Knowledge of carbohydrate counting and insulin dose calculations in paediatric patients with type 1 diabetes mellitus

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ABSTRACT

Background: Patients with type 1 diabetes mellitus (T1DM) who are able to adjust their insulin doses according to the carbohydrate content of a meal, as well as their blood glucose, are likely to have improved glycaemic control (Silverstein et al., 2005). With improved glycaemic control, patients have a lower risk of developing long-term microvascular complications associated with T1DM (Diabetes Control and Complications Trial Research Group, 1993).
To assess the carbohydrate and insulin knowledge of patients attending our paediatric diabetes clinic at the University Hospital Limerick (UHL), the validated PedCarbQuiz (PCQ) was applied to our clinic population.
Methods: This study was completed by applying a questionnaire called the PedCarbQuiz (PCQ) to children exclusively attending our paediatric diabetes clinic at UHL. Of the clinic's 220 patients, 81 participated in the study.
Results: The average total PCQ score (%) was higher in the continuous subcutaneous insulin infusion (CSII) group compared with the multiple daily insulin (MDI) injection user group (79.1 ± 12.1 versus 65.9 ± 6.6 p = 0.005). The CSII group also had a higher average carbohydrate score (%) compared with the MDI group (79.4 ± 12.4 versus 66.3 ± 16.2, p = 0.004).
Conclusions: This study demonstrates that in a representative Irish regional paediatric T1DM clinic, knowledge of carbohydrates and insulin is better among patients treated with CSII compared with MDI. However, knowledge in both groups is poorer than in the original US sample.
General significance: This study demonstrates that in a representative Irish regional paediatric T1DM clinic, knowledge of carbohydrates and insulin is poorer than in a US based sample, although this knowledge is better among patients treated with CSII compared with MDI. This highlights the need for improved resources for diabetes and carbohydrate counting education for patients with T1DM.

1. Background

Patients with type 1 diabetes mellitus (T1DM) who are able to adjust their insulin doses according to the carbohydrate content of a meal, as well as their blood glucose, are likely to have improved glycaemic control [1]. With improved glycaemic control, patients have a lower risk of developing long-term microvascular complications associated with T1DM [2].

To assess the carbohydrate and insulin knowledge of patients attending our paediatric diabetes clinic, the validated PedCarbQuiz (PCQ) was applied to our clinic population. The PCQ was created and validated in a tertiary paediatric diabetes clinic in the USA [3]. The questions evaluate the patients' understanding of the carbohydrate content of commonly eaten foods, the ability to read nutritional labels, and the calculation of proper insulin dosage and a report is generated which estimates skills in calculating carbohydrate content, insulin doses and overall skills [3]. The PCQ is a 78-item, self-administered, multiple-choice, paper-based questionnaire requiring 20–30 min to complete. Higher scores (expressed as %) indicate greater degree of knowledge about carbohydrates and insulin-dosing ability.

UHL includes a regional paediatric unit, providing secondary paediatric care to the local population. During the study period, there was no service to commence insulin pumps at UHL and there was no paediatric diabetes dietitian. In this context, the aim of this study was to assess the carbohydrate knowledge of paediatric patients with T1DM attending the designated paediatric T1DM clinic at the University Hospital Limerick (UHL).

2. Methods

The PCQ was adapted for an Irish population, by converting the blood glucose readings from mg/dl to mmol/L. The PCQ was offered to

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Table 1
Patient demographics and results of PCQ questionnaire.

	All participants	CSII participants	MDI participants	p-value CSII vs MDI
Number of participants	81	15	66	–
Participant sex				–
Male	35	8	27	
Female	46	7	39	
Age of participant (years)	10.6 ± 3.9	9.6 ± 4.0	10.8 ± 3.9	0.501
Age at diagnosis (years)	6.7 ± 3.8	5.1 ± 3.4	7.1 ± 3.8	0.731
Diabetes duration (years)	3.7 ± 3.3	4.5 ± 2.0	3.5 ± 3.5	0.429
Total PCQ score (%)	68.9 ± 15.8	79.1 ± 12.1*	65.9 ± 16.6*	0.005
Carbohydrate PCQ score (%)	68.7 ± 16.3	79.4 ± 12.3*	66.3 ± 16.2*	0.004
Insulin PCQ score (%)	68.9 ± 24.9	78.2 ± 21.8	66.8 ± 25.4	0.108
HbA1c mmol/mol	71.8 ± 14.7	72.8 ± 15.6	67.1 ± 8.1	0.909
Questionnaire completed by parent	56	11	45	
Questionnaire completed by patient	14	2	12	
Questionnaire completed by parent and patient	10	2	8	
Questionnaire completed by another responsible adult	1	0	1	
Knowledge obtained from internet or books	10	2	8	
Knowledge obtained from a dietitian	46	7	39	
Knowledge obtained from a combination of sources	17	5	12	
Knowledge attainment not specified	8	1	7	

the parent(s) or guardian of each child attending the paediatric T1DM clinic from July until November of 2012. Only patients who were attending exclusively our paediatric diabetes clinic at UHL were eligible for inclusion, irrespective of what institution they had attended for previous education (e.g. pre CSII education). Patient data were collected, including gender, current age, age at diagnosis, insulin regimen, and source of carbohydrate knowledge (e.g. dietitian-taught, self-taught). For comparisons, insulin regimen was subdivided into continuous subcutaneous insulin infusion (CSII) and multiple daily injections (MDI). Anonymised data were analysed using SPSS. Statistical significance was set at $p < 0.05$. Local institutional ethical approval was obtained.

3. Results

During the study period, the outpatient paediatric T1DM population included 220 patients; 101 patients were invited to participate; 20 declined and 81 PCQs were completed and submitted. Of those who declined, 4 were within the clinic setting and stated that they were not interested in participating. The remaining 16 were attendants who had not attended their clinic appointment over the time of the study and had the study mailed to their home address but did not respond. The characteristics of the sample are outlined in Table 1.

The maximum overall obtainable score was 78/78, with a maximum score of 58/78 in the carbohydrate knowledge domain and 20/78 in the insulin-dosing knowledge domain. Average PCQ scores were: Total 68.9 ± 15.8%, carbohydrate 68.7 ± 16.3%, and insulin 68.9 ± 24.9%. No participant obtained a perfect score in the carbohydrate domain or overall, but 8 participants obtained a perfect score in the insulin-dosing domain. 2 of these participants belonged to the CSII group and 6 in the MDI group.

The CSII group compared with the MDI group had a higher average total PCQ score (79.1 ± 12.1% versus 65.9 ± 16.6% p = 0.005) and higher average carbohydrate score (79.4 ± 12.4% versus 66.3 ± 16.2%, p = 0.004) but there was no difference for average insulin score (78.2 ± 21.8% versus 66.8 ± 25.4%, p = 0.108).

PCQ scores showed no significant correlation with gender, age, age at diagnosis, HbA1c or diabetes duration.

Our study identified higher knowledge of carbohydrate counting and insulin dosing in paediatric T1DM patients treated with CSII compared with MDI. This is consistent with best practise, where patients receive carbohydrate counting prior to starting CSII therapy. The scores from our Irish cohort were lower than those from the original US cohort, indicating poorer knowledge of carbohydrates and insulin

in our patients. Disappointingly, only 57% of our patients had been taught carbohydrate and insulin skills by a dietitian, compared with all of the patients in the American study. The low levels of dietitian-led carbohydrate teaching are due to significant dietetic resource limitations at UHL prior to this study. Nonetheless, we did not ask at which institution dietetic education was received, and for some patients, this may have been elsewhere. Even patients who have already started CSII therapy should have ongoing education with a diabetes dietitian and this was not possible at UHL during the study period. This study measures knowledge of carbohydrate counting and insulin dose calculations, but it does not measure the real-life behaviour of patients in calculating and administering insulin doses.

Our study has limitations. The PCQ was developed for a US population and adaptations for our Irish populations were difficult, e.g. some food types might not be commonly consumed among Irish children. Disappointingly, we had a low response rate to this study. It is possible that only patients with confidence in their carbohydrate and insulin skills might have consented to this study. In this case, the true PCQ knowledge of our cohort may be significantly lower than indicated in this study. Thirdly, while some results reach statistical significance, clinical significance in different PCQ scores is difficult to estimate. However, this is a novel study in an Irish population and the results are interesting; specifically, the results suggest suboptimal carbohydrate and insulin calculation knowledge compared with a large American centre where all patients receive dietetic education.

This study demonstrates that in a representative Irish regional paediatric T1DM clinic, knowledge of carbohydrates and insulin is better among patients treated with CSII compared with MDI. However, knowledge in both groups is poorer than in the original US sample. No patient treated with a regime other than CSII or MDI agreed to participate. Some patients in our study group received dietetic input even in the absence of a paediatric diabetes dietitian as part of the MDT, either in another hospital or privately. In either case, follow-up consultations and integrating information to the rest of the MDT education would have been difficult for the family. A notable difference between the Irish and US cohorts is the significant dietetic resource limitation in the Irish cohort. Following investment in dietetic support to this clinic, with consequent increased teaching of carbohydrate and insulin skills to our patient population, we intend to repeat this study.

4. General significance

This study describes a low level of carbohydrate knowledge among children with type 1 diabetes mellitus (and their parents) despite

carbohydrate knowledge improving the success of medical treatment of T1DM and being a basic topic of education following diagnosis with T1DM. This study was performed in the context of poor dietetic support at this institution and we intend to repeat the study following improved dietetic resources to the paediatric type 1 diabetes mellitus service.

Transparency document

The Transparency document associated with this article can be found in online version.

References

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