TABLE 1
Patient profile

Group	*n* (M/F)	Age (yr)	Mean duration of IDDM (yr)	Dialysis (*n*)	Complicating factors			
					Cardiomegaly	CHF	Pleural effusion	Respiratory symptoms
Kidney failure, IDDM	33/20	37.50 ± 1.07	25.90 ± 1.23*	No, 32 Yes, 21	9	4	5	25
Kidney failure, no IDDM	36/25	33.70 ± 1.94		No, 35 Yes, 26	9	3	0	31
IDDM only	8/6	34.70 ± 2.75	19.60 ± 2.17*	No, 14	0	0	0	0

Values are means ± SE. IDDM, insulin-dependent diabetes mellitus; CHF, congestive heart failure.
*Significantly different by *t* test.

pancreas transplant has a beneficial effect on the restrictive picture in patients with IDDM could help clarify the picture.

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REFERENCES

1. Schernthaner G, Haber P, Kummer F, Ludwig H: Lung elasticity in juvenile onset diabetes mellitus. *Am Rev Respir Dis* 116:544–46, 1977
2. Schuyler MR, Niewoehner DE, Inkley SR, Kohn R: Abnormal lung elasticity in juvenile onset diabetes mellitus. *Am Rev Respir Dis* 113:37–41, 1976
3. Oulhen PH, Barthelemy L, Bellet-Barthas M, Darragon T: Contribution a l'etude de la fonction respiratoire du diabetique insulino-dependant. *Rev Fr Mal Respir* 10:213–24, 1982
4. Schnapf BM, Banks RA, Silverstein JH, Rosenbloom AL, Chesrown SE, Loughlin GM: Pulmonary function in insulin dependent diabetes mellitus with limited joint mobility. *Am Rev Respir Dis* 130:930–32, 1984
5. Asanuma Y, Fujiya S, Idfa H, Agishi Y: Characteristics of pulmonary function in patients with diabetes mellitus. *Diabetes Res Clin Pract* 1:95–101, 1985
6. Sandler M, Bunn AE, Stewart RI: Cross-section study of pulmonary function in patients with IDDM. *Am Rev Respir Dis* 135:223–29, 1987
7. Bell D, Collier A, Matthews DM, Cooksey EJ, McHardy GJR, Clarke BF: Are reduced lung volumes in IDDM due to defect in connective tissue? *Diabetes* 37:829–31, 1988
8. Lee HY, Stretton TB, Barnes AM: The lungs in renal failure. *Thorax* 30:46–53, 1975
9. Hamlin CR, Kohn PR, Luschin JH: Apparent accelerated aging of human collagen in diabetes mellitus. *Diabetes* 24:302–304, 1975
10. Primak RA, Whincup G, Tsankas JN, Milner RDG: Reduced vital capacity in insulin-dependent diabetics. *Diabetes* 36:324–26, 1987

Differential Effect of Diabetes Education on Self-Regulation and Life-Style Behaviors

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Objective: To examine the effect of diabetes education on self-regulation and life-style behaviors. Research Design and Methods: Participants in an outpatient diabetes education program completed a protocol measuring several self-care behaviors and glycemic control at entry (n = 165) and 6 (n = 124) and 12 (n = 89) mo after the program. Results: Improvement was noted at 6 mo for most self-care behaviors and glycemic control. At 12 mo, lower glycosylated hemoglobin levels were maintained ($P < 0.001$) without increases in perceived hypoglycemia. Improvement was not maintained for those self-care behaviors that require change in life-style, i.e., diet and exercise. However, self-care behaviors that allow patients to self-regulate their glycemic control—self-monitoring of blood glucose and insulin dose self-adjustment—were improved at 12 mo over preprogram levels ($P < 0.001$). Frequency of insulin self-adjustment continued to increase during the period between follow-ups. Conclusions: The findings suggest that diabetes education is effective in promoting self-regulation behaviors, although it has less effect on traditional regimen behaviors such as diet and exercise.
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Encouraging reports of successful educational and behavioral interventions in diabetes are appearing with increasing frequency. In a meta-analysis of findings from 47 studies conducted between 1954 and 1987, Brown (1) wrote that patient teaching in diabetic adults yields a moderate to large positive effect. The effect of educational interventions on self-care behavior is particularly important, because self-care is a critical factor in metabolic control. Two recent studies found that some self-care behaviors, specifically self-monitoring of blood glucose (SMBG) and self-adjustment of insulin dose, were improved 6–7 mo after an educational intervention, whereas other behaviors, specifically diet and exercise, were not (2,3).

These results suggest education effects may be more powerful or more enduring for behaviors such as SMBG and insulin-dose adjustment, which allow patients to self-regulate their glycemic control. These self-regulation behaviors may be distinguished from self-care activities such as diet and exercise, which are rooted in the individual's life-style and may be more resistant to change.

This study describes a 12-mo follow-up of a week-long outpatient diabetes education program. We examined whether improvements in self-regulation behaviors are more robust than improvements in life-style–based behaviors. We also describe relationships among improved self-care, improved glycemic control, and perceived symptoms of hypoglycemia. Finally, we discuss implications of these findings for designing effective educational interventions.

RESEARCH DESIGN AND METHODS

Subjects, procedures, measures, and statistical methods are described in detail elsewhere (4). Briefly, the study population consisted of 165 individuals who completed the Johns Hopkins Diabetes Center 5-day outpatient-education program. The group was 70% white, middle-aged (mean ± SD 47.4 ± 16.5 yr), and well educated (59% had some college education). Sixty-two percent were diagnosed with non-insulin-dependent (type II) diabetes, and 63% were taking insulin. Mean duration of diabetes was 9.1 ± 8.2 yr. Study participants completed the entire research protocol on the day they entered the diabetes center program. Six and 12 mo later, participants were contacted by mail and asked to complete the same set of questionnaires they had filled out on entering the program and to obtain current glycosylated hemoglobin (HbA_{1c}) scores.

Diabetes self-care and symptom patterns were measured with a questionnaire that contained questions about medications, diet, exercise, testing for glucose and ketones, and perceived symptoms of hypoglycemia and hyperglycemia. All self-care data were based on patient self-reports, and symptom data were based on subjective criteria rather than blood glucose level. Metabolic control was measured by HbA_{1c} assay, with the upper limit of normal being 7.7%.

Repeated-measure analysis of variance (ANOVA) was used to assess change in outcome scores over time. Change from preprogram to 6- and 12-mo follow-up was analyzed with planned contrasts.

RESULTS

Of the 165 people who completed the study protocol on entering the diabetes center program, 124 (75%) completed the preprogram and 6-mo questionnaires, and 71 (43%) had HbA_{1c} tests at preprogram and 6-mo follow-up. One hundred two people (62%) completed the 12-mo follow-up questionnaires, of which 89 (54%) completed all three protocols. Seventy-nine people (48%) had HbA_{1c} tests at 12 mo, of which 44 (27%) had these tests at all three times. The results regarding program effects are based on analyses that include only those individuals who had valid scores on the variable at all three times. Note that separate analyses compared preprogram and 12-mo follow-up scores for all subjects who had only these two scores, and the results were no different.

Program effects. Table 1 compares preprogram and 6- and 12-mo follow-up scores for the study population on all measures. Scores presented in Table 1 for self-care behaviors (insulin adjustment, binge eating, exercise, and SMBG) represent the self-reported monthly frequency of each behavior. In our earlier article, we reported that at 6-mo follow-up the two life-style self-care behaviors were improved over preprogram levels; exercise had increased, and binge eating had decreased. At 12 mo, program effects for exercise and binge eating had decayed to the point that follow-up scores on these measures were no longer significantly better than they had been at the outset of the program.

The overall tests for binge eating and exercise in this analysis do not reach significance because of the smaller number of subjects due to dropping out; sensitivity analysis performed with the larger sample size from the 6-mo follow-up and the means and variances from Table 1 indicated that the 6-mo follow-up scores would be significantly better than baseline, but the 12-mo follow-up scores would not be significantly different from baseline.

Self-care behaviors involving independent self-regulation (SMBG and insulin-dose adjustment) showed a different pattern. At 12-mo follow-up, program participants tested their blood for glucose and adjusted their insulin doses more frequently than when they entered the diabetes center ($P < 0.001$). SMBG was significantly improved at the 6-mo follow-up and remained improved at 12 mo. Insulin adjustment was somewhat improved at 6 mo ($P = 0.086$) and continued to improve between the 6- and 12-mo follow-ups.

Frequency of perceived low blood glucose symptoms

TABLE 1
Comparison of preprogram and 6- and 12-mo follow-up scores

		Score			P*	
	n	Preprogram	6 mo	12 mo	Overall	Preprogram 12 mo
Self-care behaviors						
Insulin adjustment	41	5.8 ± 1.3	8.8 ± 1.6	11.4 ± 1.6	<0.01	<0.001
Binge	88	7.8 ± 0.9	6.1 ± 0.7	6.8 ± 0.7	NS	NS
Exercise	73	15.3 ± 1.2	17.5 ± 1.0	16.8 ± 1.1	NS	NS
SMBG	81	9.6 ± 1.2	16.5 ± 1.1	15.1 ± 1.1	<0.001	<0.001
Glycemic control						
Low blood glucose symptoms	78	3.0 ± 0.6	3.2 ± 0.5	3.2 ± 0.5	NS	NS
High blood glucose symptoms	82	6.8 ± 1.0	2.9 ± 0.7	3.0 ± 0.6	<0.001	<0.001
HbA_{1c}	44	11.8 ± 0.6	9.6 ± 0.3	9.5 ± 0.2	<0.001	<0.001

Scores are means ± SE. *n* differs for each measure for 3 reasons: *1*) respondents filled out only questions that were applicable, e.g., if they used insulin; *2*) a few respondents did not answer questions that were applicable, e.g., for other regimen behaviors and symptoms; *3*) only a subset of respondents had HbA_{1c} tests performed.
**P* values determined by repeated-measure analysis of variance.

remained essentially constant, whereas frequency of perceived high blood glucose symptoms fell between the outset of the program and the 6-mo follow-up ($P < 0.001$) and remained essentially unchanged at 12 mo. HbA_{1c} scores improved significantly between the outset of the program and the 6-mo follow-up ($P < 0.001$) and remained at these improved levels at 12 mo.

Dropout analysis. To evaluate the potential effect of patient attrition on our findings, we assessed group differences between participants who completed both follow-ups (completers) and those who did not (dropouts). Differences at the outset of the program between completers and dropouts were evaluated by one-way ANOVA. The only significant result was that completers had diabetes longer (10.5 ± 9.2 vs. 7.5 ± 6.6 yr, respectively, $P < 0.05$). Differences in changes over time between completers and dropouts were evaluated by mixed-effects ANOVA, in which the between-subject factor was completion status and the within-subject factor was the repeated measure of the outcome variable at the onset of the program and follow-up. These differences never reached statistical significance (1-tailed $P > 0.05$ for all comparisons).

CONCLUSIONS

We found that an intensive comprehensive diabetes education program incorporating self-care skills training and other behavioral techniques produced benefits that lasted for 12 mo. At 1 yr, program participants who had completed both follow-up protocols were significantly improved on two of four measures of self-care (insulin adjustment and SMBG) and two of three measures of metabolic control (HbA_{1c} and perceived hyperglycemia). Tighter control was achieved without increases in perceived hypoglycemia. These results were not meaningfully affected by excluding from the analysis those who did not complete both follow-ups.

Although this study is based on a single-group design, our findings are similar to those of a published multicenter controlled randomized study of diabetes education (2); SMBG and insulin adjustment were improved at follow-up, whereas diet and exercise were not. Why might self-regulation improvements be easier to achieve and maintain than life-style improvements? The answer may lie in behavioral differences between the two types of self-care. Self-regulation behaviors take much less time. Adjusting insulin dose and testing one's blood take only 10–15 min/day, even if tests are done several times daily. Ensuring a healthy diet and exercising properly take much more time. In addition, self-regulation activities are new behaviors unique to diabetes, and they do not require a person to overcome the inertia of deeply rooted habits. Healthy eating and exercise plans often require basic changes in the way people enjoy themselves, both on their own and in social situations. Finally, self-regulation activities may also offer immediate reinforcement, providing a valuable status report and an instantaneous effect-of-treatment benefit. Improvements in life-style, on the other hand, provide benefits only over a longer time.

The self-regulation changes reported in this study apparently were highly effective, because improved HbA_{1c} levels were maintained between 6- and 12-mo follow-ups even though diet and exercise regressed to near-preprogram levels. It is possible that the education program empowered its participants, offering them an effective means to improve their metabolic control without the burden of major changes in life-style. It is also possible that self-regulation allowed patients to avoid hyperglycemia with less risk of hypoglycemia. Preliminary evidence suggests that self-regulation helps achieve better glycemic control, but more research is needed to

evaluate the role of self-regulation behaviors in this process (5).

Our findings may have important implications for educational program planning in diabetes. Patients who take insulin could potentially derive major benefits from participation in relatively inexpensive short-term education programs that teach self-regulation skills. Effective education for patients who do not take insulin may require more expensive programs with frequent contact and long-term follow-up, because targets for improved metabolic control necessarily involve changes in life-style. In the interests of efficient resource allocation, we should provide self-regulation training to all who may benefit from it and reserve more resource-intensive alternatives for those who need to make fundamental changes in life-style.

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REFERENCES

1. Brown SA: Effects of educational interventions in diabetes care: a meta-analysis of findings. *Nurs Res* 37:223–30, 1988
2. De Weert I, Ph Visser A, Kok G, van der Veen EA: Randomized controlled evaluation of an education program for insulin treated patients with diabetes: effects on psychosocial variables. *Patient Educ Counsel* 14:191–215, 1989
3. Peyrot M, Rubin RR: Effect of education on lifestyle and self-regulation intentions and behavior (Abstract). *Diabetes* 39 (Suppl. 1):16A, 1990
4. Rubin RR, Peyrot M, Saudek CD: Effect of diabetes education on self-care metabolic control, and emotional well-being. *Diabetes Care* 12:673–79, 1989
5. Peyrot M, Rubin RR: Insulin self-regulation predicts better glycemic control (Abstract). *Diabetes* 37 (Suppl. 1):53A, 1988

Elevated Cholesteryl Ester Transfer Protein Activity in IDDM Men Who Smoke

Possible Factor for Unfavorable Lipoprotein Profile

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Objectives: To determine the effect of cigarette smoking on the activity of cholesteryl ester transfer protein (CETP) and high-density (HDL), low-density (LDL), and very-low-density (VLDL) lipoproteins in insulin-dependent diabetic (IDDM) men with microvascular complications. Research Design and Methods: We perfomed a case-control study in a referral-based diabetes clinic on a sequential sample of 9 cigarette-smoking and 12 nonsmoking IDDM men with microvascular complications and 12 nonsmoking control men. CETP activity was determined in each serum with an isotope assay with exogenous cholesteryl ester–labeled LDL and HDL. The method is independent of the endogenous lipoprotein present in serum. Results: The HDL-cholesterol (VLDL and LDL) ratio was lower in the smoking diabetic men than in the other groups ($P < 0.05$ vs. the nonsmoking diabetic men and $P < 0.01$ vs. the control subjects). CETP activity was 70% higher in the smoking diabetic men than in the control subjects ($P < 0.01$) and 30% higher than in the nonsmoking diabetic men ($P < 0.05$). The HDL-cholesterol (VLDL and LDL) ratio and the apolipoprotein A-I–B ratio were inversely correlated to CETP activity in the diabetic patients ($r = -0.52$, $P < 0.02$ and $r = -0.45$, $P < 0.05$, respectively). Conclusions: CETP activity is increased in cigarette-smoking IDDM men with microvascular complications. High CETP activity may contribute to the unfavorable lipoprotein profile in these patients.
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The excess risk for cardiovascular mortality in cigarette smokers can in part be attributed to an atherogenic lipoprotein profile (1). In insulin-dependent diabetes mellitus (IDDM), the major cause of premature death is cardiovascular disease.(2)

Among all other pathways involved in lipoprotein metabolism, the process of cholesteryl ester transfer, catalyzed by the cholesteryl ester transfer protein (CETP), is instrumental in the distribution of cholesteryl ester between lipoproteins (3). CETP activity, measured independently of endogenous lipoproteins, was higher in hypercholesterolemic and dys-β-lipoproteinemic subjects and in IDDM patients with microvascular and macrovascular complications (4–6). A deficiency of CETP