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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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 43 admissions. Hence, DKA admissions resulted in 300,145 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.

Acknowledgments — This project was supported by grant R01 DK59067 from the National Institute of Diabetes and Digestive and Kidney Diseases.

**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 1 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, Klarka 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