Effectiveness of Structured Diabetes Education for Children Newly Diagnosed with Type 1 Diabetes Mellitus

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Abstract

Main objective: To evaluate the effectiveness of systematized diabetes education in children with new onset of DM1 at the Fuenlabrada University Hospital (HUF), Madrid.

Methodology: Comparative study between two samples of children aged 0 to 14 years who had new onset of DM1 before and after the introduction of a diabetes education programme. A total of 34 children enrolled at the HUF who were admitted with new onset of DM1 were studied. To evaluate the effectiveness of the programme, bivariate analyses were performed to find relationships between systematized diabetes education and the variables: days of admission, visits to the emergency room due to complications, home leave and HbA1c at 3 and 6 months.

Main results: The number of days of admission was reduced by 3 days ($p < 0.001$), complications within 6 months after discharge decreased by 41.2% ($p = 0.019$) and home leave increased by 23.6% ($p = 0.001$).

Main conclusion: The results suggest the effectiveness of systematized diabetes education in children with DM1 onset.

Introduction

Diabetes mellitus (DM) is a serious public health problem worldwide due to its high prevalence, associated morbidity and mortality, and high costs. Standardized epidemiological research validated internationally also shows an increasing trend in the incidence of type 1 DM (DM1) in children, which could double in children under 5 years of age between 2005 and 2020. [1-4] In Spain, annual incidence rates of between 10 and 17 new cases per 100,000 inhabitants/year have been described. [5-7] The incidence rate in the Autonomous Community of Madrid (CAM) is 15.9/100,000 person-years (95%CI, 15.0-16.8), which shows a moderately high incidence compared to other European countries. [7] The child population is a particularly vulnerable group, both due to the complexity that its clinical management may pose, and due to the early age of onset itself, since poor control can produce alterations in the growth and development at the bio-psychosocial level of the child. [8,9] International organizations emphasize the importance of ensuring the continuity of care in these patients and promoting education in their self-care as essential tools for prevention, both of acute complications and long-term complications. [10]

The role of nursing professionals with knowledge and skills in diabetes education is consolidated, in the context of a multidisciplinary team that provides direct care at the onset of the diabetic child. The development of diabetes education programs at the survival level is equally important, which includes: the insulin injection technique, self-monitoring of blood glucose, action in the event of hypoglycemia, knowledge of the diet in carbohydrate portions or exchange units, as well as at the

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intermediate level, which adds to the explanation, understanding or realization of the survival level, action in the event of hyperglycemia, action in the event of physical exercise, special situations, knowledge and management of the diet in carbohydrate portions or exchange units, and the adjustment of insulin units based on the level of blood glucose. These health education programs have the objective of providing the child and their caregivers, in a short space of time, with the necessary skills and knowledge so that the hospital stay is not unnecessarily prolonged and a safe discharge is favored. [11-13]

In 2007, Montilla-Pérez et al. conducted a training activity on diabetes education, aimed at nursing professionals in the Pediatric Hospitalization Unit, with the aim of ensuring the continuity of diabetes education provided to children/caregivers, without being conditioned by the shift factor/freedom of the professionals involved in it. Two years after the training activity, it was observed that children who debuted with DM1 remained hospitalized for less time and that the diabetes education at the intermediate level they received was of higher quality. [14] In Australia and the United Kingdom, this same hypothesis was analyzed by comparing the pre-intervention group with the post-intervention group, observing that the training activity reduced the average days of stay. [13,15]

The fact that children and caregivers have adequate knowledge about DM1 and its self-care should be the basis for improved metabolic control, as well as for reducing the frequency of visits to the emergency room due to complications of the disease (hypoglycemia, hyperglycemia with or without ketoacidosis). The general objective of this study has been to evaluate the effectiveness of systematized

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diabetes education in children who debuted with DM1 at the Fuenlabrada University Hospital. The specific objectives have been to evaluate the average hospital stay, HbA1c levels at 3 and 6 months after diagnosis, frequency of visits to the emergency room due to episodes of decompensation or complications related to the disease and obtaining home leave during admission.

Methodology

A quasi-experimental comparative study was designed between two independent samples of children who debuted with DM1 before and after a diabetes education programme (pED) had been established and systematised. The study setting was the Fuenlabrada University Hospital, a public hospital in the CAM healthcare network that has provided specialised healthcare to the population of Area 9 since 2004. The total assigned population is 216,803 inhabitants. Of these, 33,866 inhabitants (16.49%) correspond to the child population aged between 0 and 14 years. The subjects studied were all children-caregivers who were admitted to the Pediatric Hospitalization service with a debut diagnosis of DM1, from June 2004 to October 2009. The exclusion criteria were all children from 0 to 14 years of age who debuted with DM1 whose main caregivers were not Spanish speakers and those whose caregivers had mental or sensory disabilities.

From the study subjects, 2 groups were created. The pre-pED group consisted of all children aged 0 to 14 years who debuted with DM1 and their main caregivers who were admitted from June 2004 to November 2007 for stabilization of glycemic control and initiation of diabetes education before the establishment of a new diabetes education (DE) program. The post-pED group included all children

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aged 0 to 14 years who debuted with DM1 and their main caregivers who were admitted from November 2007 to October 2009 for stabilization of glycemic control and initiation of diabetes education after the establishment of a new DE program.

The independent variable used was the establishment of a ED program. The season of the year at the time of onset, the clinical symptoms upon admission, and the socio-demographic variables that included age and sex were also used. The clinical symptoms upon admission were classified into three main medical diagnoses: ketoacidosis, hyperglycemia, and ketosis, since in both children and adolescents they are usually the first manifestation of the disease. [16] The establishment of the ED program, its implementation, and its systematization were achieved after the completion of a training and education course for all nursing professionals in the pediatric unit of the HUF on October 17 and 18, 2007 on ED. The course was taught by two endocrinologists and a nurse educator in pediatric diabetes. It consisted of ten theoretical-practical hours distributed in six sessions (Diabetes, Treatment, Acute Complications, Nutrition, Therapeutic Education in Diabetes, and Chronic Complications) and a pre- and post-course evaluation, aimed at the attending students. [14] This training led to the establishment of a consensus by the entire nursing team of the pediatric unit in the ED at the survival and intermediate levels. Because the clinical history is computerized, a computerized schedule was designed and implemented to serve as a guide for the professional. In this way, a logical sequence of education could be followed, avoiding interruption of the

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educational process if the professionals involved were off or changed shifts. Education would be carried out during the morning and afternoon shifts.

The outcome variables used were days of admission, visits to the emergency department, home leave and HbA1c levels at 3 and 6 months after diagnosis. Days of admission were considered to be the days elapsed from admission to the pediatric hospitalization unit, for metabolic control and initiation of diabetes education, until medical discharge. The hospital discharge criteria used were: normalization of blood glucose levels, acquisition of knowledge and management of self-care at the survival level and intermediate level.

Emergency department visits were defined as the number of times patients went to the emergency department for episodes of decompensation or complications related to the disease within the first six months of the diagnosis of the disease. The complications that were assessed were ketoacidosis: acute decompensation state, which occurs in situations of significant insulinopenia and presents with hyperglycemia >300 mg/dl and metabolic acidosis caused by ketonemia; hyperglycemia: glycemia >300 mg/dl; hypoglycemia: glycemia <60 mg/dl related to intercurrent processes or poor disease control.

Following the establishment of the PED, the active learning tool for children and their caregivers, known as home leave, was promoted. With this, the child and their caregivers go home while they are admitted to the hospital and observe the difficulties that may arise in their daily life in relation to their new state of health. In this way, when they return to the hospital, they share their experience and

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resolve any doubts that may have arisen during this period of time with the nursing staff and endocrine pediatrician of the unit.

Patients' home leave (PD) was classified into two groups. Those who had permission to go home to have a meal (PD1). To leave PD1 they had to be able to handle survival level knowledge and self-care with ease, being essential to manage hypoglycemia and know the technique of administering glucagon. Those with permission to go home after the meal in the hospital until the next day before having breakfast (PD2). To leave PD2 they had to be able to handle intermediate level knowledge and self-care with ease. HbA1c levels were assessed at 3 and 6 months after diagnosis. Values of 8% or higher were considered poor diabetes control .

Approval for the study was obtained from the HUF Research Committee. The computerized clinical records of the patients were used to obtain information on these variables. To protect confidentiality and anonymity, the extraction and exploitation of the data was carried out by separating the clinical data and eliminating the identifying data of the patients. The data was collected by a member of the research team in an Excel document and exported to the statistical program SPSS version 15 for Windows $^{®}$, for subsequent statistical analysis by the rest of the research team.

Data from children in the pre-pED group and the post-pED group were analyzed separately and jointly. Qualitative variables were presented with frequency distribution. Quantitative variables were summarized with mean, standard deviation, and median (interquartile range). In all cases, the distribution of the

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variable was checked against theoretical models with the Kolmogorov-Smirnoff normality test. To evaluate the effectiveness of the pED, bivariate analyses were performed to find possible relationships between variables, using the nonparametric Mann-Whitney U test to compare medians of two independent samples.

Results

The total number of children studied was 34, 17 children in the pre-pED group and 17 children in the post-pED group. Table 1 shows the socio-demographic, clinical and follow-up characteristics of the hospital admissions of children in both the pre-pED and post-pED groups. Regarding the days of admission, the median for the pre-pED group is 12 days (10-14 days) while for the post-pED group it is 9 days (3-12 days), this difference of 3 days being statistically significant ($p < 0.001$).

Table 1. Socio-demographic, clinical and follow-up characteristics of children's hospital admissions

		Grupo CONTROL		Grupo INTERVENCION		TODOS	
		n	%	n	%	n	%
Estación Debut	primavera	3	17,6	3	17,6	6	17,6
	verano	2	11,8	3	17,6	5	14,7
	otoño	1	5,9	4	23,5	5	14,7
	invierno	11	64,7	7	41,2	18	52,9
Sexo	niñas	4	23,5	7	41,2	11	32,4
	niños	13	76,5	10	58,8	23	67,6
Edad (años)	Media(DE) *	8,71 (3.72)		8,35 (3.69)		8,53 (3.65)	
Grupo de Edad	<5 años	8	47,1	4	23,5	12	35,3
	≥5 años	9	52,9	13	76,5	22	64,7
Clínica al Ingreso	cetoacidosis	5	29.4	6	35.3	11	32,4
	cetosis	12	70.6	8	47.1	20	58,8
	hiperglucemia	0	0	3	17.6	3	8,8
Causas de frecuentación a Urgencias	Ninguna complicación	4	23,5	11	64,7	15	44,1
	hipoglucemia	4	23,5	1	5,9	5	14,7
	hiperglucemia sin cetosis	7	41,2	5	29,4	12	35,3
	hiperglucemia con cetosis	2	11,8	0	0	2	5,9

* Media y desviación estándar

Table 1 also shows data on emergency room visits after hospital discharge due to episodes of decompensation or complications related to the disease within the first 6 months of diagnosis for both groups, with a statistically significant difference (p=0.019) observed between the pre-pED group and the post-pED group.

Regarding PD1, statistically significant differences were observed depending on the onset of pED between both groups [see Table 2 . Similarly, significant differences were also found regarding the days of admission required for the patients to begin to leave PD between the two groups [see Table 2 .

Table 2. Characteristics of the Residence Permits in both groups

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	Grupo CONTROL	Grupo INTERVENCION	p
Permiso Domiciliario 1 (PD1) (n, %)	13 (38,2 %)	21 (61,8%)	0,002
Permiso Domiciliario 2 (PD2) (n, %)	0	17 (100%)	-
Día de ingreso a partir (mediana, R.I) del cual se van de PD1	10 (8-11)	5 (4-6)	0,001
Día de ingreso a partir (mediana, R.I) del cual se van de PD2	-	7 (6-8,5)	-

n= muestra; %= porcentaje; R.I.= Rango Intercuartílico. Estadístico utilizado: U Mann-Withney

The mean HbA1c levels at 3 months after diagnosis are 6.61% with a standard deviation of 0.91 and the mean HbA1c levels at 6 months after diagnosis are 6.78% with a standard deviation of 0.92 for the total sample. After performing the bivariate analysis, no statistically significant differences are observed in the HbA1c levels at 3 months (p=0.15) and at 6 months (p=0.12) after onset between the comparison groups.

Discussion

Since the pED was started at the intermediate level, a statistically significant reduction (p<0.001) in the days of admission has been achieved. These results coincide with other studies that point out the effectiveness of different therapeutic diabetes education programs at the survival level in reducing hospital stay between 2.5 and 3.5 days, in newly diagnosed patients. [13,15,17]

Similarly, there was a statistically significant decrease in the number of emergency department visits within the first 6 months of diagnosis due to hyperglycemia without ketosis, hyperglycemia with ketosis, or hypoglycemia between the pre-pED group and the post-pED group of children who debuted with DM1. Other studies that analyzed this variable did not find such a decrease. [15,17] A possible

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explanation for this result is that the pED of the pediatric unit at HUF includes the intermediate level and not just the survival level.

Statistically significant differences were observed in PD1 home leave based on the diabetes education received in both groups. It is noteworthy that in the pre-pED group they began to leave from the tenth day of admission and in the post-pED group they did so from the fifth day.

In the pre-pED group, no children went on PD2 leave, whereas in the post-pED group, the median number of days that had to pass until they went on PD2 leave for the first time was seven days. We cannot conclude that it is statistically significant because the corresponding statistical analysis cannot be performed, however, it is an interesting fact, since it enhances significant learning for caregivers and children. This teaching tool is what differentiates our pED from those carried out in other studies in the United Kingdom, Australia and the USA. [13,15,17] The HbA1c levels at 3 and 6 months after the debut were similar in both groups, coinciding with other studies with similar characteristics. [13,15,17]

In a study analyzing the incidence and clinical characteristics of the onset of DM1 in children in Galicia, carried out by Cepedano et al., they indicated ketoacidosis as the first manifestation of the disease in 31.7%. [5] In our study, we found ketosis as the most frequent clinical manifestation at the time of onset (58.8%).

Regarding the seasonality of incidence, the results obtained are consistent with the seasonal epidemic pattern of incidence studies carried out in different Spanish communities between 1988 and 2005. [3,5-7] During the period in which the study

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was carried out, 67.6% of the total new cases of DM1 were diagnosed in autumn-winter and 32.4% in spring-summer.

Some of the limitations of this study are, firstly, the small sample size, which reduces its power and precision. Secondly, the data refer to children who debut with DM1 in the area where the study was carried out, so the data could not be inferred to other populations. However, the data are relevant because it is a novel pED, which is characterized by dealing with the survival level and the intermediate level (the latter being the most novel aspect), as well as home leave as an active learning tool (an aspect of great interest that has not been studied until now). All of this represents a benefit for both the child-caregivers, the professionals in charge of their diabetes education, as well as the health institution where they are cared for.

Based on the data obtained, we can conclude that the pED in a pediatric unit seems to achieve a series of benefits for the pediatric patient recently diagnosed with DM1, although there could be other socio-cultural factors not considered in this study. These benefits are the reduction of days of admission for training in diabetes at the intermediate level and the reduction of episodes of frequenting the emergency room within the first 6 months of diagnosis due to: hyperglycemia without ketosis, hyperglycemia with ketosis or hypoglycemia.

We understand that the establishment of a PED together with home leave, understood as an active learning tool, could be key elements to reduce the number of days of admission and the number of visits to the emergency room. However, it would be interesting for future research to carry out a multi-centre study, involving

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hospitals with similar characteristics and from different geographical areas, in order to expand the information obtained.

The data obtained in the study suggest the need to include the pED in the survival and intermediate levels in all pediatric hospitalization units where children are admitted at the time of diabetic onset. In clinical practice, this could lead to an improvement in the quality of nursing care provided, minimizing individual dependence on a single educational professional and avoiding a longer hospital stay increased by the shift factor.

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