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Metabolic Control, Residual Insulin Secretion and Self-care Behaviours in a Defined Group of Patients with Type 1 Diabetes

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ABSTRACT

A population of 185 type 1 diabetes patients (insulin-dependent, IDDM), 25-45 years old, was studied retro- and prospectively over a 9-year period with the aim of analysing background factors of importance for the ability to perform adequate self-care.

Expressed as mean HbA1c, the metabolic control was slightly improved at the end of the study, when the insulin schedule had been changed in 60 % of the patients to multidose treatment. The degree of metabolic control remained constant over the years. The impact of residual insulin secretion, measured as 24-hour urinary C peptide, was low. Patients with less good metabolic control often had a poor educational background and made less use of self-monitoring of blood glucose (SMBG); they also experienced difficulties with SMBG. The applied knowledge of diabetes also differed between groups with good and poor control. Subjectively, most patients considered their metabolic control to be good, irrespective of the HbA1c values. When asked about their own diabetes complications, their answers were often discrepant from the medical records. Patients with particularly "good" or "poor" metabolic control were on the whole less satisfied with the education and information received than those with intermediate blood glucose regulation.

Development of strategies for individually adjusted education seems important.

INTRODUCTION

During the last decade patients with type 1 diabetes have increasingly been expected to be active participants in their own treatment, and to perform adequate self-care. Factors influencing the patient's ability to do this and to achieve satisfactory metabolic control have been subject to vast investigations but are still not clear.

Studies on self-care performance often deal mainly with psychological influences on the performance (3, 5). Other studies have medical and metabolic factors in focus, such as the residual insulin secretion, modes of insulin administration, technology for self-determinations of blood glucose, and so on (2, 14-18). Sjöberg et al (15) suggested that patients without any residual insulin secretion might experience more restrictions of their life-style compared with patients with a measurable amount of C peptide. It has been proposed that changes in the management of type 1 diabetes, with the introduction of flexible multidose insulin regimes (2, 14, 16) and self-monitoring

of blood glucose (14, 17-18), may have a positive influence on the patient's daily self-care and on the metabolic control of the diabetes.

Education of the patients has long been viewed as an important component of the treatment of diabetes (1, 4, 11), although the knowledge *per se* sometimes has only a limited effect on the performance.

A number of studies have been focused on the influence of social factors on self-care and metabolic control (6, 8-9, 12-13, 19). Some of them have dealt with factors influencing compliance with treatment (8, 12, 24), and others have pointed to the importance of social support (9, 12). The selection of patients has varied between different studies reported in the literature, and the degree to which patient materials are described is also highly variable.

In the present study an analysis was made of diabetes-related variables in a well-defined group of patients with type 1 diabetes with the aim of identifying factors affecting the patient's ability to achieve adequate self-care.

SUBJECTS AND METHODS

Investigated group

To obtain a defined and representative sample of type 1 diabetic patients with experience of living with diabetes, the following criteria were established:

1. born between 1939 and 1959,
2. duration of diabetes of at least 5 years (onset of diabetes in 1975 or earlier),
3. currently treated with ≥ 20 U insulin daily.

Of the 1025 patients with type 1 or type 2 diabetes who in 1984/85 were regularly visiting the out- patient clinic at the University Hospital in Uppsala, 193 patients fulfilled these three criteria. At the first screening it was discovered that five of the patients had to be excluded because of brain lesions or mental retardation. Three other patients declined to participate. Thus the final number of patients in this survey was 185.

General procedure

For the period 1980-84 a *retrospective evaluation* was performed. It was possible here to include an assessment of "long-term metabolic control". Glycosylated haemoglobin (HbA1c) had been measured routinely at all out-patient visits since 1980. The patient files also contained reliable information about the duration of diabetes, the treatment schedule and the size of the total insulin dose, height and body weight, serum creatinine and the presence of albuminuria. Most patients also underwent regular screening for retinopathy.

In 1985 a *cross-sectional study* was performed. A questionnaire was mailed to 170 of the 185 patients (12 were excluded because of advanced visual impairment, 2 patients had moved abroad and 1 patient had died). After two reminders it was completed by 139 patients (77 males and 62 females). The 31 "drop-outs" from this inquiry showed a higher percentage of male subjects and a higher mean HbA1c than the total material.

The cross-sectional study included measurement of C peptide in the urine in those 166 of the 185 patients from whom an apparently reliable 24-h urine specimen could be obtained.

In 1985-1988 a *prospective evaluation* of the further treatment and metabolic control of the

patients was undertaken.

Drop-outs: During the 5 years of the prospective study three patients died and 11 moved from the area.

Methods

Glycosylated haemoglobin (here called HbA1c) was initially assayed by means of total HbA1 microcolumns (Bio-Rad, Richmond) and later by HbA1c methods (Bio-Rad, Pharmacia HPLC System). The methods correlate well in linear regression, with correlation coefficients of 0.96-0.98 during periods of double determinations at the laboratory. Thus all HbA1c values were converted to HbA1c %. The upper normal limit (mean ± 2SD) was 6.1 % in subjects with a normal oral glucose tolerance test. HbA1c was usually measured 3-5 times yearly.

The classification of *retinopathic changes* (mainly based on photometric examinations performed by the same ophthalmologist) comprised three categories: no important retinopathic changes, simplex retinopathy (background retinopathy) and preproliferative-proliferative retinopathy.

Renal function was evaluated by means of Albustix® strips at all visits. For the serum creatinine method of the hospital laboratory, the reference limits were 64-106 μmol/l .

The *relative body mass index* (BMI) was used to describe the body weight. Relative BMI was calculated from an ideal BMI of 20.9 kg/m^2 in females and 22.4 kg/m^2 in males, as proposed by West (21).

For screening of *C peptide in the urine*, a commercial kit (Behringwerke) was used.The method was applied semiquantitatively (C peptide below the detection level of <0.4 nmol/24 h, above the detection level but low, 0.4-3.9 nmol/24 h, or within the reference limits of 4.0-50 nmol/24 h).

The *self-care questionnaire* was constructed to obtain demographic data, social data and information concerning subjective health perception, self-care ability, the educational level and applied knowledge about diabetes. The questionnaire consisted of 29 multiple-choice questions, 17 open-ended questions and 5 Likert scales for self-estimation of physical health. The social data were classified according to the socio-economic classification system (SEI) developed by Statistics, Sweden (a copy of the questionnaire is supplied by the authors on request).

Statistical methods: Some results are simply presented as group mean values ±SD. According to the data level, median values have also been used. For comparison of mean values, the t test was used and proportions were compared with the use of chi-square tests. Correlations were calculated by Pearson's product-moment correlation coefficient and the Spearman-Rank correlation. One factor Anova (two-tailed) was used for group comparison.

RESULTS

CLINICAL CHARACTERISTICS

Age and duration

In 1985, as implied by the inclusion criteria, all patients were between 26 and 46 years old, with the same mean age of 36 for males (n= 104) and females (n= 81). The mean age at onset of diabetes (total range 1-33 years) was 15.5 ±7.7 years in male and 12.3 ± 7.9 years in female subjects. The total mean duration of diabetes was 22.1 years ± 8.5 (range 10-41 years).

HbA1c values

During the five-year baseline period 1980-1984 the mean HbA1c value in the whole material was 8.7 ±1.2 %. In 1986 the mean HbA1c was unchanged, 8.7 ±1.5 %, and in 1988 it was significantly lower, 8.3 ±1.2 % ($p<0.01$).

As shown in Table 1, the patients were arbitrarily divided into four groups according to their metabolic control (good, acceptable, unsatisfactory and unacceptable) as evaluated at baseline. In the intermediate range, groups II and III, there was a higher proportion of men with better control ($p<0.05$).

Table 1. Patients with various degree of metabolic control. Classification based on mean HbA1c during the five years 1980-1984.

HbA1c %	Group	male (104) % of patients (n)		female (81) % of patients (n)		Mean HbA1c % ± SD
≤7.5	I	17	(18)	20	(16)	6.9±0.65
7.6-8.4	II	30	(31)	20	(16)	8.0±0.27
8.5-9.4	III	24	(25)	34	(28)	8.9±0.25
≥ 9.5	IV	29	(30)	26	(21)	10.1±0.68

Insulin dose

During 1980-1984, the five-year baseline period, 31 patients had changed to a multidose regime from their previous 1-2 daily injections. As seen in Table 2, during the 9 years from 1980 to 1988 the number of patients on a multidose schedule increased continuously from 0/182 to 103/170. At the same time the number of patients maintained on one single daily dose decreased from 103 to 18. Meanwhile the mean daily total insulin dose seemed to increase slightly.

Table 2: Total insulin doses and number of injections in 185 type 1 diabetic patients.

Year	Insulin dose (Units/kg/day)	Number of patients with 1 daily dose	2 daily doses	multidose
1980*	0.64	103	79	0
1984*	0.70	44	107	31
1986**	0.72	25	86	69
1988***	-	18	49	103

*n=182, **n=180, ***n=170

Finally in 1988 patients with poor metabolic control more often had a multidose schedule than those with good control ($p<0.05$).

When a separate analysis was made of the 31 first multidose patients in 1980-1984, both an increase in the total insulin dose (0.70 U/kg/day in 1980 compared to 0.78 in 1984) and a decrease in the mean HbA1c, from 9.1% to 8.5%, were seen after the dose intervention (n.s, $p<0.1$). A change from 1 to 2 doses of insulin daily had no impact on the mean HbA1c level in 44 patients during the baseline period.

Body weight

Overweight, defined as a standardized BMI exceeding 120 %, is not common in patients with type 1 diabetes, particularly not in males. In 1980, overweight was found in 3% of the men compared to 13% of the women of this material ($p<0.001$). In 1986 these figures had increased to 12 % and 14 %, respectively, a difference which was at least partly attributable to a more intensive insulin regime. The mean weight increase from 1980 to 1986 in the 69 patients who had changed to 3-4 daily injections was 2.7 kg, whereas the 25 patients remaining on a single daily dose only showed a small mean weight change, +0.8 kg.

Retinopathy

In 1980 126/183 patients were found to be free from clear signs of retinopathy. This proportion decreased to 77/183, 65/177 and 62/170 in the years 1984, 1986 and 1988, respectively. There was a relation between the development of retinopathy and the previous HbA1c level (classified as in Table 1), as seen in Table 3 A. Patients with HbA1c < 7.5% had significantly higher percentage of freedom from retinopathy than those with higher HbA1c values ($p< 0.01$). In 1988 proliferative retinopathy was found in 20/51 subjects with HbA1c ≥9.5 %, but only in 2/34 subjects with HbA1c < 7.5 % ($p<0.001$). The patients without retinopathic changes had significantly lower mean HbA1c values than those with clear changes ($p<0.005$).

Table 3 A. Percentage number of type 1 diabetic patients "without retinopathy" as related to the mean HbA1c level during the five-year period 1980-1984.

HbA1c 1980-84		n	diabetes duration (mean±SD)	% without clear changes 1980	1984	1986	1988
≤7.5	(I)	34	22.0±7.7	91	62	59	53
7.6-8.4	(II)	47	24.0±8.1	64	36	30	28
8.5-9.4	(III)	53	24.9±9.9	58	40	36	30
≥ 9.5	(IV)	51	21.1±7.7	70	37	29	29

Nephropathy

The qualitative test for proteinuria, Albustix®, was normal in 149/183 patients in 1980 but only in 126/183 five years later, at the end of the baseline period. After 1984 129/178 subjects remained free from proteinuria until 1988, when 121/168 had a negative proteinuria test. The relation between the HbA1c level and a negative proteinuria test is shown in Table 3 B, which is analogous to Table 3 A. Patients with HbA1c ≤ 8.4% had significantly higher percentage of freedom from albuminuria than those with HbA1c > 8.5% ($p < 0.01$).

Ninety-seven per cent of the patients with good metabolic control and 90 % of those with unacceptable control had serum creatinine values within the reference limits.

Table 3 B. Percentage number of type 1 diabetic patients "without proteinuria" as related to the mean HbA1c level during the five-year period 1980-1984.

HbA1c 1980-84		n	diabetes duration (mean±SD)	% with negative proteinuria test 1980	1984	1986	1988
≤7.5	(I)	34	22.0±7.7	97	91	88	88
7.6-8.4	(II)	47	24.0±8.1	91	77	77	77
8.5-9.4	(III)	53	24.9±9.9	75	64	66	58
≥ 9.5	(IV)	51	21.1±7.7	67	49	55	47

Stability of metabolic control (Fig.1)

In the analysis of the possible effect of metabolic control on the rate of occurrence of late complications of diabetes (Tables 3 A and 3 B), and in the study of self-monitoring of blood glucose and other aspects of self-care, it was of interest to assess the degree of fluctuation between good and poor metabolic control. In this respect considerable stability was found. In each of the four metabolic control groups (Table 1), the mean HbA1c value was calculated for each of the years 1980, 1984, 1986 and 1988, and no change was found in any of the groups over this 9-year period (Fig 1). If the mean HbA1c for 1988 instead of the mean for the period 1980-1984 had been used as a basis of the grouping, some patients would of course have been allocated to a group above or below the previous rating (borderline cases), but only 18 of the 185 patients would have had to be moved two steps or more upwards or downwards on the 4-grade scale.

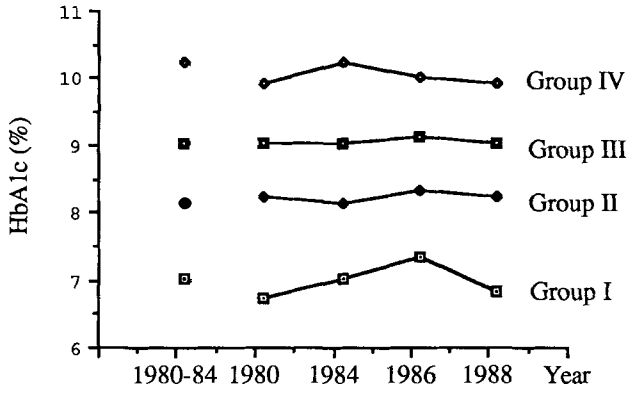

Figure 1: The mean values of HbA1c in the four groups of patients with type 1 diabetes (n=34-53) with different degrees of metabolic control, as defined in Table 1, in 1980-1984, are shown to the left. The mean HbA1c for each of these groups in four different years between 1980 and 1988 is then shown, to illustrate the degree of stability over this 9-year period.

Residual insulin secretion

The 24-hour excretion of urine C peptide was determined in 90 % of the 185 patients.

As expected, with a mean duration of 22 years and a shortest duration of 10 years, the majority of the patients had no or very little urinary C peptide. No or only a small amount (< 0.4 nmol/24 h)

was found in 133 patients. Twenty-two patients had a definite excretion but so low that it was clearly in accordance with type 1 diabetes. Eleven patients had C-peptide excretion of such a magnitude that it was likely to be of clinical importance (≥ 4.0 nmol/24 h).

The 33 patients with a detectable amount of C peptide in the urine were matched according to sex, age and duration of diabetes with 33 patients with non-detectable levels of C peptide. The two groups each consisted of 18 males and 15 females. The mean age of the two groups of patients was 38 ± 5 years and the mean duration of their diabetes was 22 years (22±9 in the C-peptide group and 22±10 in the matched group). The mean HbA1c values were only slightly lower in the patients with urinary C-peptide excretion (excretors) than in those without detectable C peptide in the urine (non-excretors) (excretors: 8.7±1.30%; non-excretors: 9.3±1.65%) and there was no correlation between HbA1c values and urinary C-peptide values (r=-0.07).

There was no difference between the two groups in the daily amount of insulin administered (0.65 ±0.18 U/kg/day in C-peptide excretors and 0.68±0.17 in non-excretors). Neither was there any difference in relative BMI. The urinary C-peptide excretion showed no correlation with the daily amount of insulin (r=0.20), but was weakly correlated with relative BMI (r=0.31).

There was a tendency (n.s) towards a lower frequency of late complications among excretors than among non-excretors: 15 excretors had retinopathic changes, against 20 non-excretors, and three had proliferative retinopathy, against six non-excretors; for albuminuria the figures were five and ten ($p<0.02$).

The two groups gave similar answers to the self-care questionnaire.

SOCIAL CHARACTERISTICS

Seventy-four per cent of the patients were married or living with a partner, without any differences between the four HbA1c groups. The type of occupation of the partners differed, however, between group IV and the other three groups. Fifty-six per cent of the group IV partners were manual workers, compared with 9% of those of group I, 22% of those of group II and 21% of those of group III ($p<0.01$, group I vs group IV). The same pattern was found regarding the patients' educational level (Fig. 2), most patients with good control having completed upper secondary school education.

SELF-CARE CHARACTERISTICS

Estimation of own metabolic control

Eighty-five per cent of the patients considered that their own metabolic control was good or very good and 15 % that it was poor or very poor (Fig. 3). The correlation between the self-rating of metabolic control and HbA1c values was weak (r=0.27), mainly because HbA1c did not differ between the the two intermediate groups.

Self-monitoring of blood glucose (SMBG)

Forty-nine per cent of all males and 29 % of all females reported that they never monitored their own blood glucose. SMBG was carried out systematically by 27 % of the patients with good or acceptable metabolic control but only by 16 and 11 %, respectively, of those with unsatisfactory or unacceptable control. Problems with self-monitoring were usually of a practical nature, with

difficulties in organizing the tests and getting reliable results, but psychological pressure and "test hysteria" was also reported. Self-monitoring was associated with difficulties for the performers in 13 % of group I (good control), 38 % of group II (acceptable control) and 57 % of groups III and IV.

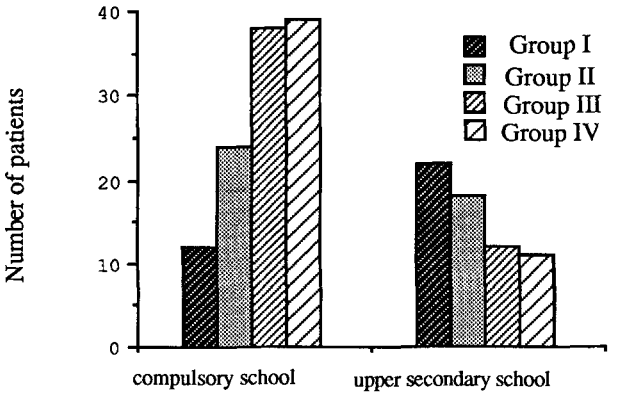

Fig 2. Educational background of the patients.

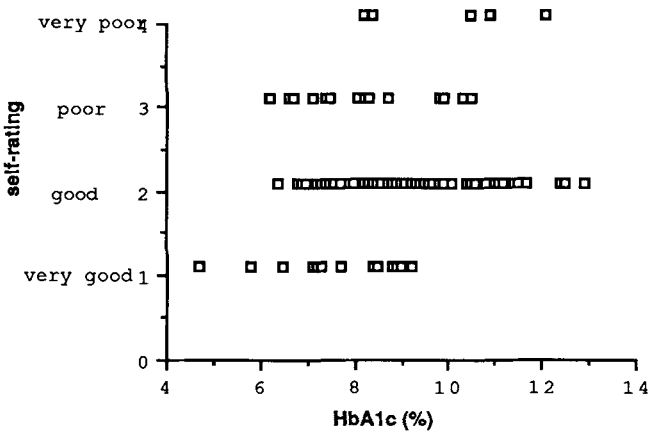

Figure 3: Comparison between measured HbA1c values and patients' self-rating of metabolic control.

Perception of health, symptoms and complications

The self-rating of physical health and mental balance, as perceived by the patient, in relation to the metabolic control is shown in Figs 4 and 5. No correlation between HbA1c and the subjective assessment of physical health ($r=-0.05$) or mental balance ($r=-0.06$) was found. However, both concerning physical health and mental balance, the patients in group II ("acceptable") had the highest mean self-ratings and those in group IV the lowest ($p<0.05$).

Regarding the patients' opinions as to whether perceived physical unhealth and mental unbalance were diabetes-related, 15 % of the patients in group I who reported physical unhealth and 38 % of

the corresponding patients in group IV considered this to be totally diabetes-related. On the other hand 27 % of those in group I who reported mental unbalance and 11 % of the corresponding patients in group IV considered this to be totally diabetes-related.

A comparison between the patients' knowledge about their late complications and information collected from the patient files showed a discrepancy (Table 4). Patients in the group with good metabolic control were more well-informed about their retinopathy than those in the other groups.

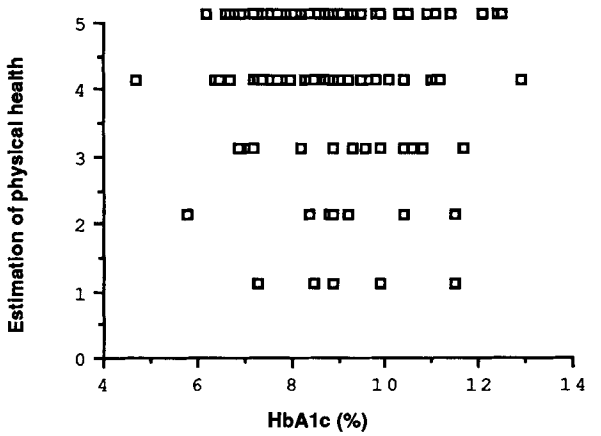

Figure 4: Patients' self-estimation of physical health in relation to measured HbA1c values (1=not well at all, 2=not quite well, 3=moderately well, 4=almost well, 5=healthy)

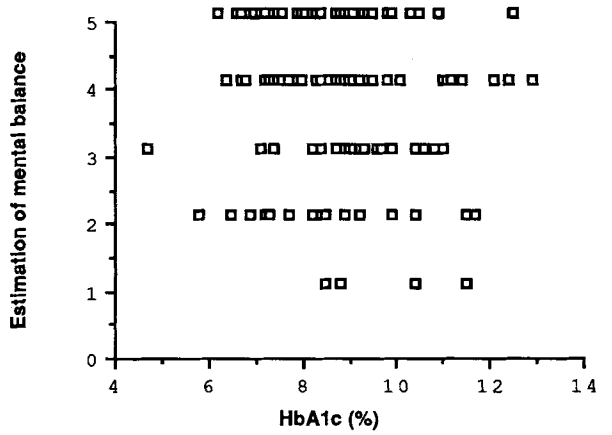

Figure 5: Patients' self-estimation of mental balance in relation to measured HbA1c values (1=not at all in balance, 2=not very good balance, 3=moderate balance, 4=good balance, 5=very good balance)

Table 4: Percentage number of patients with late complications according to information in patient files and the patients' own report (in brackets) (1985)

Complication	Group I n=34	Group II n=47	Group III n=53	Group IV n=51
Retinopathic changes	21 (20)	64 (35)	58 (41)	63 (40)
Albuminuria	12 (7)	23 (11)	34 (14)	49 (23)

Knowledge about diabetes used in daily practice

Fifty-seven per cent of the patients gave satisfactory answers when asked how they would balance the insulin dose in the event of an infection with fever. Thirty-two per cent would never change the insulin dose, 4 % described irrational actions and 7 % did not know what to do. A satisfactory answer was more common (63%) in patients with good metabolic control than in those with unacceptable metabolic control (54%).

When asked a similar question about acute gastroenteritis, 42 % gave satisfactory answers, 36 % did not correct the dose, 15 % felt insecure and 7 % described an incorrect action. A comparison between group I and IV showed that 64% of the former patients, with good metabolic control, gave satisfactory answers, compared with 29% of those of the latter group, with unacceptable metabolic control.

One-third of the 139 patients seemed to understand how the amount of food interacts with exercise and insulin.

Sixty-five per cent of the patients were satisfied with the amount and quality of the education and information they had received about diabetes and its treatment. The patients in the intermediate groups, II and III, were more content than those in groups I and IV (group I: 60%, group II: 70%, group III:73% and group IV:54%).

The question "Do you tell your friends, relatives and colleagues that you are a diabetic?" was answered as shown in Table 5. Patients with good metabolic control seemed to tell about their diabetes more often than the others.

Table 5: Percentage number of patients that told others that they were a diabetic, in each of the four metabolic control groups as defined in Table 1.

	group I	group II	group III	group IV
tells close friends	80	54	54	66
tells relatives	83	59	54	63
tells colleagues	67	43	59	60

DISCUSSION

Characteristics of the material

It was the aim of this study to follow up type 1 diabetic patients regarding their metabolic control over a long period of time (1980-1988). This 9-year study was performed in a well-defined group of patients with type 1 diabetes. By using both retro- and prospective data, virtually all the patients could be followed up throughout the entire period. This would not have been possible if the study had had an exclusively prospective design.

This long-term investigation showed that new treatment strategies, such as multidose treatment with insulin pens (60% of the patients had changed to multidose) and more intensive patient education, seemed to have had an impact on the metabolic control. A more aggressive treatment of hypertension in diabetes patients during the recent years could have contributed to the decrease, here observed, in the number of patients with albuminuria.

The patients of the study group, identified in 1984-1985 in the middle of the study, were between 25 and 45 years old (mean 36 years) and had had diabetes for at least 10 years (mean 22 years). Type 1 diabetes was defined as diabetes requiring treatment with at least 20 units of insulin daily. The out-patient clinic, in an unbiased mode, handles a majority of the young adult patients with type 1 diabetes in the area and all patients who fulfilled the criteria were included. Thus the study material was representative of type 1 diabetes patients 25-45 years old with a disease duration of 10-40 years, with two further possible selection factors to consider: 1) such patients would be lost as had died at a young age before 1984 or referred e.g. to dialysis 2) patients not steadily living in the Uppsala area but having left the city, or moved in, during the retrospective analysis period (1980-1984) would not be included.

The results obtained in the present study should also be viewed in the light of the fact that during the years preceding 1980 the diabetes clinic had been reorganized. A diabetes nurse specialist and a dietician had been included in the staff, and both specific therapeutic intervention and diabetes education activities had been introduced. That the care provided had a reasonable standard is illustrated by the fact that all patients in this study had been examined regarding retinopathy. Measurement of glycosylated haemoglobin had been used as a means of identifying patients in particular need of attention, although only 1-2 daily doses of insulin had been used before 1981 and, on the whole, only previously pregnant women had been trained to monitor their own blood glucose. As shown in Table 2, multidose treatment (3-dose, 4-dose, CSII) was successively introduced betwen 1980 and 1988. To an increasing extent the patients were also taught the usefulness of SMBG.

Main findings in the study

HbA1c stability. When the mean HbA1c value for 1980-1984 in each patient was used for classification into four groups with different degrees of metabolic control, the groups showed remarkable stability over time, as assessed by calculating the mean values for different years in these patient groups (Fig. 1).

Effect of intervention The first 31 patients in whom a change was made to a three-dose regime showed a decrease in mean HbA1c from 9.1 to 8.5 %. About one-third of these patients had changed the insulin regime because of poor metabolic control and it was found that a reduced HbA1c level was only obtained in the patients with initial values of above 8 %, although most of them found other advantages from a multidose regime (22). In the whole material, the mean HbA1c of 8.3 % in 1988, was significantly lower than the mean base-line value of 8.7 %, a reduction which may have reflected the increasing use of a multidose insulin regime (Table 2), continuous patient education and/or increased SMBG. A slight increase in bodyweight was observed in multidose patients but overweight was uncommon in this material.

The use of SMBG is correlated to good metabolic control. About 25 % of the patients in the groups with good or acceptable metabolic control regularly measured their own blood glucose and used the values for balancing, compared with 11-16 % in the groups with unacceptable or unsatisfactory metabolic control. In the latter groups SMBG was associated with more difficulties.

The educational level is an important factor. One major difference between the group of patients with good control and the other groups lay in the educational background, as shown in Fig. 2. Here it is seen that "good control" patients had completed upper secondary school. About one-fourth of all patients were single, but among the others 56 % of those with the worst metabolic control (group IV) had partners with manual work. This may be compared with the 9 % in group I and thus seems to provide some confirmation of the importance of the educational level.

Possible value of confidence and a social network. Patients with good metabolic control (Table 5) more often talked to their friends, relatives and colleagues about their diabetes. This finding may be related to the importance of the amount of education obtained and of the potential ability to receive education.

Residual insulin excretion does not seem important. As measured by 24 h urinary C-peptide excretion, the residual beta-cell function seemed to be of little or no influence on metabolic control in long-standing type 1 diabetes. Only 11/185 patients excreted more than 4.0 nmol/24 h and 133 of the patients excreted less than 0.4 nmol. All 33 C-peptide excretors were compared with and found to be similar to the 33 matched controls. There were no correlations between HbA1c, the daily insulin dose and urinary C peptide.

Patients can experience difficulties with the assessment of health. It seems to be common to underestimate the presence of late complications of diabetes and the degree of metabolic derangement, when the metabolic control is poor, as shown in Fig. 3 and Table 4. This may be explained by wishful thinking or by absence of a feeling of decreased well-being. Jacobsen et al (3) pointed out that poor metabolic control may be associated with a higher threshold for physical symptoms caused by hyperglycaemia. The experience of well-being is determined by other factors than metabolic control (23). When patients were asked to estimate their own physical and mental health (Figs 4 and 5), virtually no correlation was found between HbA1c and the ratings. However, there was a tendency for the patients with acceptable, but not very good metabolic control to experience the highest degree of mental and physical health.

Factors affecting metabolic control and self-care

Among all patients who changed to multidose treatment, there was an overrepresentation of patients in groups III and IV (poor metabolic control). Though the change was partly a technical solution to problems of poor metabolic control, there are other important aspects. Even if the primary aim was to achieve better metabolic control, it will probably in the long term prove to give the type 1 diabetes patient a greater sensation of freedom. Adequate knowledge will probably also increase the patient's self-esteem.

Twenty per cent of the patients had detectable levels of C peptide in the urine, but only 6% had levels within the reference limits. This could be compared with findings of Sjöberg et al (14), who reported that 36% of the patients were urinary C-peptide excretors but that in these patients the duration of diabetes was shorter (9-16 years) and the detection level for urinary C peptide was 0.2 nmol/24 hours, which could explain the difference. The authors found better metabolic control, however, in patients with C-peptide excretion and this could not be statistically verified in our study. The only significant difference between excretors and non-excretors in our study was the frequency of late complications, which was lower in the C-peptide excretors.

It has been found difficult to provide definite proof that good metabolic control in itself is able to prevent the development of late complications. However, this study adds to other circumstantial evidence by finding a significant difference in mean HbA1c values between patients without late complications and those with clear retinopathic changes, for example ($p<0.01$). This is also in line with the findings in a randomized study (10) on intensified diabetes treatment, in which a relationship was observed between late complications and blood glucose levels.

It is quite obvious that patients with only a short period of general education have poorer metabolic control than those with higher education. The reason for this is not clear, but it is possible that the education and information given to the patients regarding their diabetes is on too high a level for those with only compulsory schooling as an educational basis. The knowledge about diabetes among relatives, friends and colleagues of diabetic patients is an important part of the patient's safety-net. That the patient has the courage to inform others about his diabetes may reflect his self-esteem.

Regarding self-care behaviours such as self-monitoring of blood glucose, we found that the patients with poor metabolic control did not use this aid as often as those with good control and more often reported difficulties in carrying it out. This is in accordance with the finding that only those who used the results of their SMBG in balancing the glycaemic control received a better metabolic control. This could of course be due to lack of information. An explanation for the discrepancy between the late complications as reported in the patient files and as described in the patients' own reports could be either that the patients had been told about the occurrence of late complications but had suppressed the information or that the information had been given in a disguised way in order not to worry the patient too much and was hence unclear.

Also the fewness of the right answers to the question concerning interactions between food, exercise and insulin might have reflected a misunderstanding of the question, but it might also illustrate how problematic it is for the patients to handle the complex interplay between these three variables. The interaction may seem easy to understand for a non-diabetic, but for patients with type 1 diabetes, who know how hard it is to achieve a balance between food, activities and insulin in their daily social life, it is not always easy to manage (20).

Achievement of good metabolic control is today the best way of delaying the occurrence of late complications (10). When trying to improve the patient's HbA1c values, it is important to tell him that the principal aim of this is to prevent complications and not to increase his well-being. The patient with good metabolic control is not necessarily the patient with the highest feelings of well-being. It is desirable that besides the goal of obtaining good metabolic control there should also be a goal of achieving a high sense of well-being in the patient irrespective of the metabolic control.

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