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ORIGINAL ARTICLE

The Effect of the Change in the Definition of Type 2 Diabetes on Patient Demographics

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In 1998 the definition of type 2 diabetes was revised, in particular the fasting plasma glucose (FPG) diagnostic level was lowered from 7.8 mmol/L to 7.0 mmol/L. The purpose of this study was to examine the effects of this change on patient demographics.

Materials & Methods: We reviewed data from 1700 type 2 diabetes patients, who attended the St. Paul's Hospital Diabetes Teaching and Training Centre before (group 1) and after (group 2) the definition change. Demographical data from a baseline and follow-up were analyzed. The frequencies of patients in groups and cohorts <60 years of age and ≥60 years of age were calculated and HbA1c data was analyzed.

Results: Compared to Group 1, Group 2 was younger, had a significantly lower mean HbA1c level (7.3% vs 8.1%, p<0.0001), blood pressure (127/78 vs 133/82 mmHg, p<0.05) and cholesterol (5.2 vs 5.5 mmol, p<0.05) and was more often treated with multiple medications (p<0.001). Patients in Group 2 were significantly more likely to meet the target HbA1c level of 7.0% than patients in Group 1 (p<0.0001). It was also found that at baseline, patients ≥60 years old in Group 2 had significantly lower HbA1c values than those <60 years old (p<0.001).

Conclusion: Since the change in the definition of type 2 diabetes, a greater frequency of patients presented with lower mean HbA1c values and met target HbA1c levels. Patients ≥60 years old initially presented with lower HbA1c levels than those <60 years old.

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Introduction

Diabetes mellitus (DM) is a chronic metabolic disease estimated to affect more than two million Canadians, and its prevalence is anticipated to rise to three million by the year 2010.[1] Approximately 85% of individuals with diabetes have type 2 DM, characterized by hyperglycemia due to defective insulin secretion and/or insulin action.[1,2]

Prior to 1998, the diagnosis of type 2 DM could be confirmed by a fasting venous plasma glucose (FPG) > 7.8 mmol/L or a 2 hour plasma glucose (2hPG) > 11.1 mmol/L,[1] based on an oral glucose tolerance test. The 2hPG diagnostic threshold was considered the gold standard, based on the risk of developing microvascular complications.[1,3] Specifically, the incidence of retinopathy and nephropathy was significantly higher among individuals whose glycemic levels were above the 2hPG threshold of 11.1 mmol/L, compared to those with lower glucose levels.[1] In contrast, the fasting venous plasma glucose > 7.8 mmol/L was considered an arbitrarily chosen value that lacked sensitivity.[3]

In 1998, the Canadian Diabetes Association's (CDA) Clinical and Scientific Section updated and published the Clinical Practice Guidelines for the management of DM. One of the major adjustments was to lower the FPG diagnostic level from 7.8 to 7.0 mmol/L.[1] This change was based, in part, on population studies suggesting that a FPG of 7.0 mmol/L correlated better with the 2hPG of 11.1 mmol/L and thus, was a superior predictor of the development of microvascular disease, compared to an FPG of 7.8 mmol/L.[4-6] It also reflected the need to increase the sensitivity of diagnosis and for timely diagnosis and prevention of retinopathy.

More than a decade later, no studies have examined the implications in lowering the FPG diagnostic threshold. The purpose of this study was to compare the demographics of individuals diagnosed with type 2 diabetes, prior to and following the 1998 definition change.

Materials and Methods

Design: The present study reviewed data from patients with type 2 diabetes who attended the Diabetes Teaching and Training Centre (DTTC), located at St Paul's Hospital in Vancouver, British Columbia, Canada between 1991 and 2005. Since 1984, all patient visits and clinical parameters including age, weight, HbA1c, blood pressure, lipids, creatinine and diabetes medications were assessed and recorded in a computerized database (FileMaker Inc., California). All study data was collected from this database.

Subjects included all patients with type 2 DM who first visited the DTTC between 1991and 1997 (Group 1), and between 1999-2005 (Group 2). Patients were categorized as having type 2 DM based on the CDA criteria for diagnosis.[1,3] Only newly diagnosed participants or those whose year of onset of DM matched their baseline visit to the DTTC were included in the study. The baseline visit was defined as the patient's first visit to the DTTC. Participants were also required to have a follow-up visit, defined as the patient's second visit within 18 months of the baseline visit. Furthermore, participants in each group were categorized in age-related cohorts of <60 years of age and ≥60 years of age and used for analysis.

Data Analysis: Data was analyzed using a computerized database (Excel, Microsoft Inc., California) and the SAS statistical software (Version 8, SAS Institute Inc., North Carolina). Student's two-sample t-test was used to investigate differences between groups at both visits, mean change between groups from baseline to follow-up and to compare differences in HbA1c levels within and between cohorts and groups. The Chi-Squared test was used to determine group differences in proportions of patients receiving various types of therapies. Multiple linear regression was used to investigate group and cohort differences across mean HbA1c values. Lastly, proportions of patients with HbA1c values below 7.0% were compared between groups and cohorts by means of logistic regression, as well, the group-cohort interaction was assessed in this analyses. The statistical significance level used in this analysis was adjusted by dividing the established level of significance, $p<0.05$, by the number of subgroup analyses. The significance level was determined to be $p<0.01$ for these multiple subgroup analyses.

Results

Key demographic and clinical characteristics are summarized in Table 1. In Group 1 (1991-1997), 810 subjects had a mean age of 57.6±13.3 years (range 20-93 years). Group 1 had baseline and follow-up mean HbA1c values of 8.1%±2.1% and 6.9%±1.3% respectively. In Group 2 (1999-2005), 890 subjects had a mean age of 55.5±11.9 years (range 20-86 years). Group 2 had baseline and follow-up mean HbA1c values of 7.3%±1.9% and 6.5%±1.5% respectively.

Table 1: Demographic and clinical characteristics for the study population

Characteristics	Group 1 (n=810)		Group 2 (n=890)	
Age(years)*	57.6±13.3		55.5±11.9	
	Baseline	Follow-up	Baseline	Follow-up
Weight (kg)†	87.7±20.7	86.0±20.1	88.8±21.4	87.8±21.3
BMI (kg/m2)	31.4±7.7	30.7±7.4	31.3±7.1	30.8±7.1
HbA1c (%)*, †	8.1±2.1	6.9±1.3	7.3±1.9	6.5±1.5
Systolic blood pressure (mmHg)*, †	133±20	134±19	127±19	126±18
Diastolic blood pressure (mmHg)*, †	82±10	82±10	78±11	77±10
Creatinine (μmol/L)†	85.3±40.5	87.7±38.8	83.6±61.4	81.9±49.1
Cholesterol (mmol/L) *, †	5.5±3.8	5.3±1.1	5.2±1.2	5.1±2.6

Data are presented as means ± SD, *Initial visit results showed significant differences ($p < 0.01$) between groups, †Follow-up visit results showed significant differences ($p < 0.05$) between groups

Statistically significant differences between groups 1 and 2 at baseline were found in age, HbA1c, systolic blood pressure, diastolic blood pressure and cholesterol ($p<0.01$). At follow-up, there were statistically significant differences between the two groups in weight, HbA1c, systolic blood pressure, diastolic blood pressure, creatinine and cholesterol ($p<0.05$).

Mean change from baseline to follow-up within each group was assessed. Group 1 was found to have greater mean changes in HbA1c ($p<0.001$), BMI and weight ($p<0.05$). group 2 was found to have greater mean changes in systolic blood pressure ($p<0.01$), diastolic blood pressure ($p<0.05$) and creatinine ($p<0.001$).

Proportions and frequencies of patients receiving dietary therapy, monotherapy, dual and triple combination therapy are presented in Table 2. There were a higher proportion of group 1 patients receiving dietary therapy at follow-up and monotherapy at baseline compared to group 2 ($p<0.01$). At both baseline and follow-up, a higher proportion of group 2 patients were receiving dual combination therapy compared to group 1 ($p<0.001$).

Table 2: Proportions and frequencies of patients receiving dietary therapy, monotherapy and dual and triple combination therapy

	Baseline			Follow-up		
	Group 1	Group 2	p-value	Group 1	Group 2	p-value
Dietary therapy	410 (51%)	490 (55%)	NS	464 (57%)	441 (50%)	0.001
Monotherapy	354 (44%)	324 (36%)	0.002	289 (36%)	338 (38%)	NS
Dual combination therapy	31 (4%)	67 (8%)	0.001	53 (7%)	102 (12%)	0.0004
Triple combination therapy	0	3 (0.3%)	NS	0	3 (.3%)	NS

Data are presented as number (%)

Mean HbA1c levels were assessed for each age-related, group at baseline and follow up. Results are shown in Table 3. The HbA1c values were modelled using multiple linear regression with group, cohort and their interaction as predictor variables. Group 2 showed a lower mean HbA1c values than Group 1 for both baseline and follow-up vis-

its ($p<0.0001$). Also, at baseline, patients≥60 years in group 2 had lower HbA1c values than those <60 years old ($p<0.001$), a result not found in group 1. There was no indication of an interaction between group and cohort for mean HbA1c values at baseline or follow-up (p=NS).

The proportions and frequencies of patients, by cohort, with HbA1c levels <7.0% are shown in Table 3. The HbA1c cut off of 7.0% was used; as this is the CDA recommended target for glycemic control for diabetes patients.[3] In group 1, 58% of all subjects met the HbA1c target of 7.0% at follow-up, whereas, in group 2, 79% of all subjects met the HbA1c target at follow-up. In group 2 only, at baseline and follow-up, a greater proportion of patients ≥60 years achieved target HbA1c levels compared to those <60 years.

Table 3: Frequency of patients and HbA1c levels per group and cohort. As well, proportions and frequencies of patients in groups and cohorts with HbA1c <7.0% at follow-up and baseline visits.

Frequency of Patients	<60 years			≥60 years		
HbA1c (%)	Group1 (n=456) 56%	Group 2 (n=567) 64%	p-value	Group 1 (n=354) 44%	Group 2 (n=323) 36%	p-value
Baseline Average (%)	8.2±2.1	7.5±2.0*	<0.0001	8.0±2.1	7.0±1.6*	<0.0001
Follow-up Average (%)	6.9±1.3	6.5±1.3	<0.0001	6.9±1.3	6.4±1.7	<0.0001
<7.0% Baseline	152 (33%)	309 (55%)*	<0.0001	136 (38%)	215 (67%)*	<0.0001
<7.0% Follow-up	267 (59%)	430 (76%)*	<0.0001	201 (57%)	273 (85%)*	<0.0001

Data are presented as means ± SD or %, *In Group 2 only, there was a significant difference between the two cohorts ($p<0.05$)

A formal analysis of the outcome of HbA1c level <7.0% was carried out using logistic regression. For both baseline and follow-up, the likelihood of having an HbA1c level <7.0% was higher in Group 2 than in Group 1 ($p<0.0001$). Between cohorts, a significant difference was demonstrated at baseline only, with the ≥60 cohort more likely to meet the HbA1c target than the <60 cohort ($p<0.001$). The group-cohort interaction was found to be significant at follow-up ($p<0.05$), but not at baseline.

Discussion

In this study, the first to investigate the effect of the 1998 FPG diagnostic threshold revision on patient demographics, patients diagnosed after the definition change (Group 2) were found to have lower mean HbA1c levels than those diagnosed before the definition change (Group 1) at both visits. Since the FPG revision there have been changes in patient therapy. At baseline significantly less patients are on monotherapy ($p<0.01$) and at follow-up significantly less patients are on dietary therapy ($p<0.01$). In addition, significantly more patients are seen at baseline and follow-up on dual combination therapy ($p<0.01$) such as metformin and insulin. These differences in therapies between groups demonstrate the increasing use of dual combination therapy and a recent move away from monotherapy.

Patients are now more likely to meet the target HbA1c level of 7.0% ($p<0.0001$) at baseline and follow-up. While there was no difference in mean HbA1c levels between the <60 and ≥60 cohorts seen in Group 1, a lower

mean HbA1c level ($p<0.001$) was observed at baseline in the older cohort of Group 2. A difference in mean HbA1c values was not expected to be seen at follow-up as all patients had been receiving diabetes therapy for up to 18 months and had been treated to an HbA1c target of <7.0%.

Following the threshold revision a lower mean HbA1c and greater frequency of patients meeting target HbA1c levels, especially in those ≥60 years of age. In fact, 67% of patients ≥60 years old initially present with an HbA1c <7.0% and because baseline visits took place the same year as onset of DM, this result suggests that 67% of patients ≥60 years old are being diagnosed with near normal HbA1c levels.

A study by Ford et al. also showed that there have been improvements in glycemic control among diabetes patients.[8] Specifically, they found that the unadjusted percentage of patients with type 1 and 2 DM who had an HbA1c <7.0% increased significantly from 37.0% in 1999-2000 to 56.8% in 2003-2004.[8] While our study draws comparisons between the years 1991-1997 and 1999-2005, during the years 1999-2000 and 2003-2004, we found that 58% and 57%, of our type 2 DM study population, respectively, to have an HbA1c <7.0%. In our study, improvements in glycemic control are not observed by comparing groups within the post definition change population but rather by comparing the pre- and post definition change populations. This suggests that the definition change of diabetes has had an effect on the overall type 2 DM population.

In conclusion, the FPG diagnostic threshold change from 7.8 mmol/L to 7.0 mmol/L has resulted in a younger patient cohort with lower HbA1c levels, blood pressure and cholesterol, whose diabetes is more aggressively treated as reflected in the use of multiple medications. Since the change in definition, patients are initially seen with a mean HbA1c value of 7.3%. At follow-up, almost 80% of patients now reach target HbA1c levels and a significantly lower mean HbA1c level of 6.5% is observed. While these findings provide evidence that blood glucose levels are now lower in comparison to before the revision, it remains to be seen if this will result in decreases in long-term morbidity, mortality and healthcare costs.

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