs ($) for Multisystemic Therapy (MST) vs. Standard Care

	Baseline			Study		
	M	*SD*	Range	*M*	*SD*	Range
MST						
Hospital charges	3,455	7,454	0–22,992	1,902	5,742[a]	0–22,531
Hospital direct costs	990	2,056	0–6,188	382	1,114[a]	0–4,325
Third-party payor costs	3,334	7,426	0–28,228	923	2,503[b]	0–8,470
Standard care						
Hospital charges	3,464	8,064	0–23,531	7,513	15,415	0–46,497
Hospital direct costs	1,101	2,623	0–8,157	2,038	4,238	0–13,279
Third-party pay or costs	2,740	6,065	0–20,873	3,571	6,425	0–20,578

[a]MST < control, $p \leq .05$.
[b]MST < control, $p = .07$.

ER use and inpatient hospitalizations among adolescents with poorly controlled type 1 diabetes and to determine whether the associated costs of care were also reduced. Although no differences were found for change in the number of ER visits between the MST and control groups, participants who received MST had a significant decrease in number of hospital admissions over the study period, whereas controls had more admissions. The vast majority of the hospital admissions during both the baseline and 9-month study period were due to DKA. As DKA can be life threatening, documentation of MST's ability to reduce number of DKA admissions was an important component to demonstrating its utility as an intervention that can improve quality of life among adolescents in poor metabolic control.

Other data from our group suggests that MST has the potential to improve metabolic control (Ellis et al., 2003; 2004). For those participants who received MST, decreased numbers of hospital admissions were strongly associated with improved metabolic control. Therefore, health outcomes for the MST group were related in an expected fashion. For the control group, no such associations were found. Improved metabolic control could account for decreases that were found in rates of inpatient admissions. However, improving patient-provider relationships was also a goal of treatment. Families receiving MST whose children were in the early stages of DKA may have more effectively accessed clinic emergency staff and hence been able to take actions that prevented hospitalization (e.g., taking extra insulin, consuming extra fluids to stay hydrated).

DKA during the postdiagnostic period is most often caused by noncompliance with insulin administration (Musey et al., 1995; Smith et al., 1998). Therefore, the costs associated with such DKA admissions should be reduced by interventions that improve adherence to medical regimen. The direct care costs to the health care facility for ER and inpatient admissions during the 9 months before study entry were very similar for the MST and control groups at approximately $1,000 per adolescent. However, costs for the MST group dropped by approximately 68% during the 9-month study period, whereas the costs for the control group almost doubled. Because there was no significant difference in change in ER utilization between the groups, most of these cost savings were in fact due to decreased inpatient admissions. Although not as strongly supported as reductions in costs to the health care facility, there was some suggestion that MST reduced costs to insurance companies for such largely preventable hospital utilization as well.

It is also worth noting that although the number of participants who had multiple admissions was similar for the two groups during the baseline period (two adolescents in each group), during the 9-month study period no adolescent receiving MST had multiple admissions, whereas three control adolescents did. Javor et al. (1997) have previously demonstrated that a subgroup of those patients who experience a DKA admission account for most DKA admissions through repeated admissions. Few published interventions to date have demonstrated the ability to prevent recurrent DKA (Golden, Herrolds, & Orr, 1985; Steindel, Roe, Costin, Carlson, & Kaufman, 1995) and existing programs may require an inpatient psychiatric admission as part of treatment. In a period of declining inpatient mental health care resources, outpatient treatments such as MST may provide a viable alternative to preventing recurrent DKA.

Although the current article documents reductions in some types of medical utilization and related costs, it is limited by the fact that a comprehensive cost analysis was not conducted. As would be expected, intensive interventions such as MST have necessary costs. Prior MST studies have suggested that the cost of the intervention can be as high as $6,000 per youth (Schoenwald, Ward, Henggeler, Pickrel, & Patel, 1996). To prove MST's cost effective with adolescents with poorly controlled diabetes,

it will be important for future studies to document that MST continues to produce cost savings and improved health outcomes over time. It should also be noted that the cost of care information presented in this article might differ substantially in other hospitals depending upon factors such as payor mix and reimbursement rates.

Additional study limitations include the fact that data regarding hospital utilization was only obtained from the institution where adolescents received their diabetes care. As this institution is the only children's hospital in the area, inpatient admissions at another institution would have been unlikely. Nonetheless, although any family calling the outpatient clinic for emergency care would have been directed to the ER at the institution in question, families could have used an ER at other health care facilities for a diabetes-related emergency for convenience or other reasons. It is therefore possible that utilization rates were underestimated. Finally, because of study attrition, data used to assess the relationship between metabolic control and admissions was available only for a subset of participants. Study completers may have systematically differed from study dropouts on variables other than available demographic information, biasing the findings.

In conclusion, findings from this study suggest that MST can successfully treat adolescents with poorly controlled diabetes by reducing the frequency with which they are admitted to the hospital and reducing the costs related to such medical utilization. Further studies are needed to determine the cost effectiveness and ultimate economic feasibility of the intervention to prevent short- and long-term health complications with such youth.

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