Effect of Diabetes Education on Self-Care, Metabolic Control, and Emotional Well-Being

Richard R. Rubin, PhD
Mark Peyrot, PhD
Christopher D. Saudek, MD

Participants (n = 165) entering a week-long outpatient education program completed a protocol measuring self-care patterns, glycosylated hemoglobin levels, and emotional well-being. Emotional well-being was reassessed at the end of the program, and the entire protocol was completed again at 6 mo (n = 124). At the program's end, participants improved on all measures of emotional well-being ($P < .01$). Self-esteem and diabetes self-efficacy rose, whereas anxiety and depression fell. At 6 mo, improvement in emotional well-being continued, and important self-care behaviors improved from preprogram levels. Self-monitoring of blood glucose and exercise rose (both $P < .001$), and binging ($P < .01$) and glycosylated hemoglobin levels ($P < .001$) fell. Program effects were unrelated to demographic or disease characteristics but strongly related to initial status. Participants who entered the program with high levels of emotional well-being or good self-care patterns or glycemic control tended to change little, if at all, at later measurements. On the other hand, people who entered the program with low levels of emotional well-being or with poor self-care patterns or glycemic control improved substantially. Our findings suggest that diabetes education can promote long-term benefits in self-care, metabolic control, and emotional status if the program is specifically designed to provide these benefits. Aspects of the program that contribute to its efficacy are discussed. *Diabetes Care* 12:673–79, 1989

Commitments to diabetes education have grown dramatically in the last few years. During that period, the Centers for Disease Control launched a major diabetes control program (1), the American Diabetes Association began recognizing education programs that met set criteria for standards of quality (2), and the American Association of Diabetes Educators initiated a certification program for professionals involved in diabetes education (3). Yet, this growing commitment to diabetes education precedes an unqualified demonstration of its effectiveness. In fact, the reported results of studies designed to assess the benefits of educational interventions are generally mixed or weak. For example, of three large-scale studies that measured the effects of education on self-care practices, two reported positive findings (5,6), whereas the other did not (4). Notably, all of the studies were based on data collected before 1983, and none included measures of self-monitoring of blood glucose (SMBG), the cornerstone of current approaches to optimal self-care. Improved metabolic control as a result of diabetes education is a more common and consistent finding, but the duration of these benefits is debated (5,7–10).

Various programmatic and methodological flaws may account for these weak and equivocal results. Interventions that are brief, infrequent, or designed solely to increase knowledge are unlikely to improve self-care or glycemic control (11). In addition, studies based on small samples and those lacking a follow-up component do not allow an accurate evaluation of the real and enduring impact of educational interventions. Finally, studies that fail to incorporate a comprehensive assessment of important factors that a program might affect, and those that do not take into account social and disease characteristics as important predictors of outcomes, may inaccurately estimate the impact of education.

This study addresses these problems by evaluating an

From the Johns Hopkins Diabetes Center and Department of Medicine; and the Loyola College Center for Social and Community Research, Baltimore, Maryland.

Address correspondence and reprint requests to Richard R. Rubin, PhD, 500 West University Parkway, Suite 1M, Baltimore, MD 21210.

intensive comprehensive program designed to improve self-care practices, emotional well-being, and metabolic control. The impact of this program on each of these target outcomes is measured for many participants over a 6-mo period.

RESEARCH DESIGN AND METHODS

All patients enrolled in the Johns Hopkins Diabetes Center's 5-day outpatient education program between 9 September 1985 and 2 February 1987 were invited to participate in this study. (Appendix 1 identifies elements of the education program.) A total of 168 patients took part in the education program during this period, 165 of whom comprised our study population. All study participants signed consent forms approved by the Joint Committee on Clinical Investigation of the Johns Hopkins Medical Institutions.

Characteristics of the study population appear in Table 1. The group was 70% White, middle-aged (mean ± SD age 47.4 ± 16.5 yr), and well educated (59% had some college education). Sixty-two percent were diagnosed with type II (non-insulin-dependent) diabetes and 38% with type I (insulin-dependent) diabetes, and 63% were taking insulin. The average study participant was overweight (128.7 ± 30.6% ideal body wt), and many had neuropathies (48%), diabetic retinopathy (28%), vascular complications (26%), or infections (24%) related to their diabetes. Many participants (23%) had been diagnosed within the last 2 yr, but a similar proportion had diabetes 2–7 yr (26%), 8–14 yr (28%), and ≥15 yr (23%).

TABLE 1
Characteristics of study population

Sex (%)		Type of diabetes (%)	
Male	58.2	Insulin dependent	37.6
Female	41.8	Non–insulin dependent	62.4
Race (%)		Medication (%)	
White	70.3	Insulin	63.7
Black	29.7	Oral	28.5
Education (%)		None	7.9
Less than high school	14.8	Complications (%)	
High school graduate	26.7	Neuropathy	47.9
Some college	25.5	Retinopathy	27.9
College graduate	17.6	Vascular	26.1
Postgraduate	15.7	Infections	23.6
Marital status (%)		Nephropathy	6.1
Married	57.0	Duration diabetes (yr)	
Formerly married	17.6	≤1	23.0
Never married	25.4	2–7	26.1
Age (yr)		8–14	27.9
<30	22.4	>14	23.0
31–50	27.8	Percent of ideal body weight	
51–60	22.4	<100	14.5
>60	27.6	101–120	37.0
		121–150	27.9
		>150	20.6

n = 165.

All 165 study participants completed the research protocol on a Monday, when they entered the Diabetes Center program. They completed the instruments measuring emotional well-being again on a Friday at the end of the program. Six months later, participants received a package containing all questionnaires and a request to either have their regular physicians transmit current glycosylated hemoglobin (HbA_{1c}) scores or have these tests performed and then send the scores. Participants who did not respond to the follow-up mailings and requests were contacted by telephone in an effort to encourage their cooperation.

Emotional well-being was measured by means of four widely used scales: a version of the Grossman Self-Efficacy in Diabetes Scale (12) that was modified for this study (copies are available from the authors), the Rosenberg Self-Esteem Scale (13), the Zung Self-Rating Anxiety Scale (14), and the Center for Epidemiological Studies Depression Scale (15). Knowledge was measured with forms of the Diabetes Knowledge Assessment Scales that were modified for this study (copies are available from the authors; 16).

Diabetes self-care patterns were measured by means of a questionnaire that contained questions about medications, diet, exercise, and testing for glucose and ketones. Response categories for frequency of binging, vigorous exercise, SMBG, and adjustment of insulin dose were never, monthly, weekly, or daily. For statistical analysis, these responses were assigned numerical values of 0, 2, 8, and 24, respectively, indicating the interpolated monthly frequency of each behavior. Analyses comparing this quantitative scoring with original categorical values revealed that this quantitative scoring yielded a conservative estimate of program effects.

Metabolic control at program entry and follow-up was measured at Johns Hopkins by means of HbA_{1c} gel electrophoresis, with the upper limit of normal being 7.7% (17). Forty-two percent of the follow-up assays were performed at outside laboratories, in which case values were corrected as follows: each observed score was multiplied by 7.7 and divided by the upper limit of normal for the laboratory. Differences between the group with the Johns Hopkins laboratory and those that used other laboratories were examined by comparing the change scores for patients in the two groups. There was no significant difference between groups ($P > .5$); therefore, groups were collapsed for subsequent analyses.

Statistical methods. Change in outcome scores over time was assessed by repeated-measures analysis of variance. Changes from pre- to postprogram and follow-up were tested by planned contrasts. Although one-tailed tests would be appropriate for the contrasts because hypothesized program effects are directional, the more conservative two-tailed significance levels are reported.

Group differences in changes over time were evaluated by mixed-effects analysis of variance in which the between-subject factor was the relevant grouping of subjects on demographic, disease, and initial functional status, and the within-subject factor was the repeated measurement of the outcome variable at the outset of

the program and follow-up. Significance levels were adjusted for unequal group variances. Two subanalyses were conducted for analysis of variance of initial functional status groups. First, where there was a significant group-by–repeated-measure interaction, a test was conducted for a linear trend in the change by group to determine if the worse the score at the outset, the more the improvement. Second, a simple effects test was conducted to determine if group scores at follow-up were significantly different; if there was a significant difference, a test was conducted for a linear trend in the group scores to determine if groups that started worst, intermediate, or best remained that way at follow-up.

RESULTS

Of the 165 subjects who completed the study protocol on entering and graduating from the Diabetes Center program, 124 (75%) completed the set of 6-mo follow-up questionnaires and 71 (43%) had HbA_{1c} tests at 6-mo follow-up. All results presented here are based on analyses that include only the 124 subjects who completed the follow-up component. (Separate analyses were performed for comparisons between pre- and postprogram scores that used all subjects who completed these measures, and there were no differences in the results obtained with this procedure.)

Table 2 compares preprogram, postprogram, and follow-up scores for the study population on all measures.

Emotional factors. At completion of the Diabetes Center program, participants had improved on all measures of emotional well-being ($P < .01$). Levels of self-esteem and diabetes self-efficacy rose (mean ± SE 8.2 ± 0.2 preprogram to 8.7 ± 0.2 postprogram and 113.4 ± 1.4 preprogram to 124.8 ± 1.3 postprogram, respectively), whereas levels of anxiety and depression fell (35.7 ± 0.7 preprogram to 32.4 ± 0.6 postprogram and 13.3 ± 0.9 preprogram to 9.4 ± 0.8 postprogram, respectively).

Six months later, scores on all measures were still better than they were at preprogram ($P < .025$). Self-esteem scores at 6 mo were almost identical to postprogram levels (8.7 ± 0.2 postprogram to 8.6 ± 0.2 at follow-up). Anxiety ratings at follow-up were also nearly the same as at graduation (32.4 ± 0.6 postprogram to 32.3 ± 0.7 at follow-up), and depression scores at follow-up were significantly better than preprogram levels (13.3 ± 0.8 preprogram to 10.8 ± 0.8 at 6 mo). The same was true for diabetes self-efficacy scores (113.4 ± 1.4 preprogram to 121.8 ± 1.4 at follow-up).

Diabetes-related knowledge improved during the Diabetes Center program (11.6 ± 0.2 preprogram to 12.8 ± 0.2 postprogram; $P < .001$). The knowledge test was not included in the 6-mo follow-up.

Self-care behaviors. Scores shown in Table 2 for self-care behaviors (insulin adjustment, binging, exercise, and SMBG) represent the self-reported monthly frequency of each behavior. Program participants exercised more frequently at 6-mo follow-up than when they arrived at the Diabetes Center (13.3 ± 1.0×/month preprogram to 16.9 ± 0.8×/month at 6 mo; $P < .001$). Participants also tested blood glucose more frequently at 6 mo than on entry to the program (9.5 ± 1.0×/month preprogram to 15.8 ± 0.9×/month at follow-up; $P < .001$). The frequency of adjusting insulin doses increased by 33% between entry to the program and 6-mo follow-up but this increase did not reach the conventional cutoff for statistical significance (7.4 ± 1.2×/month preprogram to 9.9 ± 1.3×/month at 6 mo; $P = .086$). Binging decreased between the beginning of the program and follow-up (8.5 ± 0.8×/month preprogram to 6.3 ± 0.6×/month at 6 mo; $P < .01$).

HbA_{1c} scores at 6-mo follow-up were better than preprogram levels ($P < .001$), decreasing from 11.5 ± 0.4 to 9.5 ± 0.3% (normal range 3.9–7.7%).

TABLE 2
Comparison of preprogram, postprogram, and follow-up scores

Variable	*n*	Score			Significance*		
		Preprogram	Postprogram	6 mo	Overall	Preprogram versus postprogram	Preprogram versus 6 mo
Emotional factors							
Self-esteem	124	8.2 ± 0.2	8.7 ± 0.2	8.6 ± 0.2	<.001	<.01	<.025
Anxiety	123	35.7 ± 0.7	32.4 ± 0.6	32.3 ± 0.7	<.001	<.001	<.001
Depression	123	13.3 ± 0.9	9.4 ± 0.8	10.8 ± 0.8	<.001	<.001	<.01
Self-efficacy	122	113.4 ± 1.4	124.8 ± 1.3	121.8 ± 1.4	<.001	<.001	<.001
Knowledge	134	11.6 ± 0.2	12.8 ± 0.2		<.001		
Self-care behaviors							
Insulin adjustment	65	7.4 ± 1.2		9.9 ± 1.3	.086		
Binge	122	8.5 ± 0.8		6.3 ± 0.6	<.01		
Exercise	116	13.3 ± 1.0		16.9 ± 0.8	<.001		
SMBG	123	9.5 ± 1.0		15.8 ± 0.9	<.001		
HbA_{1c}	71	11.5 ± 0.4		9.5 ± 0.3	<.001		

Scores are means ± SE. SMBG, self-monitoring of blood glucose; HbA_{1c}, glycosylated hemoglobin.
*Probability by repeated-measures analysis of variance.

Subgroup analyses. Given the apparent effectiveness of the program in producing broad benefits of some duration, we were interested in the possibility that these benefits might accrue disproportionately to particular types of participants. We undertook two sets of analyses to address this question, first looking at program effects as a function of demographic and disease characteristics and then looking at these effects as a function of preprogram levels on the measures of interest.

Demographic and disease characteristics. The first set of analyses compared program effects for participants taking insulin and those who did not; participants with type I and those with type II diabetes; participants with diabetes of long duration (>7 yr) and those more recently diagnosed; participants with education above the median level (13 yr) and those with less; and men and women. Program effects varied little as a function of disease or demographic characteristics. There were significant interactions ($P < .05$) between type of diabetes and changes on two of the outcome measures. People who had type I diabetes improved more in diabetes self-efficacy and increased more in insulin adjustment than people who had type II diabetes. There also were significant interactions ($P < .05$) between sex and changes on two outcome measures. Men increased the frequency of insulin adjustment and decreased the frequency of binging to a greater degree than women.

Initial functional status. To evaluate the hypothesis that program effects varied with initial status, participants were assigned to one of three groups (best, moderate, and worst) on each of six preprogram measures (depression, diabetes self-efficacy, binging, insulin adjustment, SMBG, and HbA_{1c} level); results for other outcome factors are not shown, but all closely paralleled the pattern noted below. Table 3 describes this classification.

Figure 1 shows preprogram, postprogram (when present), and 6-mo follow-up scores on program outcome measures as a function of preprogram group (best, moderate, and worst). For each measure, differences between groups were smaller at follow-up than they had been at the beginning of the program. Comparing groups in terms of changes over time in each measure yielded a striking pattern. There was significant interaction ($P < .001$) between the initial status groups and changes over time for the six measures; for each outcome measure the amount of improvement from preprogram to follow-up increased linearly as a function of worst preprogram status ($P < .001$), and only binging showed a significant quadratic deviation from linearity ($P \leq .05$). On every measure, participants who entered the program in the worst condition improved the most, those who entered the program in moderate condition improved to an intermediate degree, and participants who entered the program in the best condition improved little, if at all.

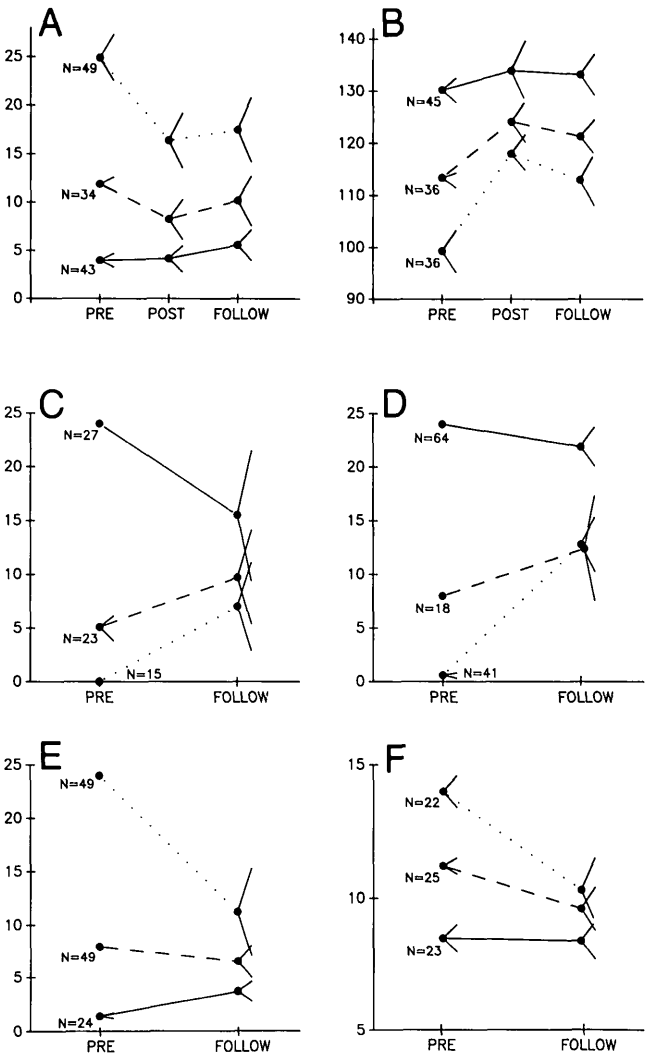

FIG. 1. Preprogram, postprogram, and follow-up scores by preprogram group. For each variable, *solid line* represents best preprogram status, *dashed line* moderate status, and *dotted line* worst status. ●, Group means with 95% confidence intervals. *A*, depression; *B*, diabetes self-efficacy; *C*, insulin adjustment; *D*, self-monitoring of blood glucose; *E*, binging; *F*, glycosylated hemoglobin.

TABLE 3
Classification of preprogram groups

Variable	Preprogram groups		
	Best	Moderate	Worst
Depression*	0–8	9–15	≥16
Self-efficacy†	42–109	110–119	≥120
Insulin adjustment	≥Daily	1 wk–1 mo	Never
Binge	≤1 mo	1 wk	≥Daily
Blood glucose	≥Daily	1 wk	≤1 mo
HbA_{1c}†	6.5–9.9	10.0–12.4	≥12.5

Entries represent scores or responses on which preprogram grouping was based. HbA_{1c}, glycosylated hemoglobin.
*All individuals whose preprogram Center for Epidemiological Studies Depression Scale scores were ≥16 (the standard for clinical depression according to this scale) were placed in the worst category. Those with lower scores were divided equally between moderate and best categories based on their scores.
†All individuals were divided equally among best, moderate, and worst categories based on their preprogram scores.

Figure 1 also reveals that although the differences between initial functional status groups had shrunk by follow-up, there was a tendency for the best group to remain best, the intermediate group to remain intermediate, and the worst group to remain worst. At follow-up, there were significant differences among group means for all measures ($P < .001$) and a significant linear trend for all measures ($P < .05$). Only for SMBG frequency was there a significant ($P \leq .05$) quadratic deviation from linearity, reflecting the fact that follow-up scores for the group which were initially worse now slightly exceeded scores for the group which were initially intermediate.

DISCUSSION

With data from a sample of adult participants in an intensive outpatient diabetes education program, we examined changes after the program in emotional factors, self-care practices, and glycemic control. First, we determined whether the emotional status of participants was better at the end of the program than it had been at the outset. Second, we wanted to ascertain whether these gains were maintained 6 mo later and whether self-care practices and glycemic control were improved over preprogram levels. Finally, we determined whether any of these gains were related to participants' preprogram status, with regard to demographic or disease characteristics, or to initial status on the measures of interest.

We found that the emotional status of program participants was better at the end of the program than it had been at the outset. We also found that these improvements were substantially maintained at 6-mo follow-up, and that 6-mo self-care patterns and HbA_{1c} values were better than preprogram levels. Finally, we found that although changes over time in the measures of interest were essentially unrelated to demographic and disease characteristics, these changes varied markedly as a function of preprogram status, with those who entered the program in the worst condition improving most after the educational experience.

Our results must be interpreted in light of certain limitations of the study. This study does not represent a randomized controlled trial. Program participants were sufficiently motivated to devote 5 days to diabetes education, and the sample included a disproportionately large number of highly educated individuals and people who were taking insulin. In addition, our results might be dependent on the program's multidisciplinary staff and high staff-to-patient ratio. Thus, our findings cannot be generalized to populations or programs that are markedly different. In addition, the lack of a control group leaves open the possibility that the substantial and enduring improvements we report may be attributable to causes other than program effects. We cannot rule out the potential impact of Hawthorne effects on our results. However, it seems likely that these improvements do represent true program effects, because we can think of no other process to plausibly account for benefits as wide ranging, large, and enduring as those we found.

As a final limitation of the study design, we note that not all of the subjects who participated in the educational program completed the 6-mo follow-up. It could be that the 25% who did not complete the follow-up improved less on the measures of interest than the 75% who did. If this was the case, our analysis would overestimate actual improvements after the program. Although we cannot rule out the possibility that dropouts would have been different from completers at follow-up, we did examine the possibility that these two groups were different at the outset or at the end of the program, two times for which we did have data. We found no significant differences between dropouts and completers on any of the measures of emotional well-being, self-care practices, or glycemic control at either the beginning or end of the program. The only significant difference we found on demographic or disease characteristics was on duration of diabetes. Those who completed the follow-up had been diagnosed earlier than those who did not complete the follow-up.

This study, its limitations notwithstanding, addresses the findings of Bloomgarden et al. (6) for new and innovative approaches to patient motivation in achieving healthful outcomes. The efficacy of some promising elements of the Johns Hopkins program could be tested in randomized controlled trials. Future tests of educational interventions in diabetes should examine programs that are intensive. Participants in the Diabetes Center program received education and training for 37 h over 5 consecutive days. Educational interventions that consist of a few sessions spread out over a long period will probably be less effective. In addition, the Diabetes Center program was specifically designed to improve diabetes self-care skills, including SMBG and insulin self-adjustment. Educational interventions designed primarily to provide an overview of diabetes cannot be expected to improve metabolic control. Simply stated, educational interventions can be expected to influence only those factors which the interventions are specifically designed to influence.

We believe that self-care skills training should be a cornerstone of diabetes education. In this we differ with Bloomgarden and Brown (18), who see a distinction between education and modalities such as SMBG, which they consider therapeutic endeavors. Self-care skills can be taught, and self-care practices can affect glycemic control. Educational interventions incorporating effective behavioral strategies for improving self-care patterns have been successful (5,19,20). Thus, there is no basis for excluding from the educational curriculum efforts to teach these skills. Note that this study is among the first to evaluate the effectiveness of an educational program in reinforcing the most sophisticated self-management skills, such as SMBG and insulin-dose adjustment.

The Diabetes Center program is among the first to

address a second set of critical self-management skills that we refer to as coping skills. Staff helped program participants learn to use a cognitive-behavioral restructuring model for coping with situations in which the risk of lapsing into poor self-care was high. This diabetes-specific model was based on principles of self-efficacy and social learning theory (21,22). Although we have not evaluated the independent contribution of coping skills training to the benefits of the education program, the comments of graduates suggest that this component may be critical in maintaining the degree of self-confidence and motivation that is crucial to long-term regimen adherence and improved glycemic control.

We noted that effects varied markedly as a function of preprogram status, with subjects who entered the program in the worst condition apparently receiving the most benefit from the educational experience. (The lack of a no-treatment control or comparison treatment group prohibits us from ruling out regression to the mean as an explanation of this pattern.) One potentially disturbing finding was the lack of a program effect for the group who entered in the best clinical state. They showed no improvement on any of the outcome measures. This finding might be the result of the program design, which was intended to teach participants how to follow an optimal regimen for self-care. Because the group who entered the program in the best condition was already closest to this regimen, they had the least to gain from the program's interventions. This finding of no improvement in the best group might also be a methodological artifact, because the best group's preprogram scores for most measures were close to the optimal score, thus creating a potential floor or ceiling effect. On only one measure, insulin-adjustment frequency, did the best group's scores change significantly by follow-up. This may reflect worsening self-care or it may reflect improvement in overall status because, although participants were taught to adjust insulin doses when SMBG revealed unacceptable levels, they were also taught how to avoid hypoglycemia and hyperglycemia. Thus, as participants improved their glycemic control, they may have needed to adjust their insulin doses less frequently.

Results of this study with regard to emotional well-being should be considered in the context of growing evidence that emotional well-being contributes to improved self-care (23–26). Emotional well-being also contributes to physical health outcomes, either indirectly via its effects on self-care patterns or directly as a risk factor (27,28). Certain negative emotional states are likely to interact in a self-reinforcing manner with concrete self-management patterns. If an individual is depressed or anxious, self-management practices are likely to suffer, and deterioration of self-care patterns contributes to worsening of glycemic control. Thus, psychosocial distress indirectly leads to poor glycemic control, and comprehensive programs to improve glycemic control should address these factors (27).

Note that optimal glycemic control is only a means to a greater goal: prevention of life-threatening conditions, including complications such as cardiovascular disease. Regarding this point, we note a recent review that points to the direct role of negative emotions as a risk factor in coronary heart disease (28). The picture of proneness to coronary heart disease revealed by this review is not one of a hurried, impatient workaholic but rather of an individual with one or more negative emotions, notably, depression and anxiety. Thus, improved glycemic control and decreased emotional distress are both means to a common goal: improved long-term physical health. Carrying the point one step further, we believe that emotional well-being must be considered a legitimate end point in its own right. The quality of an individual's life is determined not only by physical health but also by emotional well-being. This makes it important to recognize, respect, and reinforce the contribution of emotional well-being to the lives of diabetic patients.

Although the results of this study are encouraging, we have noted aspects of our study sample and program that limit the generalizability of our findings, as well as the preliminary nature of the study and uncontrolled nature of its design. We look forward to randomized controlled studies that more definitively assess the effectiveness of diabetes education programs as promising as the one we have described.

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APPENDIX 1
Elements of Diabetes Center education program

Element	Description
Group size	5–12 people
Duration	37 h; Monday through Friday on outpatient basis
Initial assessment	By physician, nurse educator, nutritionist
Physician contact	Daily to monitor progress, adjust medication
Nutritionist contact	Daily to educate, develop and practice individualized meal plans
Self-care training	Daily with focus on SMBG, situational adjustment of insulin dose, safe exercise, managing emergencies
Coping skills training	Two sessions to teach model for dealing with problems in regimen adherence and practicing solutions
Graduation	Exit interview based on completed contract for changes in self-care; note to regular physician

SMBG, self-monitoring of blood glucose.

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