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Determinants of loss of glycemic control in patients with type 1 diabetes mellitus. Prospective cohort study from Iraq

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Abstract

Background: Despite advances in insulin therapeutics during the past 25 years, only a few individuals with type 1 diabetes achieve glycemic control. The aim of this study is to assess the determinants of loss of glycemic control in patients with type 1 diabetes mellitus in Basrah, Iraq.

Methods: The data presented are derived from the Al-Faiha Diabetes Endocrine and Metabolism Center (FDEMC) in Basrah. Eligible patients were those with type 1 diabetes. Follow-up started from August 2008 to the end of February 2012. Seven hundred and forty one patients completed the study.

Results: Deterioration of glycemic control was seen in 42.8%. Those who achieved age group specific target HbA1c were 12.4%. Those with worse glycemic control are younger age (21.0 ± 10.4 vs. 23.1 ± 10.9 ; $p=0.01$), have lower education level (9.45 ± 2.0 vs. 11.75 ± 2.6 ; $P=0.01$) and lower baseline HbA1C percent (9.45 ± 2.048 vs. 11.75 ± 2.619 ; $p < 0.0001$) than those with more optimal glycemic control.

Conclusion: Factors contributing to worse glycemic control were lower age, less education level, and lower baseline HbA1c. Factors that do not contribute to loss of glycemic control are: gender, number of visits, urban/rural, family history, duration of diabetes, self-monitoring of blood glucose (SMBG) use, Body mass index (BMI) or use of pen for insulin delivery.

Keywords: Type 1 diabetes mellitus, glycemic control, HbA1c

Background

Type 1 diabetes is an immune-mediated disease that develops as a consequence of the gradual destruction of the insulin-producing beta cells, which eventually results in total beta cell loss and complete dependence on exogenous insulin. The disease may present at any age, but the majority of patients are diagnosed before the age of 30 years [1].

More recent data suggests that only about 50–60% of those with type 1 diabetes are younger than 16–18 years at presentation and that such disease occurs at a low incidence level throughout adulthood [2].

Intensive approaches to management are based on three sentinel observations highlighted by the extensively documented cohort of type 1 diabetes subjects enrolled in the Diabetes Control and Complications Trial (DCCT) and followed in the Epidemiology of Diabetes Interventions and Complications (DCCT/EDIC) study [3,4]. These observations were linear relation between HbA1c and onset or progression of complications, those achieving reduced HbA1c concentrations, continue to have greater protection against development or progression of complications and there is an inverse relation between glycemic control and the risk of severe hypoglycaemic episodes.

Nonetheless, despite advances in insulin therapeutics during the past 25 years, only a few individuals with type 1 diabetes achieve glycemic control [5].

Diabetes self-care requires a high standard of both

initial and continuing education and care, best provided by a multidisciplinary health care team consisting of physicians, nurses, dietitian, and behavioural specialists experienced in the management of type 1 diabetes [6]. Furthermore self-monitoring of blood glucose (SMBG) is fundamental to diabetes care [7].

Approaches with carbohydrate counting to the nutritional management of type 1 diabetes have developed in parallel with basal-bolus insulin regimens [8]. Suboptimal glycemic control that is established during early adolescence may be very difficult to change, even with state-of-the-art behavioural intervention [9].

The aim of this study is to assess the determinants of loss of glycemic control in patients with type 1 diabetes mellitus in Basrah, Iraq.

Patients and methods

Data collection

The data presented are derived from the Al-Faiha Diabetes and Endocrine Center in Basrah. Eligible patients recruited were those with type 1 diabetes. Type 1 diabetes was defined by age at onset of diabetes <40 years, C-peptide ≤ 0.3 nmol/l or insulin treatment initiation within 1 year of diagnosis if C-peptide was not measured or anti-GAD, islet cell or insulin antibodies positive [10–12].

Study procedures

The patients were visiting the center every 2 months to

Table 1. Clinical and demographic data of 741 patients with type 1 diabetes mellitus.

	(mean \pm SD)	22.2 \pm 10.7
Age (years)	Toddlers and preschoolers (0-6) *No.(%)	35(4.7)
	School age (6-12) No.(%)	115(15.5)
	Adolescents and young adults (13-19) No.(%)	192(25.9)
	Adults (>19) No.(%)	399(53.8)
Gender	Male No.(%)	396(53.4)
	Female No.(%)	345(46.6)
Number of visits (mean \pm SD)		11.0 \pm 5.9
Years of academic qualification (mean \pm SD)		7 \pm 4.8
Rural/urban No.(%)		499(67.3)/ 242(32.7)
Family history No(%)		445(60.1)
Duration of diabetes No(%)		5 \pm 6.2
**BMI kg/m ² (mean \pm SD)		20.41 \pm 4.9
***SMBG No(%)		353(47.6)
Baseline HbA1c (mean \pm SD)		10.7 \pm 2.6
HbA1c A1c at end of the study (mean \pm SD)		10.2 \pm 2.6
Deterioration of HbA1c No(%)		317(42.8)
Use of pen for insulin delivery No(%)		629(84.9)

*No.=number

**BMI= body mass index

***SMBG= self-monitoring of blood glucose

be evaluated and given their treatment free of charge using human insulin only according to standard protocols [13]. Briefly we started with premixed human insulin then added prandial mid day regular insulin. If this approach failed, then Multiple daily injections consisted of neutral protamine Hagedorn insulin were given once or twice daily as the basal insulin, with regular human insulin bolus before meals (basal-bolus approaches). Insulin pumps are still not used in Iraq. At baseline, patients underwent a thorough clinical examination and details of the clinical characteristics of patients were recorded. Details of clinical characteristics of patients, including age at diagnosis of diabetes were taken. Family history was considered only for first degree relatives with diabetes, whether type 1 or type 2 diabetes.

The follow-up started at the time of registration, *i.e.*, from August 2008 continued until the end of February 2012. A total of 1400 patients were enrolled. There was a dropout of 659 and the remaining 741 patients completed the study.

Patients were excluded if the follow up period was less than 6 months pregnant, or having only one reading of HbA1c.

The SMBG was considered as present if the patient did at least one measure a day. Blood samples for glycosylated hemoglobin (HbA1c) analysis were taken each 3-4 months. Analysis was done using Bio-Rad D10 analyzer (HPLC cation-exchange chromatography).

Age group specific target HbA1c was according to the recommendation of the ADA [14].

The study was performed according to the criteria of the Helsinki II Declaration and was approved by the

Table 2. HbA1c levels at presentation and end of the study.

Age group (years)	*HbA1c at presentation mean \pm SD	*HbA1c at end of study mean \pm SD	Achieved target HbA1c at end of study No. (%)	Total No.(%)
Toddlers and preschoolers (1-6)	11.0 \pm 1.9	10.2 \pm 2.4	6(17.1)	35(4.7)
School age (6-12)	11.2 \pm 2.4	11.4 \pm 2.5	9(7.8)	115(15.5)
Adolescents and young adults (13-19)	11.4 \pm 2.9	10.8 \pm 2.8	25(13.7)	192(25.9)
adults (>19)	10.3 \pm 2.5	9.5 \pm 2.3	52(13.0)	399(53.8)
HbA1c percent				
<7 No. of patients (%)	40(5.4)	74(10)	-	-
7-9 No. of patients (%)	164(22.1)	190 (25.6)	-	-
10-11 No. of patients (%)	131 (17.7)	124 (16.7)	-	-
12-13 No. of patients (%)	87 (11.7)	68 (9.2)	-	-
\geq 14 No. of patients (%)	319 (43.0)	285 (38.5)	-	-

*P value between groups < 0.0001

**P value between groups < 0.0001

local ethical committee. All the patients or their parents/guardians gave informed consent.

Statistical analysis

Statistical analysis was carried out using Statistical Package for Social Sciences (SPSS, version 15). Baseline characteristics of the diabetes population were compared using a t-test for continuous variables and a Chi-squared test for dichotomous variables respectively. Means and standard deviations were reported for continuous variables, proportions for dichotomous variables. A p-value of <0.05 was taken as statistically significant for individual variables.

Results

Patient's characteristics are shown in (Table 1). The Age range was 1-64 years. More than half of the patients were adult >19 years with number of visits ranging from 2-36 times. Duration of diabetes ranged from 1 to 30 years. Family history of diabetes mellitus was present in 60.1%. SMBG was used by 47.6%. Baseline mean (\pm SD) HbA1c 10.7 \pm 2.6 percent compared to 10.2 \pm 2.6% at the end of follow up. Deterioration of glycemic control was seen in 42.8%. A pen to deliver insulin (NovoPen 3) was used by 84.9%.

Different ranges of HbA1c are shown in (Table 2). At inclusion, 5.4% have HbA1c <7% compared to 10% at the end of follow up; while 43.0% have an extremely high HbA1c (\geq 14%) compared to 38.5% at the end of the study.

Outcomes of groups are shown in (Table 3). The study population was divided into two groups; group one with increased HbA1c and group two with improved HbA1c or no change. Group one constituted 317 (42.8%) patients. Variables associated with group one were age, education

Table 3. Variables associated with deterioration of glycemic control.

	Deterioration of HbA1c (group one) N=317(42.8)	Improved HbA1c or no changes (Group two) N=424(57.2)	P value
Age years (mean ±SD)	21.0± 10.4	23.1±10.9	0.011
Gender	Male No.(%)	220(51.9)	0.3
	Female No.(%)	204(48.1)	-
No. of visits	11.52±5.4	10.65±6.2	0.05
Years of academic qualification	6.5 ±4.9	7.4±4.8	0.015
Rural/urban No. (%)	213(67.2)	286(67.5)	0.9
Family history No. (%)	203(64.0)	242(57.1)	0.056
Duration of diabetes (mean ±SD)	4.9±5.8	5.1±6.5	0.597
SMBG No.(%)	150 (47.3)	203 (47.9)	0.8
Baseline A1c HbA1c (mean ±SD)	9.4±2.0	11.7±2.6	<0.0001
HbA1c at end of the study (mean ±SD)	11.6±2.5	9.1±2.2	<0.0001
BMI (mean ±SD)	20.4±4.9	20.4±5	0.970
Use of pen for insulin delivery No.(%)	271(85.5)	358(84.4)	0.69

level, baseline and last HbA1c. The mean age in group one was less than group two (21.0±10.4 vs. 23.1±10.9; p=0.01). The education level was lower in group one (9.45±2.0 vs. 11.75±2.6; P=0.01). Baseline HbA1c was lower in group one compared with those with group two (9.45±2.048 vs. 11.75±2.619; p <0.0001). At the end HbA1c was lower in group two (9.14±2.221 vs. 11.64±2.500; p <0.0001). No significant differences were seen between the two groups regarding gender, number of visits, urban/rural, family history, duration of diabetes, SMBG use, Body mass index (BMI), use of pen for insulin delivery.

Discussion

At the end of follow up, the age specific target HbA1c was achieved in only 12.4%, while 38.5% had HbA1c ≥14%. A lot of published series have shown that glycemic control is still often poor in many children with Type 1 diabetes mellitus despite easier home monitoring of blood glucose, the introduction of pen devices for insulin injection, and the introduction of new insulin types and regimens during the last decade [15,16,18,19 and 20].

Fewer than 15% of children and young people with diabetes in England and Wales achieve an HbA1c of <7.5 and this figure remains essentially unchanged over the seven year period of follow up and 30.68% of them have very high HbA1C (HbA1c of >9.5%) [21].

In this study, adults achieved a better reduction in HbA1C than younger patients, but the achievement of target age specific HbA1c was not different. While in the King Abdul-Aziz University Hospital study younger children had a better control compared to adolescents [16]. In Welsh children with type 1 diabetes glycemic control was worse in children aged >10years [22].

Gender had no effect on outcome this study, which

was the same finding seen in King Abdul-Aziz University Hospital study and pediatric diabetes units in Wales [16,22], while in patients with type 1 diabetes mellitus referred to endocrinology clinic in children's hospital medical center in Tehran, Iran, the mean HbA1c was higher in females [23].

Duration of diabetes did not affect the glycemic control in our study in contrary to King Abdul-Aziz University Hospital study where patients with a duration of diabetes <2 years had better metabolic control than those with a longer duration [16].

In our study the education level was higher in those with improved glycemic control. Studies conducted on children and adolescents with Type 1 diabetes mellitus have demonstrated that both patient and family education were associated with a reduction in number of hospitalizations, emergency room visits, and a reduction in overall healthcare expenses [24,25].

Conclusion

Of patients with type 1 diabetes, only 12.4% achieved age group specific target HbA1c. Worsening of glycemic control (increase of HbA1c) while on treatment was seen in 42.8%. Factors contributing to worse glycemic control were younger age, low education level, and lower baseline HbA1c.

Study limitation

The daily frequency of SMBG was not studied, we acknowledge that the mere presence of SMBG does not guarantee that the patient is using it.

The socioeconomic status of family and educational background of parents also need to be studied, because it could have a role in metabolic control [19]. Medical nutritional therapy is not feasible in Iraq yet, which could contribute to poor outcome.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

Mansour AA, Al-Maliky AA were involved in the concept and design of the study. All authors were involved in the data collection and/or analysis, interpretation of the results and conclusion.

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