Glycemic Control in Patients With Diabetes in Finland

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OBJECTIVE — To evaluate the quality of diabetes care at a national level in Finland, using level of glycemia as a determinant of success in treatment.

RESEARCH DESIGN AND METHODS — Physicians and diabetes nurses in 76 randomly selected clinics (59 primary care units and 17 hospitals) evenly covering the whole of Finland were asked to fill in a questionnaire asking for data based on the 1993 medical records of a random sample of 50 diabetic patients from each center (total n = 3,800). HbA_{1c} was used as an index of glycemic control.

RESULTS — Information on 3,195 (84%) diabetic patients was received. HbA_{1c} was measured in 67% of the patients in 1993. The mean HbA_{1c} in the whole population was 8.6 ± 1.9% (normal range 4–6%). Some 25% of patients had $HbA_{1c} \leq 7.3\%$, while 25% had $HbA_{1c} \geq 9.7\%$. The mean HbA_{1c} was 8.8 ± 1.9% in type 1 and 8.5 ± 1.9% in type 2 diabetic patients. There was no sex difference in the HbA_{1c} level in type 1 diabetic patients. However, male type 2 diabetic patients had better glycemic control than female patients (8.3 ± 1.9 vs. 8.8 ± 1.9%, $P < 0.0001$). The sex difference was independent of the type of therapy. The mean level of glycemic control was lowest among individuals with the shortest duration of diabetes. After 7–9 years after the diagnosis, there was no change in the mean level of glycemia.

CONCLUSIONS — Average glycemic control is poor in a majority of the diabetic patients in Finland. Better treatment strategies and methods should be used to improve glycemic control and to reduce long-term complications.

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It is well established that good glycemic control can prevent microvascular complications in type 1 diabetic patients (1–3), and recent data suggest the same may be true also in type 2 diabetic patients (4,5). Regarding macrovascular complications, a number of cross-sectional studies have shown an association between good control and low incidence of macroangiopathy and its manifestations, such as stroke (6), cardiovascular mortality (7–9), and total mortality (8,10,11), in diabetic patients. In prospective studies, the reduction of macrovascular complications by good control has been of borderline statistical significance both in type 1 (Diabetes Control and Complications Trial) (1) and in type 2 (4) diabetic patients. Thus in recent years, clinical recommendations throughout the world have set good glycemic control as one of the main goals in diabetes care.

Despite the importance of glycemic control for development of complications, there are very few data on glycemic control of diabetic patients at a national level. The purpose of our study was to examine the average level of glycemia in diabetic patients in Finland. HbA_{1c} was used as a determinant of glycemic control. The results of this study will serve as a basis for future efforts to improve diabetes care in Finland.

RESEARCH DESIGN AND METHODS

Out of the estimated 150,000 patients with diagnosed diabetes in Finland, 113,000 patients are treated with insulin or oral antidiabetic drugs. In our study, a minimum goal of 3,000 patients was calculated to be representative of diabetic patients in Finland. To cover the whole country, we randomly selected 51 health care centers from the 11 provinces of Finland, taking into account the distribution of population between the provinces. In addition, 17 hospitals located near the health care centers were included in the study. It has previously been shown that 70% of the patients with diabetes in Finland visit health care centers and 20% visit outpatient hospital clinics for treatment of the disease (12). In our study, 78% of the questionnaires were sent to health care centers and 22% to outpatient hospital clinics. In the selected study clinics, physicians and diabetes nurses were asked to fill out a questionnaire based on the 1993 medical records of a random sample of 50 consecutive diabetic patients aged >15 years visiting the clinic. Thus, a total of 3,800 questionnaires were sent out to study clinics.

The key questions in the questionnaire were the following: *1*) year of birth, *2*) sex, *3*) year of diabetes diagnosis, *4*) mode of treatment, *5*) the last HbA_{1c} (or HbA_1) value as measured in 1993, *6*) height and weight, and *7*) opinion on whether the diabetes care was regarded as successful or not. The study period was from September 1994 to March 1995.

In the analysis, patients diagnosed under the age of 30 years and treated with insulin were regarded as type 1 patients. Patients diagnosed at the ≥40 years of age were regarded as type 2 diabetic patients. Patients with an age-at-diagnosis between 30 and 39 years were

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Abbreviations: DCCT, Diabetes Control and Complications Trial; OHA, oral hypoglycemic agent.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

Table 1—*Distribution of HbA_{1c} values in Finland*

	n	HbA_{1c}	Percentile				
			10%	25%	50%	%75	90%
All study patients	2,047*	8.6 (8.5–8.7)	6.3	7.3	8.5	9.7	11.1
M	1,056	8.5 (8.4–8.6)	6.2	7.2	8.4	9.6	10.9
F	988	8.8 (8.6–8.9)	6.3	7.4	8.6	9.9	11.4
Type 1 diabetes	599	8.8 (8.6–8.9)	6.5	7.5	8.6	9.9	11.2
M	320	8.8 (8.6–9.0)	6.7	7.6	8.7	9.8	11.0
F	278	8.8 (8.5–9.0)	6.3	7.2	8.5	10.1	11.7
Type 2 diabetes	1,165	8.5 (8.4–8.6)	6.2	7.1	8.4	9.7	11.0
M	567	8.3 (8.1–8.4)	6.1	6.9	8.0	9.4	10.7
F	597	8.8 (8.6–8.9)	6.4	7.4	8.6	9.9	11.4
Mode of treatment							
Diet only	120	6.4 (6.2–6.7)	5.1	5.5	6.4	7.2	8.0
OHAs alone	585	8.3 (8.2–8.5)	6.3	7.0	8.0	9.3	10.7
Insulin alone	1,086	8.8 (8.7–8.9)	6.5	7.5	8.7	9.8	11.2
Combined insulin and OHAs	238	9.5 (9.2–9.7)	7.2	8.2	9.3	10.4	11.8
Duration of diabetes (years)							
0–3	302	7.7 (7.5–7.9)	5.7	6.4	7.4	8.6	10.2
4–6	289	8.1 (7.9–8.4)	5.9	6.7	7.8	9.3	10.9
7–9	310	8.9 (8.7–9.1)	6.6	7.5	8.7	10.1	11.6
10–12	237	9.0 (8.7–9.2)	6.7	7.7	8.8	10.0	11.6
13–15	212	8.9 (8.6–9.1)	6.5	7.4	8.8	10.0	11.2
16–20	247	8.9 (8.7–9.1)	6.7	7.9	8.8	10.1	11.1
>20	466	8.9 (8.7–9.0)	7.0	7.7	8.7	9.8	10.7

Data for HbA_{1c} are means (95% CI). *Sex information missing for three patients.

not included in the analysis of type 1 and type 2 diabetic patients. It has been shown that 92% of Finnish patients diagnosed with diabetes under the age of 30 are insulin dependent (13) and that only 3% of type 2 diabetic patients are diagnosed under the age of 40 years (14).

No additional blood samples were collected to measure HbA_{1c}. All information was gathered from medical records. Thus, the methodology used to measure HbA_{1c} varied in different study clinics. However, only HbA_{1c} values measured in laboratories with a reference range of 4–6% were included in the analysis. In our study, values of HbA_{1c} ≤6.0% were considered to reflect normoglycemia. HbA_{1c} between 6.1 and 7.5% was classified as good glycemic control, between 7.6 and 8.5% as moderate control, between 8.6 and 10.0% as poor control, and >10.0% as alarming.

Statistical analysis

Data were analyzed using Statistical Analysis Software (SAS) (version 6.12). Data are presented as means ± SD. Also, 95% CIs were calculated. Student's *t* test was used to compare means of HbA_{1c}. A *P* value of <0.05 for the difference between the mean values was considered to be statistically significant.

RESULTS

The overall response rate was 87% in hospitals and 83% in health care centers. A total of 3,195 (84%) questionnaires were returned. Of the diabetic patients, 52% were female, and the mean age was 58 ± 17 years. Diabetes was diagnosed at a mean age of 47 ± 20 years. Some 21% of the patients were classified as having type 1 diabetes and 70% as having type 2 diabetes. The mean duration of diabetes was 11 ± 9 years. BMI could be calculated from the information given in the questionnaires in 80% of the patients. The mean BMI was 28 ± 5 kg/m^2; 25 ± 4 kg/m^2 in type 1 diabetic patients and 29 ± 5 kg/m^2 in patients with type 2 diabetes. Of the patients, 13% were treated with diet only, 37% with oral hypoglycemic agents (OHAs) alone, 39% with insulin alone, and 11% with a combination of OHAs and insulin.

Glycosylated hemoglobin was recorded in 67% of the patients during 1993. In 95% of the patients, the glycohemoglobin was measured as HbA_{1c} (not as HbA_1) with a reference range of 4–6%. The remaining 5% of the measurements were excluded from the analysis. Thus, the final analysis included 599 type 1 and 1,165 type 2 diabetic patients.

The mode of treatment had an influence on the frequency of HbA_{1c} measurement. The determination was done in 91% of patients with insulin treatment alone, in 73% of patients with a combination of OHAs and insulin, in 52% of the OHA-treated patients, and in 31% of the patients treated with diet only. Since the proportion of diet treated patients with no measurement was so high, the mean duration of diabetes in the patients in whom HbA_{1c} was not measured was considerably shorter than that in patients who did have HbA_{1c} measured in 1993 (8.5 vs. 12.8 years, respectively). However, the duration of diabetes did not have an effect on the frequency of HbA_{1c} measurement within each treatment mode. In hospitals, the HbA_{1c} measurement was done more often than in health care centers, even after the type of diabetes and mode of treatment were taken into consideration (data not shown).

The mean of all the reported HbA_{1c} values was 8.6 ± 1.9%. A quarter of the patients had HbA_{1c} <7.3%. In 10% of the patients, HbA_{1c} exceeded 11.1%. Men were in better glycemic control than women (8.5 ± 1.8 vs.

Table 2—*Distribution of patients according to glycemic control*

	HbA_{1c}	Type 1 diabetes	Type 2 diabetes
Normoglycemia	≤6.0	5	8
Good control	6.1–7.5	21	26
Moderate control	7.6–8.5	23	20
Poor control	8.6–10.0	29	26
Alarming control	>10.0	22	20

Data are %.

8.8 ± 2.0%, respectively; $P = 0.0005$). The difference was explained by lower HbA_{1c} results in type 2 diabetic males (8.3 ± 1.9 vs. 8.8 ± 1.9% in females; $P < 0.0001$), whereas no sex difference was observed in type 1 diabetic patients (Table 1).

Less than 10% of patients had HbA_{1c} in the normal range. The value was <7.5% in 26% of type 1 diabetic patients (males 23%, females 30%) and in 34% of type 2 diabetic patients (males 39%, females 28%). Some 51% of type 1 (males 52%, females 49%) and 46% of type 2 (males 41%, females 52%) diabetic patients were in poor control (HbA_{1c} ≥8.6%) (Table 2).

Patients treated with diet only had the best glycemic control. However, 10% of patients in this group had HbA_{1c} >8.0%. Half of the patients treated with OHAs was HbA_{1c} >8.0%. The poorest control was seen in patients treated with a combination of OHAs and insulin, with a mean HbA_{1c} of 9.5 ± 1.9% (Table 1).

Duration of diabetes had a clear influence on glycemic level. Patients with a recently diagnosed diabetes (duration of disease <3 years) were in best glycemic control. After a duration of 7–9 years of diabetes, there was no change in the mean level of glycemia. Even though the mean concentration of HbA_{1c} did not change, the proportion of patients with alarmingly poor glycemic control was lower among patients with a duration of diabetes >12 years (Table 1).

The proportion of patients with different HbA_{1c} levels was related to BMI with a U-shaped curve. The smallest proportion of patients in alarming control was seen in a group of patients with BMI between 23 and 26 kg/m². This was the case for both type 1 and type 2 diabetic patients (Fig. 1).

CONCLUSIONS

— The aim of our study was to examine nationwide mean glycemic control in type 1 and type 2 diabetic patients in Finland. The study was initiated to provide baseline data for diabetes quality improvement projects. The centers and patients studied were carefully selected to give a representative sample covering the whole country. HbA_{1c} was chosen as an index to describe the success in diabetes care. The results of our study are based on medical records of patients visiting a clinic responsible for treatment of diabetic patients. No standardized measurements were made during the study visits, which prevents us from comparing the results between individual clinics.

Our study may be biased in two ways. First, selection of patients in a clinic was based on consecutive patient visits at the clinic. Patients who visit the clinic most frequently may thus be over-represented, and we may have a bias for patients who have more problems with diabetes care, and therefore a higher glycemic level, compared with the general diabetic population in Finland. On the other hand, patients visiting a doctor more frequently may also be highly motivated and thus have better results in treatment.

Second, HbA_{1c} was measured in only 67% of the patients in 1993. HbA_{1c} was measured in only 31% of the patients treated with diet alone, while in the vast majority of patients with insulin treatment, HbA_{1c} was measured. The selection may bias the results in two ways. It may be that HbA_{1c} was measured from those who are in worse glycemic control, and in that case our estimation of the HbA_{1c} level in Finland is higher than it really is. On the other hand, HbA_{1c} measurement should be tested at least once a year for each diabetic patient, according to the Finnish recommendations made by expert committees. So, it may also be that those individuals

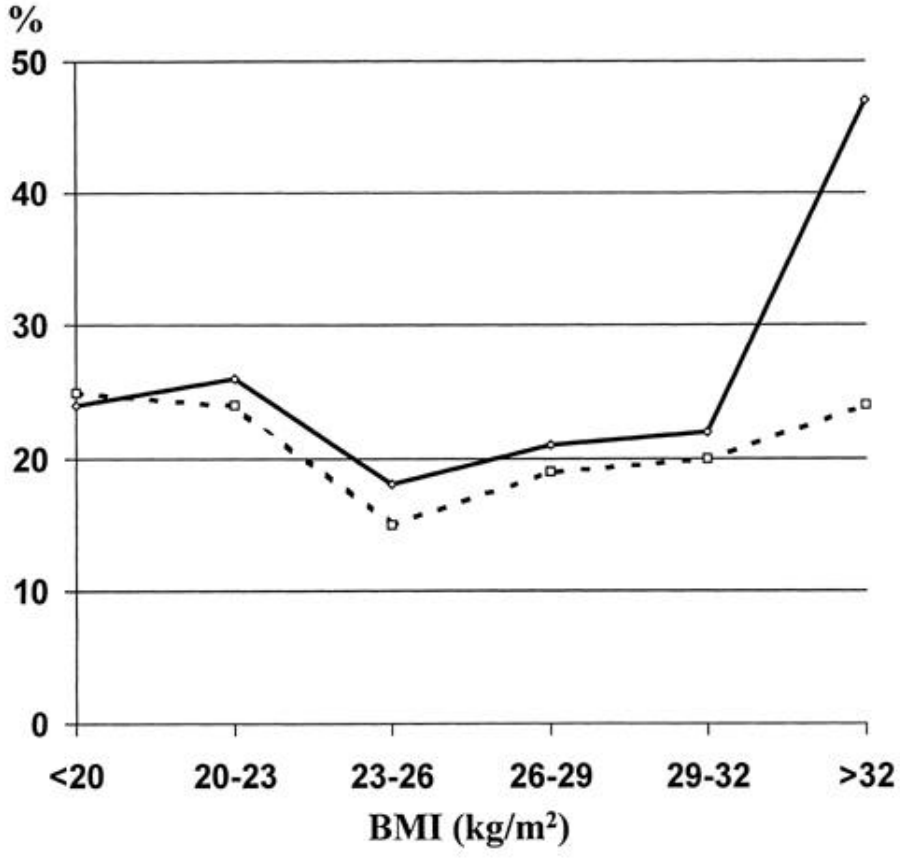

Figure 1—*Proportion of type 1 (◇) and type 2 (□) diabetic patients in alarming glycemic control (HbA_{1c} >10.0%) according to BMI.*

who were not tested in 1993 are not receiving good quality treatment and, therefore, may actually have higher glucose levels. We assume, however, that our study gives a reliable picture of the glycemic control of average diabetic patients using general health services.

In our study, we have gathered data from the year 1993. In the 1990s, there has been a growing interest in treating level of glycemia aggressively. Our study is cross-sectional and does not tell us whether the mean level of glycemia has changed during the past few years. There is only one study published in Finland that has longitudinal data for the years after 1993. In the health district of North Karelia in eastern Finland, HbA_{1c} was measured in every type 1 diabetic patient visiting a hospital clinic and health care center in 1993 and 1995. There was no change seen in the mean HbA_{1c} level in the hospital clinic (8.6%). In the health care centers, the mean of HbA_{1c} dropped from 9.1 to 8.9%. (15).

One of the most important reasons for the lack of nationwide studies is the diversity of the methodology used in measuring glycosylated hemoglobin, making it difficult to compare results in different clinics. According to our study, almost all the clinics in Finland use HbA_{1c} as the measure of glycosylated hemoglobin. Only 5% of the measurements in 1993 were done using HbA_1 or total glycosylated hemoglobin. However, even the methods using HbA_{1c} may not be comparable. There are clear differences between both the methods used and laboratories using the same methodology (16). In our study, there were several laboratories involved, using several methods for measuring HbA_{1c}, but all had the same reference value of 4–6%.

Glycosylated hemoglobin was measured as part of the routine follow-up in two-thirds of the patients in 1993. The mean HbA_{1c} level of 8.6% in the study population was by no means optimal. One out of four type 1 diabetic patients and every third type 2 diabetic patient was in good glycemic control ($HbA_{1c} \leq 7.5\%$). An alarming control ($HbA_{1c} > 10\%$) was seen in 22% of type 1 and 20% of type 2 diabetic patients.

Despite the fact that there are numerous large-scale diabetes programs throughout the world, the number of published population-based studies using glycosylated hemoglobin as an index of the glycemic control are scarce. There have been a few local studies, but none investigating the glycemic level nationwide in the diabetic population. In a rural area in Austria, 95% of the patients with diabetes were studied in 1990 (17). Compared with our study, the study population was older (67 vs. 58 years) and the duration of diabetes was shorter (6 vs. 11 years). The proportion of patients on diet treatment was three times higher in the Austrian study (37 vs. 13%): only 3% had type 1 diabetes. In the whole study population, HbA_{1c} was 7.3 ± 1.7%, and in the type 1 diabetes subgroup, it was 7.9 ± 1.8%. In a population-based study of type 2 diabetes in Italy, HbA_{1c} exceeded 8.0% in 44% of the patients (18). In our study, the corresponding number was 56% for type 2 diabetic patients. A similar proportion of patients had $HbA_{1c} > 10\%$ in these two studies.

In a pediatric and adolescent population of >2,800 type 1 diabetic patients from 18 countries in Europe, North America, and Japan, the mean HbA_{1c} level was 8.6 ± 1.7% (19). This figure is quite close to the mean (8.8 ± 1.9%) of our adult type 1 diabetic population. In the U.S., a large-scale diabetes program designed to improve diabetes care in Native Americans was launched in the late 1980s. In 1994, 29% of the type 2 diabetic patients were in good glycemic control ($HbA_{1c} \leq 7.5\%$), and 37% were in alarming control ($HbA_{1c} > 10\%$) (20).

The results from our nationwide study are similar to earlier local findings in Finland. In Kuopio, >100 type 2 diabetic patients were followed in a primary care setting from the time of diagnosis. After 10 years with the disease, the mode of treatment was very similar compared with that of type 2 diabetic patients in our study. Patients with diet treatment had a mean HbA_{1c} level of 7.4%. Means of HbA_{1c} in the OHA, insulin, and combination treatment groups were 9.5, 9.2, and 9.1%, respectively. A third of the patients had $HbA_{1c} < 7.2\%$, and a third >9.7% (21). In 1990, the quality of diabetes care was studied in three districts in Finland. All the patients were treated with OHAs and/or insulin. In 13% of patients aged 15–64 years, HbA_{1c} was <7.0%, and in a quarter of the patients it was >10.0% (12).

There are no unanimously accepted consensus criteria regarding the optimal level of glycemia in diabetes. However, there is evidence of an optimal level of HbA_{1c} in type 1 diabetes at which the risk of developing long-term complications has been minimized without increasing the risk of hypoglycemia exponentially (1). This optimal treatment window has been estimated to be an HbA_{1c} level of 7.0–7.5% (22). A retrospective study by Krolewski et al. (23) suggested that the risk of microalbuminuria increases exponentially with HbA_1 level >10.1% (equal to HbA_{1c} 8.1%). The Diabetes Control and Complications Trial (DCCT), however, does not support the hypothesis of a threshold value for the increase in complication risk (24). Thus, the prospective DCCT data (1,24) for type 1 diabetic patients and the Kumamoto study (4) and U.K. Prospective Diabetes Study data (5) for type 2 diabetic patients support the efforts to improve glycemic control as much as possible. This should be done, however, without increasing the risk of severe hypoglycemia.

In half of the Finnish patients with diabetes, glycemic control was poor. Although our cross-sectional study does not allow us to make longitudinal observations, the level of glycemia seems to worsen gradually during the 7–9 years following the diagnosis. The proportion of patients with very high HbA_{1c} starts to decrease after 12 years' duration of the disease. This might be explained by a higher selective mortality in patients with worse glycemic control (8). Body weight is also an important determinant of the level of glycemia. The proportion of patients with alarmingly high glucose levels is the lowest in individuals with normal weight. Obesity is an important risk factor for type 2 diabetes (25). Therefore, it is evident that a cross-sectional study is not the ideal way to estimate the effect of obesity on glycemic control. Even for type 2 diabetes, however, a clear increase in the proportion of patients with high HbA_{1c} values is seen after BMI exceeds 26 kg/m^2.

Since the late 1970s, increasing efforts have been made to improve the organization and level of diabetes care in Finland. Key issues in the program are patient education; availability of oral drugs, insulin, and blood glucose self-monitoring devices free of charge or at low cost to all patients; and regular visits at 3–4 month intervals to specialists by type 1 diabetic patients and to general practitioners by type 2 diabetic patients. In spite of all the effort made thus far, the mean glycemic control of diabetic patients is far from optimal in Finland. This may be the case elsewhere, too. Our data suggest that better treatment strategies and methods should be developed to improve the quality of diabetes care in Finland.

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