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A Retrospective Chart Review of a Carbohydrate-Focused Dietary Intervention for Type 1 Diabetes Management: Protocol

Background

Type 1 diabetes (T1D) is an autoimmune condition characterised by the destruction of pancreatic beta cells and absolute insulin deficiency. Affected individuals have impaired glucose metabolism and are prone to acute and chronic complications from hyper- and hypoglycaemia. Standard treatment methods consist of daily insulin injections and a high-carbohydrate (HC) diet (45-65% total energy intake [TEI] as carbohydrate) is typically encouraged. However, the lack of available scientific evidence comparing the effect(s) of different levels of carbohydrate intake on T1D management outcomes means this dietary recommendation is not based on evidence-based practice principles (1).

Dietary carbohydrate has the greatest impact on blood glucose response, and glycaemic control is the strongest predictor of diabetes complications. Achieving a haemoglobin A1c (HbA1c) of ≤7.0% is considered the primary target in diabetes management. However, data from T1D registries (2010-2013) across nineteen countries in Australasia, Europe and North America (n = 324,501) reported that 84% of patients exhibited an HbA1c >7.0%. Juutilainen et al. 2008 found that in T1D patients, a 1.0% rise in HbA1c increased individual risk of cardiovascular mortality by 52.5% (2). These data suggest current management strategies for T1D are lacking in effect and adjunctive strategies for achieving glycaemic control in this clinical population require urgent consideration.

In response, there has been growing interest in dietary strategies of varying levels of carbohydrate intake, including the role of low carbohydrate (LC) diets to improve glycemic control T1D. LC diets are defined by the American Diabetes Association classifications of less than 130 grams per day (g/day) or 26% TEI from carbohydrate. LC diets have recently been acknowledged by national diabetes and dietary bodies as an effective dietary intervention for type 2 diabetes management as part of an individualised approach (3-5). However, due to the dearth of available evidence evaluating the effect of LC diets in T1D, a consensus statement has not been able to be established and the LC diet approach

remains contradictory to the traditional HC dietary advice. A recent study in a large group of individuals with T1D showed a LC diet promoted exceptional glycaemic control, and achieved an average HbA1c well within the diabetes management target (<7.0%), closer to normal glycaemic control (6). Moreover, the first systematic review investigating LC for T1D management, conducted by members of the proposed research team, showed that varying levels of carbohydrate intake <45% TEI improved HbA1c, total daily insulin and frequency of severe hypoglycaemia, despite insufficient homogeneity to determine overall effect sizes (1). This preliminary evidence supports the need for greater research to be conducted to understand the impact of varying levels of carbohydrate intake on glycaemic control in patients with T1D, including the features of effective intervention approaches used to better inform dietary recommendations and practice guidelines for this clinical population. Currently clinicians working in T1D centres across Australia have been exploring the use of carbohydrate-focused dietary interventions for T1D management that could serve as a potentially valuable resource for understanding real-world clinical practice management of T1D and the efficacy of these approaches.

Specifically, a T1D outpatient centre in Perth, W.A. has been actively implementing carbohydrate-focused dietary interventions for T1D management as part of their care plan. Consequently, the centre has established an extensive database of intervention protocols and health outcomes in individuals with T1D who have been prescribed and managed with carbohydrate-focused dietary interventions, including LC diets. This presents an opportunity to conduct a retrospective observational analysis and chart review of individuals with T1D who have been managed with carbohydrate-focused dietary interventions, to understand the effect(s) of varying levels of carbohydrate on T1D management outcomes and to identify and describe effective dietary approaches for this clinical population.

We have modelled our proposal off a study published by Vernon et al. in 2003 (7). This study was a retrospective cart review of an outpatient program utilising a carbohydrate-restricted diet in Lawrence, Kansas (M.C.V.) aimed at assessing the effect of the program on diabetes mellitus management outcomes.

Aims/Objectives

The aim of the current study is to explore the use of carbohydrate-focused dietary interventions delivered by a Credentialed Diabetes Educator (CDE) and Accredited Practising Dietitian (APD) (hereon referred to as CDE/APD) in the clinical practice management of adults with T1D at an outpatient diabetes centre. The specific objectives of this study are to:

- Describe the core components involved in the formulation of carbohydrate-focused dietary intervention(s) for T1D management, including but not limited to; macronutrient and energy prescriptions, behavioral techniques (e.g., goal setting), patient self-tracking/monitoring (e.g., use of food diary, carbohydrate counting), diet-related education, etc.

- Determine the (pre-post) effect(s) of all carbohydrate-focused dietary interventions identified at this practice on T1D management outcomes, including HbA1c, glycaemic variability, mean fasting blood glucose levels, total daily insulin use, and patient well-being.

- Determine whether any association(s) exists between the level dietary carbohydrate prescription and change(s) in T1D management outcomes.

We hypothesise that LC dietary prescriptions (<130 g/day) will lead to improvements in all T1D management outcomes due to reduced error rates in calculating exogenous insulin requirements. We also expect very low levels of dietary carbohydrate (<50 g/day) to be associated with greater improvements in glycaemic control, so long as adherence to the interventions is not negatively impacted by this level of carbohydrate restriction.

Methods

Study Design

A retrospective chart review (observational study with a quantitative analysis) of individuals who have participated in an outpatient carbohydrate-focused dietary intervention delivered by a CDE/APD at a T1D centre in Perth, Western Australia (11 Limosa Close, Stirling 6021).

Eligibility Criteria

To be included in the study, participants must be adults (18-60 years) with previously diagnosed T1D, attended at least two consultations (≥2 weeks apart) with the centre's CDE/APD for dietary advice and have the following data items available: sex, age, prescribed carbohydrate amount (as grams per day, %TEI or a clear description of the types of foods to include and avoid) and pre-post values for at least one primary or secondary clinical outcome. The primary outcome is HbA1c and secondary outcomes are glycaemic variability, mean fasting blood glucose levels, total daily insulin use, and patient-reported well-being.

Recruitment

All existing patients of the T1D centre will be invited to participate in the study. A flyer and participant information sheet will be emailed to potentially eligible participants by the centre's administration team to inform them of the opportunity to participate in the research. Individuals wishing to participate will be instructed to provide written informed consent by completing the participant consent from on REDCap (accessed via URL). The list of consenting participants will be provided to a designated staff member of the centre who has no existing dependent relationships with any potentially eligible participant, and this staff member will make a copy of all consenting patient records to be stored on a password-protected external hard drive for assessment by the primary investigator (JT). The list of consenting patients will not be made available to any member of the centre who has existing dependent relationships with any potentially eligible participant, including the CDE/APD. All patients that provide consent before the pre-specified cut-off date (14th October 2019) will have their clinical data assessed for eligibility by JT. No sensitive patient data will leave the centre's premises and all ineligible patient records will be destroyed as soon as screening is complete. All eligible participants will be included.

Data Collection

Participants will also be asked to complete a short questionnaire on REDCap at the time of consent to provide demographic data and general health information, including age, sex, ethnicity, religion, education level, BMI, diabetes duration, co-morbidities, and use of medications (Attachment 5). If any of these data items are also recorded in the patient file, they will be extracted by JT and used to confirm the information provided by the participants in the questionnaires. Any discrepancies between the two modes of data will be resolved by calling the patient for clarification and verification, otherwise the data item(s) will be excluded. Data relating to the dietary intervention and clinical outcomes will be extracted by JT from a private room at the centre during which time JT will replace participant names and other personal identifiers with a research identification number. The following data will be extracted (verbatim) using a customised data extraction form in Microsoft Excel (Table 1):

- Details on the prescribed dietary intervention
- Details on delivery techniques used
- Details on additional intervention components (e.g., insulin regimen, physical activity)
- Outcomes used to evaluate the dietary intervention (self-report or verified)
- Length of follow-up
- Pre-post outcome values
- Adherence to dietary prescription

- Adverse effects/experiences, if any

Data Synthesis & Analysis

All data will be entered in to a secure online database without identifiers and made available to all other investigators (KR, RJ, AR, GB, HP) for collaborative analysis.

Objective 1: Thematic analysis will be used to assess the dietary prescription details and identify the core components involved in the formulation of carbohydrate-focused diet intervention(s) for T1D management. All investigators (JT, KR, GB, RJ, AR, HP) will collaboratively compare and contrast the initial themes identified in the data until consensus is reached on a final set of core dietary components.

Objective 2: Descriptive statistics for calculation will include means and standard deviations of continuous variables and proportions for categorical variables (Table 2). The analysis used will be a paired t-test comparing changes in HbA1c, glycaemic variability, mean fasting blood glucose levels, and total daily insulin use from baseline to follow-up. Any reported pre-post change(s) in patient well-being will be presented verbatim in text and/or tabular format. Individual participant results will also be presented in tabular format (case-by-case) (Table 3).

Objective 3: Participants will be classified into one of four groups:
1. Very low-carbohydrate ketogenic diet (<50 g/day)
2. Low-carbohydrate diet (50-130 g/day)
3. Moderate carbohydrate diet (130-225 g/day)
4. High carbohydrate diet (>225 g/day)

The mean (pre-post) change for each outcome will be calculated and compared between groups using correlational analysis. We plan to use a one-way ANCOVA for the change in each outcome variable (HbA1c, glycaemic variability, mean fasting blood glucose levels, and total daily insulin use), with the four carbohydrate groups as fixed factors and age, sex, and BMI as covariates. If adequate quantitative data on the dietary carbohydrate prescriptions are available, we will use a dose-response regression analyses between continuous carbohydrate (g/day) and outcome variables, adjusting for potential confounders (i.e., age, sex, BMI) as covariates.

Tables

Table 1. Customised data extraction form

Patient ID	
Eligibility	
2 x CDE/APD appointments ≥2 weeks	
Age (years)	
Sex	
Prescribed dietary carbohydrate amount	
Outcomes measured on ≥2 time points	
Participant Characteristics	
Ethnicity	
Religion	
Education level	
BMI	
Diabetes duration	
Co-morbidities	
Use of medications	
Dietary Intervention	
Total energy prescription	
Carbohydrate amount prescription	
Protein amount prescription	
Fat amount prescription	
Types of foods to include/avoid	
Additional diet details (e.g., fluid, salt)	
Nutritional supplements recommended	
Delivery Techniques	
Mode(s) of delivery	
Frequency of contact	
Participant self-monitoring	
Behavioural techniques (e.g., education, goal setting)	
Additional Intervention Components	
Changes to anti-diabetic medication (including insulin) regimen	
Physical activity	
Other	
Clinical Outcomes	

Outcome 1	Description	
	Subjective / objective	
	Self-report / verified	
	Time-points	
	Baseline value	
	Follow-up value	
Outcome 2	Description	
	Subjective / objective	
	Self-report / verified	
	Time-points	
	Baseline value	
	Follow-up value	
Outcome 3	Description	
	Subjective / objective	
	Self-report / verified	
	Time-points	
	Baseline value	
	Follow-up value	
Outcome 4	Description	
	Subjective / objective	
	Self-report / verified	
	Time-points	
	Baseline value	
	Follow-up value	
Outcome 5	Description	
	Subjective / objective	
	Self-report / verified	
	Time-points	
	Baseline value	
	Follow-up value	
Other Details		
Dietary adherence		
Adverse events		

Table 2. Effect of carbohydrate-focused dietary intervention on type 1 diabetes outcomes

Outcome	*n*	Baseline (mean [SD])	Follow-up (mean [SD])	Effect size (mean [SD])	Follow-up (mean [SD])	P-value
-	-	-	-	-	-	-

Table 3. Initial and follow-up outcome values in type 1 diabetes patients after a carbohydrate-focused dietary intervention

Case	Age	Sex	Diabetes duration	Length of follow-up	Outcome 1 (pre-post)	Outcome 2 (pre-post)	Outcome 3 (pre-post)	Etc.
-	-	-	-	-	-	-	-	-
Mean (SD)	-	-	-	-	-	-	-	-

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