Effects of Peer-Group Intervention on Metabolic Control of Adolescents With IDDM

Randomized Outpatient Study

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In children with insulin-dependent diabetes mellitus (IDDM), deterioration in metabolic control frequently occurs during early adolescence. To prevent this predictable increase in blood glucose levels, we randomly assigned young adolescents with IDDM to an intervention based on problem solving with self-monitoring of blood glucose (SMBG) integrated into standard outpatient care or to standard care only for an 18-mo period. At follow-up, 50% of the standard-care adolescents exhibited >1% increase in glycosylated hemoglobin (HbA_1) levels over baseline values, indicating a deterioration in metabolic control, compared to only 23% of the intervention group. Follow-up HbA_1 means ± SD were 10.10 ± 2.00% for intervention and 11.04 ± 2.28% for standard-care adolescents, indicating a significantly lower value in the intervention group ($P = .04$). At follow-up, a greater percentage of intervention than standard-care adolescents reported using SMBG information when they exercised (60.0 vs. 33.3%, $\chi^2 = 4.29$, $P = .04$). Our data suggest that clinic-based problem-solving groups can be more effective with young adolescents with IDDM than conventional treatment in preventing the expected deterioration in blood glucose. *Diabetes Care* 12:179–83, 1989

The early adolescent years are consistently identified as a period of deteriorating blood glucose control in children with insulin-dependent diabetes mellitus (IDDM; 1–3). Recent studies indicate that a network of influences disrupts metabolic stability during early adolescence. Despite increased insulin dosages during puberty, the hormonal upheaval and rapid physical growth of this period frequently continue to interfere with stable and acceptable blood glucose levels (4). Recently, several investigators have demonstrated that the physiological changes of puberty cause insulin resistance in both nondiabetic and diabetic adolescents and that this reduction in insulin sensitivity contributes to hyperglycemia in young diabetic adolescents and may undermine self-care efforts (5,6).

Investigators have often focused on psychological factors and poor self-care behavior to explain high and erratic blood glucose levels during early adolescence (7). Fundamental conflicts exist between the tasks of managing diabetes and the young adolescent striving to be comfortable with a rapidly maturing body, to define an identity autonomous of parents, and to be positively accepted by peers (8). Moreover, this struggle occurs within the broader context of increased expectations for the adolescent's adherence to the diabetes regimen by both parents and health-care providers (9).

With the introduction of self-monitoring of blood glucose (SMBG) into routine diabetes care, studies have shown that, whereas SMBG is acceptable to adolescents, poor adherence to monitoring regimen and inaccurate monitoring techniques have been consistently observed (10–12). Wing et al. (12) reported the best predictor of adherence to monitoring regimen was the adolescent's belief that SMBG improved metabolic control. Accuracy and adherence in performance of SMBG have generally been shown to have no relationship to

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glycemic control in adolescent patients (10,12). It is possible, however, that educating adolescents to directly apply the information obtained from SMBG to avoid acute emergencies and to improve glucose levels might help to prevent the deterioration in glucose control that frequently occurs during adolescence. This hypothesis was tested in this study by use of a stratified randomized control group design. It was predicted that adolescents receiving standard care plus a group intervention based on problem solving with SMBG, and whose parents participated in a separate educational group, would be helped to prevent the expected deterioration in metabolic control compared with a group of young adolescents receiving standard clinic care. The extent to which self-care behavior was modified as a result of the 18-mo intervention was also assessed.

MATERIALS AND METHODS

Subjects. All 11- to 14-yr-old adolescents with IDDM and their parents who were seen at the pediatric diabetes clinic at the University of Michigan Hospitals in 1983–1984 and had been diagnosed for at least 1 yr were invited by letter to participate in an 18-mo program as part of their regular clinic care. To participate, families had to agree to attend clinic every 3–4 mo for the 18-mo duration of the program. Of the 92 adolescents in our clinic who met the age and duration of diabetes criteria, 70 families expressed interest in participating and agreed to be randomized into the standard-care plus intervention group (hereafter the *intervention group*) or to the standard-care condition. Families randomized to the standard-care condition were able to participate in the group program after 18 mo. Families who were not interested in participating did not differ significantly from study families with respect to child's age, duration of diabetes, baseline glycosylated hemoglobin (HbA_1), or distance from the clinic. The primary reason that families gave for not participating was that they could not make the commitment to attend clinic every 3–4 mo for the 18-mo duration of the study. From eligible interested families, 35 adolescents were randomly assigned to the intervention group and 35 to the standard-care condition. Because of stratified random sampling, intervention and standard-care groups were equated by age, sex, duration of diabetes, and HbA_1 at baseline. Over the duration of the study, 5 families in each group were lost to follow-up due to changes in residence or health-insurance coverage. Adolescents who were lost to follow-up did not differ significantly from those who completed the study with respect to child's age, duration of diabetes, or HbA_1 at baseline.

The demographic characteristics of adolescents in both groups are described in Table 1. Results of a series of two-tailed independent *t* tests indicated that the sampling procedure was effective in equating the two groups at baseline, as there were no statistically significant differences in any demographic factor. In each group, 16 adolescents were females. The mean ages of adolescents in the intervention and standard-care groups were 12.9 and 12.5 yr, respectively. Mean grade in school, father's occupational status, and number of parents in the home also did not differ between the two groups.

TABLE 1
Baseline demographic measures of adolescents in intervention and standard-care groups

Measure	Groups	
	Intervention	Standard care
Female (%)	53.3	53.3
Mean age (yr)	12.9	12.5
Mean school grade	7.8	7.3
Father's occupation (%)		
Professional skilled	71.0	66.0
Semi- and unskilled	22.0	30.0
Unemployed	7.0	4.0
Two-parent homes (%)	83.0	90.0

n = 30/group. There were no significant differences between groups on any measure.

Clinical characteristics of adolescents in the intervention and standard-care groups at baseline are shown in Table 2. Results of *t* tests indicated that there were no statistically significant differences between the two groups on any clinical variable. Average duration of IDDM was 4.9 yr for intervention and 5.1 yr for standard-care adolescents, respectively. Percentile body weight, units of insulin per kilogram of body weight, and frequency of hospitalizations in the past 2 yr were not significantly different between the two groups. For both groups, HbA_1 was determined at baseline and at each subsequent clinic visit over the 18-mo period. In our laboratory, HbA_1 was determined by a commercially available microcolumn (Isolab, Akron, OH) with elimination of the labile glucose hemoglobin component (13). Values for nondiabetic individuals ranged from 5.5 to 8.5%. Mean HbA_1 was 10.47% for the intervention adolescents and 10.42% for the standard-care adolescents at baseline.

Self-reported behavior with respect to adjustment of insulin dose, diet, and exercise based on blood moni-

TABLE 2
Baseline clinical measures of adolescents in intervention and standard-care groups

Measure	Groups	
	Intervention	Standard care
Duration of diabetes (yr)	4.9 ± 3.2	5.1 ± 3.3
Percentile body weight	50.3 ± 27.9	57.9 ± 26.4
Insulin (U/kg)	0.92 ± 0.21	0.96 ± 0.23
Number of hospitalizations (2 yr)	0.40 ± 0.93	0.50 ± 0.90
Glycosylated hemoglobin (%)	10.47 ± 2.30	10.42 ± 1.90

Values are means ± SD. *n* = 30/group. There were no significant differences between groups on any measure.

toring data was assessed at baseline. For this purpose, we adapted items from the diabetes-care profile, a validated self-report instrument designed to assess a range of diabetes-related variables in patients (14). There were no significant differences at baseline between groups with respect to whether adolescents adjusted insulin dose, diet, or exercise based on SMBG data. Assessments were made again at 18 mo to determine the degree the intervention succeeded in affecting adolescent's use of SMBG information to adjust his/her treatment regimen.

Procedure. During the 18-mo intervention period, adolescents in the intervention and standard-care groups attended clinic every 3–4 mo for ~3 h each visit. For all adolescents, clinical and self-care assessments were made at baseline and again after the fifth consecutive clinic visit, (~18 mo after the baseline visit).

Standard care. Adolescents and parents in both the standard-care and intervention groups received routine clinic care provided by pediatric endocrinologists and a diabetes nurse educator, with a dietitian and social worker available for consultation. For adolescents in both groups, specific treatment goals were established on an individual basis by physicians and adolescents. Target blood glucose levels typically ranged from 80 to 180 mg/dl for both groups. Adolescents in both groups were asked by clinic physicians to monitor their blood glucose at least twice daily. Standard care was characterized by an educational approach that focused more on information, instruction, and encouragement of frequent monitoring rather than teaching youngsters to use SMBG data to solve management problems as in the intervention group.

Problem-solving intervention. For the intervention group, in addition to standard care, at each regular clinic appointment small groups of four to seven families were scheduled at 0800. Adolescents and parents met in concurrent but separate educational group sessions for 1.5 h before the adolescent's routine individual physical examination. The intervention, designed for use with adolescents as a series of five sequential modules, focused on SMBG as a tool for solving self-management problems and for improving blood glucose control (B.J.A. and M.T.B., unpublished observations, Adolescent Diabetes Curriculum 1, Michigan Diabetes Research and Training Center, Ann Arbor, MI). Emphasis in the intervention group was on adolescents learning to use data from SMBG to make regimen adjustments.

The adolescent sessions were led by a diabetes nurse educator who used an activity-based problem-solving educational approach and a five-module curriculum. The sequence in which the five modules were presented was important, as information and experiences focused on the different skills necessary for solving management problems with SMBG data presented in a logical and incremental order. Our purpose was to evaluate the impact of the entire five-session 18-mo program on HbA_1 and self-care behavior. The first module focused on technical skills involved in SMBG, insulin actions, and how regimen components interact to affect blood glucose levels. The second module emphasized the effects of puberty on blood glucose control and how to use SMBG when frequent regimen adjustments are needed. In the third module, a nutritionist emphasized how to apply SMBG to problem solving around meal planning. Adolescents ate breakfast as a group and charted individual glycemic responses to foods. In the fourth module, adolescents exercised together and used SMBG as a tool for understanding the impact of physical activity on blood glucose levels. In the fifth module, strategies for using SMBG with intensive therapies such as continuous subcutaneous insulin infusion were addressed. Over the intervention period, adolescents ate breakfast together, exercised together, and monitored blood glucose levels with guidance on how SMBG data could be used to regulate food, exercise, and insulin dose. The nurse routinely telephoned adolescents between clinic appointments to respond to questions. Parent sessions, led by a psychologist, used the same curriculum sequence but focused on strategies for negotiating appropriate levels of parental involvement and adolescent responsibility with respect to diet, exercise, and monitoring.

Statistical methods. Means and standard deviations for both groups are reported for follow-up HbA_1 levels. Age, sex, duration of diabetes, and baseline HbA_1 were investigated in preliminary least-squares multiple regression analyses for their potential impact on follow-up HbA_1. Of the four variables, only baseline HbA_1 was related to follow-up HbA_1. Because of the wide range of HbA_1 values at baseline for both groups, baseline HbA_1 was controlled for by an analysis of covariance (ANCOVA). Therefore, the final method used for analysis of follow-up HbA_1 compared standard care and intervention group means at follow-up controlling for baseline HbA_1 (15).

The impact of the intervention on three self-care measures that assessed the adolescent's use of SMBG in adjusting various components of the diabetic regimen was examined through a series of χ^2-analyses at follow-up.

RESULTS

Follow-up HbA_1 means ± SD were 10.10 ± 2.00% for the intervention group and 11.04 ± 2.28% for the standard-care group. Results of ANCOVA controlling for baseline HbA_1 indicated that follow-up HbA_1 was significantly lower for the intervention group than for the standard-care group [F (1,57) = 4.41, P = .04]. Adolescents in the intervention group exhibited a mean decrease of 0.37% in HbA_1 at follow-up, whereas adolescents in the standard-care group exhibited a mean increase of 0.62%. Regardless of the level of the subject's baseline HbA_1, the intervention group mean at follow-up was lower than that of the standard-care group by ~1% (0.97). Baseline and follow-up means are summarized in Fig. 1.

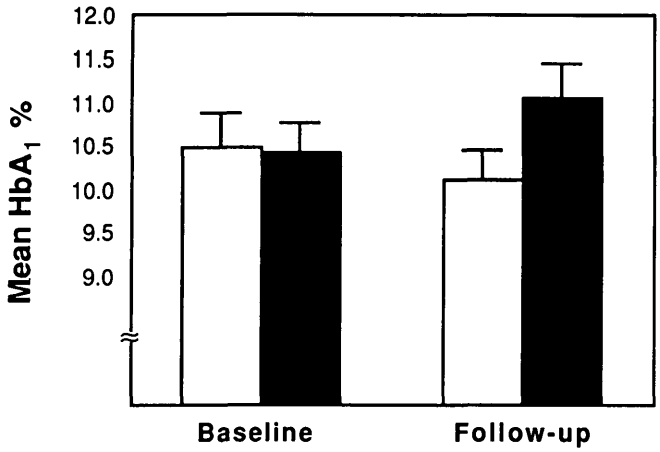

FIG. 1. Mean percent glycosylated hemoglobin (HbA_1) for intervention and standard-care adolescents at baseline and follow-up. *Vertical lines*, SEM. There was no significant difference in mean HbA_1 between groups at baseline. Mean HbA_1 was significantly lower for intervention adolescents at follow-up ($P = .04$). *Open bar*, intervention; *solid bar*, standard care.

Adolescents in the intervention and standard-care groups were descriptively categorized on the basis of their HbA_1 at follow-up as having improved or remained the same (within ≤1% of baseline HbA_1) or having deteriorated (increase >1% from baseline) by use of a standard strategy for classification of individual HbA_1 data (3). This was done for interpretative purposes to extrapolate the findings to individual adolescents rather than to group means as in the former analysis. Over 76% of adolescents in the intervention group exhibited stable or improved metabolic control, whereas only 23% exhibited >1% deterioration in control during this period. This is in contrast to adolescents receiving standard care, 50% of whom deteriorated whereas the other 50% remained stable or improved [$\chi^2(2) = 4.59$; $P = .04$].

Three χ^2-analyses were carried out for the three self-care variables at follow-up. These three analyses indicated that a significantly greater percentage of intervention than standard-care adolescents reported use of SMBG information when they exercised (60.0 vs. 33.3%; $\chi^2 = 4.29$; $P = .04$). Whereas more intervention than standard-care adolescents reported that they made use of SMBG data to adjust both their insulin dose (70.0 vs. 46.7%; $\chi^2 = 3.36$; $P = .07$) and diet (63.3 vs. 43.3%; $\chi^2 = 2.41$; $P = .12$), these differences were not great enough to reach conventional standards of statistical significance.

DISCUSSION

Over the course of this study, metabolic control deteriorated in 50% of the adolescents in the standard-care condition, a finding consistent with other studies of metabolic control in adolescents with IDDM seen in tertiary care centers (1,3,5,17). This was in contrast to a 23% deterioration from baseline for adolescents in the intervention group. Results indicated that whereas many intervention group adolescents did not show the anticipated decline in glucose control demonstrated in the standard-care group, the percentage of adolescents who improved over baseline HbA_1 values (30%) was not appreciably greater than in the standard-care group (23%). This is consistent with our initial hypothesis that participation in the problem-solving intervention program integrated into the outpatient visit schedule would not dramatically lower HbA_1, but rather would help to prevent the deterioration in glucose control expected over the early adolescent years. The intervention condition provided adolescents with the skills, practice, and support needed for adjusting insulin dose, exercise, and meal plans based on SMBG data, and this probably helped to prevent the expected deterioration in metabolic control.

In addition, this activity-based intervention in which concrete problems about adjusting food, exercise, and insulin dosage by use of SMBG were addressed, had an impact on an adolescent's report of their self-care practices. At follow-up, significantly more adolescents in the intervention group reported changing their exercise patterns based on SMBG results. In addition, there were trends for more youngsters in the intervention as compared with the standard-care group to adjust diet and insulin dosage based on information from SMBG. Self-regulation of the interdependent components of the diabetes regimen is one of the most critical aspects of self-care, and encompasses skills both in problem solving and in maintaining confidence in one's ability to make optimal disease management decisions (16). Because early adolescence is typically a time of increased stress, decreased coping skills, and high personal vulnerability, self-regulation is especially difficult during this developmental period (18,19). This group-based problem-solving approach was more effective than standard care, at least over the duration of the program, in strengthening self-regulation skills in young adolescents with IDDM.

The cognitive and social changes of young adolescent patients pose special challenges for health-care delivery, and there is increasing evidence that health care needs of both healthy and chronically ill adolescents are not effectively met by existing delivery systems (19,20). Interventions targeted specifically for adolescents with IDDM and use of the peer group to mediate health-care goals have been increasingly recommended (19,21,22). Whereas several innovative group approaches have been reported in diabetes literature, documentation and evaluation of interventions are often lacking, and frequently programs can not be readily translated into the outpatient health-care settings that serve the broadest segment of youngsters with diabetes and their families (23,24). We integrated into routine diabetes care for adolescents a program focused on increasing adolescent problem-solving skills in maintaining stable acceptable glucose levels. Our findings indicate that clinic-based problem-

solving groups for young adolescents with IDDM can be effective in preventing the increase in HbA_1 levels typically observed in early adolescence.

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