Multisystemic Therapy for Adolescents With Poorly Controlled Type 1 Diabetes

Reduced diabetic ketoacidosis admissions and related costs over 24 months

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OBJECTIVE — The study aim was to determine if multisystemic therapy (MST), an intensive home-based psychotherapy, could reduce hospital admissions for diabetic ketoacidosis (DKA) in youth with poorly controlled type 1 diabetes over 24 months. Potential cost savings from reductions in admissions were also evaluated.

RESEARCH DESIGN AND METHODS — A total of 127 youth were randomly assigned to MST or control groups and also received standard medical care.

RESULTS — Youth who received MST had significantly fewer hospital admissions than control subjects ($\chi^2 = 11.77$, 4 d.f., $n = 127$; $P = 0.019$). MST-treated youth had significantly fewer admissions versus their baseline rate at 6-month ($P = 0.004$), 12-month ($P = 0.021$), 18-month ($P = 0.046$), and 24-month follow-up ($P = 0.034$). Cost to provide MST was 6,934 USD per youth; however, substantial cost offsets occurred from reductions in DKA admissions.

CONCLUSIONS — The study demonstrates the value of intensive behavioral interventions for high-risk youth with diabetes for reducing one of the most serious consequences of medication noncompliance.

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We have previously reported on multisystemic therapy (MST), an intensive home-based family therapy, for youth with chronically poor metabolic control (CPMC). MST produced improvements in metabolic control and reducted indicators of serious nonadherence (DKA hospital admissions) at treatment termination (1,2). Reductions in admissions were maintained 6 months later (2). The present study investigated the effects of MST on DKA admissions at the conclusion of the trial and related cost savings.

RESEARCH DESIGN AND METHODS

— A total of 127 adolescents with CPMC and their families were recruited from endocrinology clinics at Children's Hospital of Michigan between 1999 and 2004. Eligible youth were diagnosed with type 1 diabetes for at least 1 year, had an average A1C of ≥8% during the year before study entry, and were aged 10–17 years. Mean ± SD A1C at study entry was 11.3 ± 2.3%. A total of 92% of the subjects used injected insulin, and 8% used insulin pumps. Mean ± SD age was 13.2 ± 2.0 years, and 63% of participants were African American.

A total of 64 participants were randomly assigned to MST and 63 to a control group. All families received quarterly visits with a multidisciplinary diabetes team. MST-treatment families also received 6 months of therapy (mean 5.7 months). Families were followed for 24 months total. MST targeted adherence-related problems within the family and broader community systems (1,3). These systems included family (e.g., poor parental supervision and oversight of the youth's diabetes care completion), school (e.g., inadequate communication between parents and school personnel regarding the youth's health needs), and health care system factors (e.g., barriers to keeping clinic appointments due to problems with transportation or family disorganization).

The number of DKA admissions was obtained from the treating hospital's information system for the 6-month window before study entry (baseline [T1]) and for the follow-up periods (baseline to 6 months [T2], 6–12 months [T3], 12–18 months [T4], and 18–24 months [T5]). Criteria used to diagnose DKA were hyperglycemia (blood glucose >16.65 mmol/l), serum acetone positive at greater than 1:2 dilution of serum, acidosis (pH <7.30 and bicarbonate <15 mmol/l), ketonuria, and glucosuria.

As decreases in A1C at treatment termination for MST-treated youth were not maintained at 6 months (2), cost-effectiveness evaluation was not appropriate. Cost savings were evaluated by reductions in admissions. A total of 45 youth (21 MST-treated and 24 control subjects) had at least one admission during the study. Costs were estimated by obtaining direct hospital costs and revenues from the hospital financial database and calculating an average cost for DKA admissions during the study. Revenues reflected third-party payor reimbursements.

Costs of MST for youth with CPMC were estimated from MST costs in the "real world" rather than costs in the trial, which

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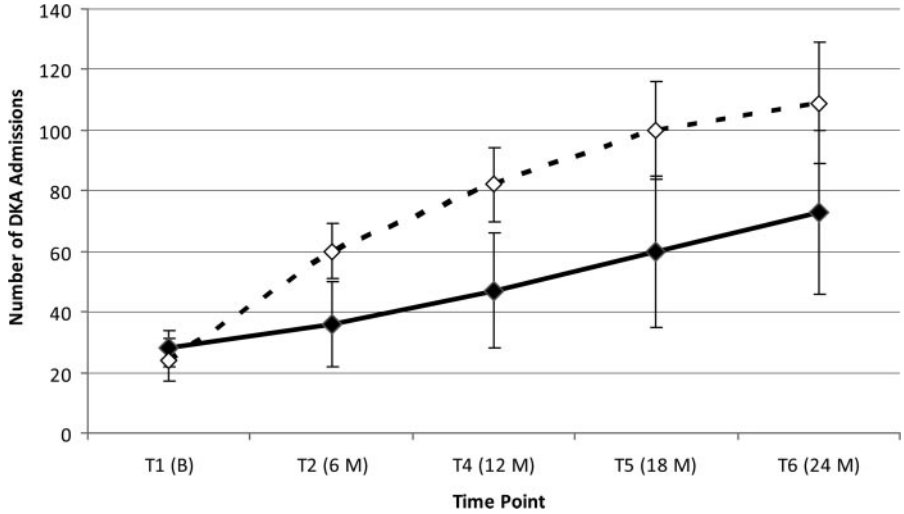

Figure 1—*Cumulative number of DKA admissions during five 6-month intervals for MST (◆) and control (◇) participants. The baseline interval (T1) started 6 months before trial entry; the subsequent intervals were from T1 to treatment termination (T2), from treatment termination to 12-month follow-up (T3), from 12-month to 18-month follow-up (T4), and from 18-month to 24-month follow-up (T5). Error bars are ± 1 SE.*

might underestimate true implementation costs. Because MST as originally developed for delinquent youth is widely disseminated, real-world estimates could be calculated. Costs included salary and benefits; overhead for therapists, supervisors, and program staff; therapist mileage; travel for training; MST licensing fees; and quality assurance costs. Costs per youth were estimated at 6,934 USD.

RESULTS — Figure 1 shows cumulative DKA admissions for MST-treated and control youth. Change in admission frequency over the 24-month trial was evaluated using repeated-measures Poisson regression. Analyses were performed with generalized estimating equations by specifying the Poisson distribution for the response variable (4,5); this accounted for correlated error. Time effects were partitioned into time-ordered contrasts comparing T1 with each follow-up period (T2–T5). The effects of MST were evaluated by the group × time interaction, followed by simple effect tests of MST within-group changes from baseline. Single-parent status was used as a covariate due to its relatedness to outcome in prior studies. The group × time interaction was significant ($\chi^2 = 11.77$, 4 d.f., $n = 127$; $P = 0.019$), indicating MST-treated youth had significantly fewer admissions than control subjects. Simple effect contrasts showed that MST youth had significantly fewer DKA admissions relative to baseline frequency at T2 ($P = 0.004$), T3 ($P = 0.021$), T4 ($P = 0.046$), and T5 ($P = 0.034$). Drops in admissions per youth were obtained over constant 6-month intervals and, hence, are measures of effect size when expressed as rates. The rates were 0.31 (95% CI 0.09–0.54), 0.27 (0.03–0.50), 0.23 (0.01–0.47), and 0.23 (0.01–0.47) for T2–T5, respectively. Control subjects had fewer admissions only at T5 ($P = 0.026$); rate 0.24 (0.02–0.45).

Hospital direct costs were 4,237 USD, and revenues were 5,446 USD per admission. The 24 control youth with any admission in 24 months had 85 DKA admissions. The 21 MST-treated youth had 45 admissions. Hence, DKA admissions resulted in 360,145 and 190,665 USD in hospital costs and 462,910 and 245,070 USD in third-party payor costs for control and MST-treated youth, respectively. Costs to provide MST for 21 youth were estimated at 145,614 USD (21 × 6,943). Therefore, MST was estimated to potentially save a total of 23,886 (institutional perspective) or 72,226 (third-party payor perspective) USD.

CONCLUSIONS — MST produced lasting reductions in postdiagnostic DKA hospital admissions, which occur most commonly due to insulin noncompliance (6,7). Reduced admissions rates in the MST group at follow-up were consistent with those reported in recent general population studies of youth with diabetes (8). The only other intervention with effects on DKA in youth with CPMC is residential psychiatric treatment (9), a costly intervention with unknown long-term impact. Costs to provide MST to youth with CPMC were relatively high. However, preliminary evaluation suggests that control youth with DKA admissions accumulated sufficient costs over 24 months and that expenditures on MST may be justified by potential for savings. MST could produce cost savings for the subset of youth with CPMC and a recent history of DKA admissions if admissions are occurring frequently. The study demonstrates the potential for intensive behavioral interventions to reduce serious consequences of medication noncompliance in high-risk youth.

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References

1. Ellis DA, Frey MA, Naar-King S, Templin T, Cunningham P, Cakan N: Use of multisystemic therapy to improve regimen adherence among adolescents with type 1 diabetes in chronic poor metabolic control: a randomized controlled trial. *Diabetes Care* 28:1604–1610, 2005
2. Ellis DA, Templin T, Naar-King S, Frey MA, Cunningham PB, Podolski C, Cakan N: Multisystemic therapy for adolescents with poorly controlled type I diabetes: stability of treatment effects in a randomized controlled trial. *J Consult Clin Psychol* 75:168–174, 2007
3. Ellis DA, Naar-King S, Frey M, Templin T, Rowland M, Greger N: Use of multisystemic therapy to improve regimen adherence among adolescents with type 1 diabetes in poor metabolic control: a pilot investigation. *J Clin Psychol Med Settings* 11:315–324, 2004
4. Zeger S, Liang K: Longitudinal data analysis for discrete and continuous outcomes. *Biometrics* 42:121–130, 1986
5. Liang KY, Zeger SL: Longitudinal data analyses using generalized linear models. *Biometrika* 73:13–22, 1986
6. Musey VC, Lee JK, Crawford R, Klatka MA, McAdams D, Phillips LS: Diabetes in urban African-Americans: cessation of insulin therapy is the major precipitating cause of diabetes ketoacidosis. *Diabetes Care* 18:483–489, 1995
7. Smith CP, Firth D, Bennett S, Howard C, Chisholm P: Ketoacidosis occurring in newly diagnosed and established diabetic children. *Acta Paediatr Scand* 87:537–541, 1998
8. Garrison MM, Katon WJ, Richardson, LP: The impact of psychiatric comorbidities on readmissions for diabetes in youth. *Diabetes Care* 28: 2150–2154, 2005
9. Geffken GR, Lewis C, Johnson SB, Silverstein JH, Rosenbloom AL, Monaco L: Residential treatment for youngsters with difficult-to-manage insulin dependent diabetes mellitus. *J Pediatr Endocrinol Metab* 10:517–527, 1997