Evaluation of the Educational Program for Children with Type 1 Diabetes Mellitus: The Experience of an Egyptian Center

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Abstract: Objectives to evaluate the current education program for diabetic children at Diabetes Endocrine and Metabolism Pediatric Unit (DEMPU) to examine the effect of the program on the glycemic control in these patients. Patients and Methods an observational longitudinal study was conducted on 100 cases of Type 1 diabetes admitted in DEMPU, using a questionnaire covering all aspects of the program solved before and after attending 5 days education sessions. Results marked increase in diabetic knowledge after attending education program, as 95% of parents had knowledge about nocturnal hypoglycemia, 97% of them realized that they weren't responsible for diabetes in their children, 94% of them declared that schools were aware about the child disease and 92% of them allow their children to share in school activities. Linear regression analysis showed that the only factor which has an effect on HbA1c was total post education score. Conclusion this study identified the efficient points of the program including; knowledge about type 1 diabetes nature, family history role in developing type 1 diabetes, hypoglycemia symptoms awareness, hypoglycemia prevention during sports and at night, school awareness of the disease and sharing school activities, while the weak point of this program was defective carbohydrate counting.

Key words: Diabetes Education · Type 1 Diabetes · Evaluation

INTRODUCTION

Diabetes care depends on the commitment of the diabetic patient to self- management through the balance of life style and medication. Diabetes care should focus on a multi- and interdisciplinary diabetes healthcare team that can establish and sustain a communication network between the patient and the necessary healthcare and community systems. Both the organization and delivery of diabetes care should be comprehensive, according to evidence-based clinical practice guidelines, equitable in access and continuous throughout a patient's lifetime. If possible, diabetes education programs and services should be culturally appropriate, community based and respectful to age, gender and socioeconomic condition [1]. Multifaceted professional interventions (As education, audit and feedback), patient oriented interventions (As patient education) and organizational interventions (As revision of professional roles, changes in medical record systems and arrangements for follow up) facilitate structured and regular review of patients and are effective in improving the process of care to reduce the risk of diabetes related complications [2]. Diabetes teams should compare their data to other regional, national and international centers and published benchmarks and guideline recommendations. Multicenter studies had published their analyses of the processes of care that affect the biological outcomes, but additional studies are needed to define best care practices [3].

The Diabetes Endocrine Metabolic Pediatric Unit (DEMPU) was founded in 1980 and its diabetes education program had been established and conducted in 5 days by diabetes specialist, nutritionist, practical trainer and psycho-social worker. T1D Patients and their parents are allowed to attend this program in group of (8 to 12 patient or their parents). Each education day provides an

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audio-visual session as well as a practical aspect to be performed by the attendees using banners, LCD screen, food models, flip chart, handed out material containing printed food exchange list, teacher's booklet, sweet counting flyer and log book for spontaneous blood glucose monitoring (SBGM). Therefore, the purposes of this study was to evaluate the current educational interventions for children with T1D applied at the DEMPU, Children's Hospital Cairo University, through evaluating the quality of education program and identifying the points of strength and weakness of this program, in addition to examining the effect of this program on the glycemic control in T1D children.

MATERIALS AND METHODS

Patients: The study is an observational longitudinal study conducted on 100 cases of T1D (50 male, 50 female), aged 2 to 14 years admitted in DEMPU inpatient section during the period between October 2011 and April 2012. T1D was diagnosed according to ADA consensus guidelines [4]. The study protocol was approved by the Cairo University's and it was conducted in accordance with the University's bylaws for human research. Written informed consent from one of parents was taken after an explanation of the study before the start.

Methods: All children were subjected to history taking, complete and clinical examination. The charts of patients were reviewed for the previous results of glycosylated hemoglobin (HbA1c) in the past year to assess the glycemic control. HbA1c was done routinely twice a year using high performance liquid chromatography (HPLC technique) [5]. For assessment of glycemic control the mean HbA1c was calculated over the last year prior to the study for each patient. Fahmy and El-Sherbini's Social Classification Scale was applied for assessing Egyptian socioeconomic status. This score encompasses paternal education and work, family size, housing condition and per-capita monthly income. A score of 25-30 is considered a high social status, a score of 20-25 is considered middle social status, a score of 15-20 is considered low social status and a score of, 15 is considered very low social status [6]. None of the patients had high social status.

Evaluation of the Educational Program: An Arabic questionnaire was conducted before the education program and after the completion of program including multiple choice questions (MCQ) that were directed at assessing knowledge of diabetes, insulin therapy, dietary management, diabetes complications and follow up. Questions were conducted either orally (For illiterate) or written (For educated). However, both educated and illiterate parent preferred the oral question to fill data in the questionnaire. This has been carried out both at beginning and at the end of the program. Each in a session that was separate from the five sessions (Every session is carried out in a separate day) designed for diabetic education. Each session had a practical aspect which was not assessed by our questionnaire. Scoring for each session before and after the program was done; +1 for correct answer and 0 for an incorrect answer, for example; in session (1) which includes 6 questions if the patient or his parent answered 2 out of 6 the score will be 2/6.

Statistical Methods: It was performed using SPSS 15.0. Measured data was described as mean and standard deviation (For parametric variables), number and percentage (For categorical variables). Difference between two groups was measured using unpaired student's t-test (For parametric variables) and Mann Whitney U test for independent samples when not normally distributed. Comparison of numerical variables between more than two groups was done using one way analysis of variance (ANOVA) test with post-hoc multiple 2-group comparisons when normally distributed and Kruskal Wallis test when not normal. Chi square test was performed for comparing categorical data. Exact test was used instead when the expected frequency is less than 5. Comparison between pre and post values was done using McNemar test. For comparing categorical data, Chi square test was performed. Yates correction equation was used instead when the expected frequency is less than 5. Multivariate analysis models were used to test for the preferential effect of the all-important independent variable(s) on HbA1c post. P values less than 0.05 were considered statistically significant [7].

RESULTS

The majority of the study groups 84 patients (84%) were newly diagnosed (diagnosed 6 months or less before the onset of the study), While only 16 patients (16%) were diagnosed more than 6 months before the onset of this study (Old diabetic patients). Twelve old diabetic patients attended the same education program before and 25 newly diagnosed patients previously attended the education

program as they were readmitted in DEMPU several times shortly after their diagnosis to adjust blood glucose. Therefore, HbA1c was compared before and after the educational intervention in old diabetic patients (16 patients) only and significant improvement in mean HbA1c% which was done 3 months after attending educational sessions (8.38 ± 1.77) than before (Mean HbA1c in the last year prior the study (9.08 ± 1.63) in the old diabetic group (16 patients) with a p-value (0.05).

Statistically significant increase in diabetic knowledge including (General information, dietary education, insulin and methods of injection, explanation of hypoglycemia, explanation of hyperglycemia, follow up knowledge and importance of social activity) is detected after attending education sessions through 5 days at DEMPU by using the same questionnaire solved before and after education program (Table 1).

Table (2) showed detailed analysis of the questionnaire solved by the patients or their parents before and after the education program.

As regards session (1) increased awareness about the role of family history in developing T1D, as before this session, 68% of interviewed parents had wrong answers, compared to after the session as 97% knew that the parents of T1D child were not responsible for their child disease. 100% of the subjects knew that blood glucose couldn't be adjusted without insulin, although 64% answered this question wrongly before the session. Therefore, statistically significant increase in knowledge after attending this session than before attending it with p value of ($\leq$0.001 for each question).

After session (2) marked increase in knowledge about diabetic nutrition was recognized, as 93% of interviewed parents didn't know about special diet and carbohydrate (CHO) counting for diabetic child. After this session only 48% of interviewed parents could count CHO points, although statistically significant (p-value of 0.05) but still there was a great defect in CHO counting as 52% couldn't count CHO after the session. The 7 patients who could count CHO before this session had history of previously attending the whole program, which means that they had to attend this session several times in order to gain this skill for CHO counting.

As regards session (3) there is significant increase in diabetic knowledge as regards symptoms of hypoglycemia. The interviewed parents who answered the questions correctly after this session (75% for 4th question, 81% for 5th question, 95% for 6th question and 100% for 7th question) were significantly higher than those

who answered it correctly before attending this session (17%, 8%, 19% and 14% for the same questions, respectively) with a p value 0.001 for each question.

As for session (4) there is a significant increase in diabetic knowledge about hyperglycemia. The interviewed parents who answered these questions correctly after this session (97% for 8th question and 91% for the 9th question) were significantly higher than those who answered it correctly before attending this session. The 15 interviewed parents who answered correctly the 8th question before attending the education program (8 of them were parents of old diagnosed patients and 7 were parents of newly diagnosed patients) and 12 of interviewed parents who answered correctly the 9th question before attending the education program (6 of them were parents of old diagnosed patients and 6 were parents of newly diagnosed) had history of previous attendance to this program.

In session (5) the interviewed parents who answered these questions regarding the importance of exercise practice and management of diabetes during exercise after this session (95% for 10th question and 89% for 11th question) were significantly higher than those who answered it correctly before attending this session (25% for 10th question and 7% for 11th question) with a p-value of 0.001.

No statistical significance between those who could count carbohydrates and those who couldn't as regards the age, social level, the onset of diabetes and HbA1c which was done for all the patients 3 months after the study. The only significant parameter was history of previous attendance of the same education program as 24 patients out of 48 who could calculate CHO had history of previous attendance, of these 24 patients 7 were old diabetics and 17 were new diabetic but they attended more than once as they were readmitted in DEMPU several times shortly after their diagnosis to adjust blood glucose (Table 3).

No statistical significance between those who attended the program for the first time and those who previously attended this program regarding the mean age, sex, social level and mean HbA1c which was done for all patients 3 months after the study. The only significant parameter was duration of diabetes as the 12 subjects who were old diabetics were more keen to attend the program repeatedly and the 25 newly diagnosed patients had a history of previous attendance as they were readmitted several times shortly after their diagnosis to adjust their blood glucose (Table 4).

Table 1: Diabetes Knowledge Score before and after Attending the Education Program

Information about	Score before Median (Min-Max)	Score after Median (Min-Max)	p-value
General Information	0 (0-6)	6 (3-6)	0.001
Dietary Education	1 (0-6)	6 (0-6)	0.001
Insulin and Methods of Injection	0 (0-10)	10 (5-10)	0.001
Explanation of Hypoglycemia	0 (0-8)	8 (2-8)	0.001
Explanation of Hyperglycemia	0 (0-5)	5 (1-6)	0.001
Follow up Knowledge	0 (0-2)	2 (0-2)	0.001
Importance of Social Activity	1 (0-5)	5 (0-5)	0.001

P-value <0.05 was considered significant.

Table 2: Detailed Analysis of Selected Questions from the Questionnaire Solved before and after the education program including Sessions 1 (General Information), Session 2 (Diabetes Nutrition), Sessions 3 (Insulin Injection and Hypoglycemic Knowledge), sessions 4 (Hyperglycemic Knowledge) and Session 5 (Importance of Social Activity and Follow up)

Questions (Q)		Before sessions Yes	No	Don't know	Correct answer	After sessions Yes	No	Don't know	Correct answer	p-value
Session (1)	Q (1)	2%	32%	66%	32%	3%	97%	-	97%	0.001
	Q (2)	5%	36%	59%	36%	-	100%	-	100%	0.001
Session (2)	Q (3)	7%	-	93%	7%	48%	-	52%	48%	0.05
Session (3)	Q (4)	12%	17%	71%	17%	24%	75%	1%	75%	0.001
	Q (5)	8%	9%	83%	8%	81%	7%	12%	81%	0.001
	Q (6)	19%	0%	81%	19%	95%	0%	5%	95%	0.001
	Q (7)	14%	0%	86%	14%	100%	0%	0%	100%	0.001
Session (4)	Q (8)	15%	-	85%	15%	97%	-	3%	97%	0.001
	Q (9)	12%	-	88%	12%	91%	-	9%	91%	0.001
Session (5)	Q (10)	2%	25%	73%	25%	2%	95%	3%	95%	0.001
	Q (11)	7%	8%	85%	7%	89%	11%	0%	89%	0.001

Q (1): Is there a role of family history in developing T1D? Q (2): can we adjust blood glucose with diet control and without insulin? Q (3): can you do carbohydrate (CHO) points counting? Q (4): are symptoms of hypoglycemia the same in all children? Q (5): can injections at site of movement cause hypoglycemia? Q (6): do you know how to prevent hypoglycemia at night? Q (7): do you know how to manage hypoglycemia? Q (8): do you know when we measure ketones in urine? Q (9): do you know how we treat hyperglycemia with ketones in urine? Q (10): do you know the importance of sports in diabetic child (Avoid it due to fear of hypoglycemia)? Q (11): do you know the management of diabetes during sport (extra CHO point for every half an hour sport)? p-value <0.05 was considered significant.

Table 3: Comparison between the subjects who could calculate CHO and those who couldn't after attending Session 2

		CHO Counting after session (2) Can calculate (48%)	Can't calculate (52%)	p-value
Mean age		8.7±3.6	7.8±3.6	0.2
Sex	Male	26 (54.2%)	24(46.2%)	0.4
	Female	22 (45.8%)	28 (53.8%)	
Onset of T1D	New 84(84%)	41	43	0.7
	Old 16(16%)	7	9	
Social level (Patient numbers)	Very Low	25	25	0.8
	Low	20	22	
	Middle	3	5	
Previous attendance (Patient numbers)	Yes	24	13	0.01
	No	24	39	
HbA1c (mean±SD)	7.6 ± 1.4	7.5 ± 1.9	0.8	

T1D: type 1diabetes, HbA1c: glycosylated hemoglobin, CHO: carbohydrate, old: diagnosed more than 6 months from the start of the study, new: diagnosed less than 6 months from the star of the study. P-value < 0.05 was considered significant.

Table 4: Comparison between Who Attended the Education Program for their 1st time and those Who Attended it Previously

		History of Previous Attendance		
		First Time Attendance (63%)	Previously Attended (37%)	p-value
Mean age (years)		8.4 ± 3.5	8.9 ± 3.8	0.5
Sex	Male	31 (49.2%)	19 (51.4%)	0.8
	Female	32 (50.8%)	18 (48.6%)	
Onset of T1D	New 84 (84%)	59 (70.2%)	25 (29.8%)	0.001
	Old 16 (16%)	4 (25%)	12 (75%)	
Social level	Very Low	34 (54%)	16 (43.2%)	0.3
	Low	23 (36.5%)	19 (51.4%)	
	Middle	6 (9.5%)	2 (5.5%)	
Mean HbA1c %		7.5 ±1.4)	7.7±2.0)	0.5

T1D: type 1 diabetes mellitus, HbA1c: glycosylated hemoglobin. P-value < 0.05 was considered significant.

Table 5: Comparison between those who Attended the Education Program for the First Time and those who Previously Attended Regarding their Education Scores in each Session

		History of Previous Attendance		
Education Scores		First Attendance N (63) (mean ± SD)	Previous Attendance N (37) (mean ± SD)	p-value
General Knowledge session (1)	Before	1.4 ± 2	2.8 ± 2.5	0.003
	After	5.8 ± 0.5	5.8 ± 0.4	0.9
Diabetes Nutrition session (2)	Before	1.1 ± 1.4	2.8 ± 2.3	0.001
	After	5.4 ± 1	5.8 ± 0.4	0.03
Insulin Injection and Hypoglycemia session (3)	Before	1.3 ± 2.6	4.3 ± 4.2	0.001
	After	9.3 ± 1	9.3 ± 0.9	0.9
Hyperglycemic Knowledge session (4)	Before	1.3 ± 1.1	4.5 ± 3.1	0.001
	After	11.6 ± 1.1	11.7 ± 1.2	0.3
Follow up and Social Activity session (5)	Before	1.6 ± 2.4	3.1 ± 3.1	0.001
	After	6.3 ± 0.9	6.2 ± 1.1	0.8

P-value < 0.05 was considered significant.

Table 6: Linear Regression Analysis of the Different Factors in Relation to HbA1c

HbA1c (post education)		p-value
	Total post-education score	0.001
	Social level	0.57
	Number of attack of DKA	0.27
	Number of hypoglycemia attack	0.99

DKA: diabetic ketoacidosis. p-value < 0.05 was considered significant

Furthermore, when Comparing who attended the education program for the first time and those who previously attended regarding their education scores in each Session. As regards sessions (1, 3, 4, 5) the education score reported before the session was significantly higher in patients attended the program previously than those who attended the program for the first time with a p-value of (0.003, 0.001, 0.001 and 0.001 respectively). While their scores were non-significant after attending the same session. The education scores reported before and after session (2) was significantly higher in patients attended the program previously than those who attended the program for the first time with a p-value of (0.001 and 0.03 respectively). It is noticed that education scores before attending all the sessions significantly improved after attending the sessions more than once and this is expected. However, in only session (2) scores after attending this session significantly improved after attending the sessions more than once (Table 5).

The only factor which had a significant effect on HbA1c is the total post-education score. This signifies the value of the assessment and evaluation of the education program (Table 6).

DISCUSSION

Diabetes self-management education is critically important, fundamental and integral component of diabetes prevention and care and should be available and accessible to every subject. The main purposes of diabetes self-management are to make informed decisions, to cope with the demands of daily living with T1D and make changes in their behavior that support their self-management efforts to improve outcomes [8].

In this study, there was significant increase in diabetes knowledge regarding (General information about T1D, dietary education, insulin and methods of injection, complication of T1D including hypoglycemia & hyperglycemia, follow up knowledge and social activity). These results were similar to the study done in Germany reporting significantly better diabetes-specific quality of life (P < 0.05) and higher self-esteem (P < 0.05) after the intervention. In addition, theoretical diabetes knowledge was increased both in the short and long term (P < 0.05) [9].

Medical nutritional therapy (MNT) has been recognized as a primary treatment strategy for diabetes since the condition was identified centuries ago. To help our patients apply nutrition recommendations, they should achieve health behavior change. MNT is important in preventing, managing existing diabetes and preventing, or at least slowing, the rate of development of diabetes complications. It is, therefore, important at all levels of diabetes prevention [10]. Although knowing how and why to eat healthy food is important, knowledge alone does not enable children to do so. It is well documented that nutrition knowledge is necessary but not sufficient for dietary change that is why education only approaches are not typically successful, behavioral modification compared with knowledge based programs, nutrition program that have a behavioral focus tend to be more successful in producing dietary change [11].

Regarding the Role of diet in diabetes management there is marked increase (but not satisfactory) in knowledge about specific diabetic nutrition as 93% of interviewed family didn't know about special diet and CHO counting for diabetic child. But after education only 48% could count CHO points although statistically significance difference but still there was a great defect in CHO counting as 52% couldn't count CHO after the education session. This is considered a weak point in our diabetes education program. In this study it was found that no statistical difference in mean HbA1c between 2 groups; who could count CHO and who couldn't count CHO, this can be explained that HbA1c isn't the only parameter to measure optimal glycemic control; there are multiple factors affecting its values such as frequency of hypoglycemia including severe hypoglycemia, hyperglycemia, type of treatment, patient's age, duration of diabetes and quality of life [12].

It was found that no statistical significance between those who could count CHO and those who couldn't as regard the social level (included college degree) and diabetes duration (new or old diagnosed). Our results were similar to the study done by Shukla *et al.* [13] who found that awareness level may be increased even in low socioeconomic class by sincere and meticulous efforts by support system. Knowledge Survey scores which showed a positive correlation with diabetes duration (p-value 0.04) and parents with a college degree; the greater degree had higher Nutrition Knowledge Survey scores than parents with less college degree with a p-value 0.001 [14]. This might point to other factors that may be present in our patients; other than the social level that may affect this part of knowledge that remain to be identified.

In the current study; the education scores reported before all sessions were significantly higher in patients attended the program previously than those who attended the program for the first time especially in session (2) (Diabetes nutrition) (Table 5). Which means that this session in particular needs to be attended more than once in order the education program can achieve its goals. This also gives us a solution as the defect found in this program was in the knowledge about CHO counting, in order to solve this defect in our program this session has to attended several times to refresh the knowledge about diabetes nutrition. This agreed with a similar study which evaluated the study group immediately after education (T0) and group who continued participate in the education program at 12 month (T12) especially session of CHO intake, they found increase the CHO intake knowledge after 12 month (T0: 59%, T12: 90% of patients, p<0.001). That's mean education led to positive changes in patient skills, which were maintained over one year [15].

There was increase in knowledge about management of diabetes during exercise in diabetic child as 89% of the interviewed parents knew how to manage their diabetic child during exercise after education session. The result is higher than that obtained by another study which stated that only 67% of diabetic child educated about exercise in the form of simple knowledge about hypoglycemia with exercise which can be avoided by eating extra carbohydrate [16]. In our study, 94% of the studied children and their families reported that their schools were aware about the child disease and 92% were sharing in school activity. These results were higher than detected from similar study which stated that as only 78% of the studied children and their families reported that their schools were aware about child disease [16].

There was significant improvement in mean HbA1c% after (8.38 ± 1.77%) than before than before (9.08 ± 1.63%) attending the education program in the old 16 diabetic

children. However another clinical trial done recently for implementing a structured education program for children with diabetes reported that HbA1c at 12 or 24 months [17]. In this study, linear regression analysis was done and showed that the only factor which has a significant effect on HbA1c was the total post-education score (Level of knowledge). These results were similar to the results obtained by another study whose regression analyses demonstrated significant relation between health-related quality of life score including level of knowledge and both of HbA1c and gender [18].

The points of strength in the educational program of DEMPU identified through this study were adequate knowledge about the nature of T1D, management of hypo and hyperglycemic symptoms, the importance of regular follow up and regular HbA1c assessment, proper management of diabetes during sport. The only weak point detected in the education program was defective CHO counting. It was noticed that the diabetes nutrition session had to be attended several times to gain this skill for CHO counting.

The main limitation of this study was that it didn't access the practical aspects of this educational program.

CONCLUSION

We need to rethink CHO counting sessions to reach adequate goals of the education program in DEMPU. This may be done by using updated methods for education; including mobile messages, social media, one to one education, evaluation of knowledge, practical application, nutrition and behavioral assessments.

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