

**Optimising nutrition interventions to improve  
postprandial glycaemia for children and  
adolescents using intensive insulin therapy**

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A thesis submitted for the degree of PhD (Nutrition and Dietetics)

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## **Statement of originality**

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. I give consent to this copy of my thesis, when deposited in the University Library, being made available for loan and photocopying subject to the provisions of the Copyright Act 1968.

Carmel Smart

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## **Acknowledgement of collaboration**

I hereby certify that the work embodied in this thesis has been done in collaboration with other researchers, or carried out in other institutions. I have included as part of the thesis a statement clearly outlining the extent of collaboration, with whom and under what auspices.

Carmel Smart

## **Acknowledgement of authorship**

I hereby certify that this thesis is in the form of a series of published papers of which I am joint author. I have included as part of the thesis a written statement from each co-author, endorsed by the Faculty Assistant Dean (Research Training), attesting to my contribution to the joint publications.

Carmel Smart

## **List of publications included as part of the thesis**

Smart CE, Collins CE, Schoonbeek J. Nutritional management of children and adolescents on insulin pump therapy - a survey of Australian Practice. *Pediatric Diabetes*. 2008;9(2):96-103.

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## **Statement of contributions of others**

I attest that Research Higher Degree candidate Carmel E M Smart contributed to the following paper through development of the research question, development of the methodology, assisting with the questionnaire dissemination, follow-up and data collation, assisting with analysis of the results, contributing to the discussion and writing the manuscript.

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## List of additional publications and conference presentations

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Ryan R, King BR, Anderson D, Attia J, Collins CE, Smart CE. Influence of and Optimal Insulin Therapy for a Low-Glycemic Index Meal in Children With Type 1 Diabetes Receiving Intensive Insulin Therapy. *Diabetes Care*. 2008;31(8):1485-90.

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Smart CE Carb counting: is close enough good enough? Lilly 2011 Diabetes Educators Forum, Sydney, Australia, May 2011.

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Smart CE Optimising nutritional interventions for children using intensive therapy. Royal North Shore Hospital, Endocrine and Diabetes Department, NSW, Australia 2009.

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Ryan RA, King BR, Collins CE, Crock PA, Anderson DA, Smart CE Glyceemic Index and preprandial insulin affect postprandial glucose control more than insulin type. ISPAD Conference, Berlin, Germany, September 2007 (Awarded Best Poster), published in *Pediatric Diabetes* 2007; 8(Suppl 7): 60.

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## List of Abbreviations

AUC	Area under the curve
BGL	Blood glucose level
BMI	Body Mass Index
CGMS	Continuous glucose monitoring system
CHO	Carbohydrate
CSII	Continuous subcutaneous insulin infusion
DAFNE	Dose Adjustment for Normal Eating
DCCT	Diabetes Control and Complications Trial
DTTP	Diabetes Treatment and Teaching Program
EDIC	Epidemiology of Diabetes Interventions and Complications
FII	Food Insulin Index
FIIT	Flexible intensive insulin therapy
g	Gram
GI	Glycemic Index
HbA1c	Glycated haemoglobin
IDF	International Diabetes Federation
ISPAD	International Society of Pediatric and Adolescent Diabetes
I:CHO	Insulin to carbohydrate ratio
IPT	Insulin pump therapy
L	Litre
MDI	Multiple daily injections
PPG	Postprandial glucose
RDI	Recommended Daily Intake
SD	Standard deviation
T1DM	Type 1 Diabetes Mellitus
Yrs	Years

## **Abstract**

Type 1 diabetes mellitus (T1DM) is a chronic autoimmune disorder that presents a significant set of challenges to the child, their family and the interdisciplinary team of health professionals. Medical nutrition therapy is an essential component of education for children with T1DM. However, there are gaps in the evidence regarding the optimal approach to dietary management of children and adolescents using intensive insulin therapy, including the precision required in carbohydrate counting to maintain glycaemic control; the ability of children and their families to accurately count carbohydrate; and the impact of errors in carbohydrate quantification on postprandial glycaemia. The primary purpose of this thesis is to investigate the effect of variations in carbohydrate quantity on postprandial glycaemia, and the ability of children and their families to estimate carbohydrate using different quantification methods.

The results of the national survey on the dietary management of children and adolescents on insulin pump therapy highlighted diversity in clinical dietetic practice. Overall, a lack of evidence and consensus was identified with regard to the degree of precision required in carbohydrate counting estimations. Furthermore, limitations exist in the accuracy of the nutrition information panel on a food label, which has direct implications for clinical practice.

The optimal method of quantifying carbohydrate (one gram increments, 10 gram portions or 15 gram exchanges) remains a controversial issue. A questionnaire conducted in clinics in Australia and the UK that examined the ability of children and their parents to count carbohydrate, demonstrated that 73 percent of all estimates (n=2530) were within a 10-15gram error margin, no matter which method of estimation was used. This study showed that children and their parents can quantify carbohydrate in meals with reasonable accuracy, provided education is given by experienced health professionals.

The carbohydrate variation studies were undertaken to assess the impact of 10 gram and 20 gram variations in carbohydrate amount of a standardised meal for a set insulin dose. The studies demonstrated that insulin covers a range in carbohydrate amounts,

and that a 10 gram variation in carbohydrate estimations for a meal containing 60 grams of carbohydrate does not make a difference to postprandial glucose levels, but that a 20 gram variation results in significant postprandial hypoglycaemia and hyperglycaemia.

Overall, this sequence of studies seeks to improve the effectiveness of medical nutrition therapy related to premeal insulin adjustment for carbohydrate amount. The clinical implications of the findings presented in this thesis are discussed and specific recommendations offered for practice and research in order to facilitate improved outcomes for children living with type 1 diabetes.