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


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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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Smart CE What is new in nutrition research? Annual State Meeting of the Australian Diabetes Educators Association (Queensland Branch), Brisbane, Australia, June 2011.

Smart CE Carbohydrate Controversies – “Precise” carbohydrate counting – necessary to optimise glycaemia? Starship Children’s Health Paediatric Diabetes Symposium, Auckland, New Zealand, April 2011

Smart CE Counting carbohydrate in paediatric diabetes management. Annual State Meeting of the Dietitians Association of Australia (NSW Branch), Newcastle, Australia, October 2010.

Smart CE Controversies in carbohydrate counting. Australasian Paediatric Endocrine Group 2010 Annual Scientific Meeting, Adelaide, Australia, August 2010.

Smart CE The impact of carbohydrate quantity and quality on postprandial glycaemia in insulin pump therapy. Australian Paediatric Society’s 5th Annual Diabetes Workshop, Gold Coast, Australia, August 2010.

Smart CE What are the optimal nutritional interventions for children on intensive therapy? Princess Margaret Hospital, Endocrine and Diabetes Department, Perth, Australia, February 2010.

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

Smart CE, Haniff-Ismail S, Delamater A Meal planning for diabetes in different age groups and cultures. International Society of Pediatric and Adolescent Diabetes 34th Annual Scientific Meeting, Durban, South Africa. 2008.

Conference Abstracts


Smart CE, Collins CE, King BR, Ross K, Edge JA Can children and adolescents with Type 1 diabetes on intensive insulin therapy count carbohydrate adequately enough to adjust pre-meal insulin? Dietitians Association of Australia, 26th National Conference, Gold Coast, Australia, May 2008 (Oral presentation).


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# Table of Contents

- Statement of originality ............................................................... ii
- Acknowledgements ........................................................................ iii
- Acknowledgement of collaboration ................................................ v
- Acknowledgement of authorship .................................................... vi
- List of publications included as part of the thesis ............................ vii
- Statement of contributions of others .............................................. viii
- List of additional publications and conference presentations ........ xiii
- List of additional publications of relevance to the thesis .................. xiii
- List of conference presentations of relevance to the thesis ............... xiii
- Invited speaker ............................................................................ xiv
- Conference Abstracts ................................................................. xiv
- List of Abbreviations ..................................................................... xxii

## Abstract ...................................................................................... 1

### Chapter 1

- Introduction .................................................................................. 3
  - Background .................................................................................. 3
    - 1.1.1 Incidence and prevalence of Type 1 Diabetes in Australian children ... 4
    - 1.1.2 Primary prevention of Type 1 Diabetes .................................. 5
    - 1.1.3 Complications of Type 1 Diabetes ........................................ 7
    - 1.1.4 Overview of insulin treatment ............................................. 10
    - 1.1.5 Monitoring of glycaemic control .......................................... 12
    - 1.1.6 Continuous Glucose Monitoring ......................................... 16
  - 1.2 Nutritional management of Type 1 Diabetes: Carbohydrate quantification .. 19
    - 1.2.1 Historical review of carbohydrate quantification .................. 19
    - 1.2.2 The evidence for carbohydrate quantification .................... 21
    - 1.2.3 Methods of carbohydrate quantification ............................. 25
    - 1.2.4 Carbohydrate counting in clinical practice ......................... 26
  - 1.3 Research aims ......................................................................... 28

## Chapter 2: Literature Review

- Nutritional management of children and adolescents using intensive insulin therapy ......................................................... 30
  - 2.1 Overview of medical nutrition therapy .................................. 31
    - 2.1.1 Paediatric Nutrition Guidelines ........................................ 31
    - 2.1.2 Goals of nutrition therapy .............................................. 32
    - 2.1.3 Dietary requirements ..................................................... 32
    - 2.1.4 Dietary behaviours ....................................................... 33
    - 2.1.5 Carbohydrate amount and distribution ............................. 34
    - 2.1.6 Glycemic Index ............................................................ 36
    - 2.1.7 Other considerations in dietary management .................... 37
  - 2.2 Nutritional management of children and adolescents using insulin pump therapy .......................................................... 39
  - 2.3 Nutritional management of children and adolescents using multiple daily injections ......................................................... 42
  - 2.4 What is the dietary knowledge of children and adolescents using intensive insulin therapy? .................................................. 44
Chapter 6  Children and adolescents on intensive insulin therapy maintain postprandial glycaemic control without precise carbohydrate counting

5.1 Introduction ..............................................................................................................98
5.2 Methods ....................................................................................................................99
5.3 Results .....................................................................................................................100
5.4 Discussion ...............................................................................................................102

Chapter 7  In children using intensive insulin therapy, a 20 gram variation in carbohydrate amount significantly impacts on postprandial glycaemia

6.1 Introduction.........................................................................................................................104
6.2 Patients and Methods........................................................................................................106
6.2.1 Patients ................................................................................................................107
6.2.2 Study procedure ................................................................................................107
6.2.3 Test meals ...........................................................................................................108
6.2.4 Blood Glucose measurement ...........................................................................109
6.2.5 Statistical analyses .............................................................................................110
6.3 Results .....................................................................................................................111
6.3.1 CSII and MDI therapy groups .........................................................................111
6.3.2 Pooled CSII and MDI Results ..........................................................................112
6.4 Discussion ...............................................................................................................115

Chapter 8  Discussion and recommendations for clinical practice and future research

7.1 Introduction.........................................................................................................................118
7.2 Patients and Methods........................................................................................................120
7.2.1 Statistical Analyses ............................................................................................122
7.3 Results .....................................................................................................................123
7.4 Discussion...............................................................................................................125

Chapter 8  Discussion and recommendations for clinical practice and future research

8.1 Overview.........................................................................................................................127
8.2 Summary of major findings ..........................................................................................127
8.2.1 Nutritional management in insulin pump therapy ..............................................127
8.2.2 Skills in carbohydrate quantification ......................................................................129
8.2.3 Effect of carbohydrate variations on postprandial glycaemia ............................132
8.3 Limitations of the research .......................................................................................133
8.3.1 Survey of nutritional management in insulin pump therapy ...............................133
8.3.2 Skills in carbohydrate quantification ......................................................................134
8.3.3 Effect of carbohydrate variations on postprandial glycaemia ............................134
8.4 Implications for clinical practice ..............................................................................135
8.4.1 Nutrition education in insulin pump therapy .......................................................135
8.4.2 Strategies to improve carbohydrate estimation skills ........................................137
8.4.3 Required accuracy in carbohydrate counting .....................................................140
8.5 Future research .........................................................................................................142
8.5.1 Nutritional management in insulin pump therapy ..............................................142
8.5.2 Carbohydrate estimation skills ................................................................. 143
8.5.3 Methods of carbohydrate quantification .................................................. 143
8.6 Summary ......................................................................................................... 144
References ............................................................................................................ 146
Appendix A: Survey of the nutrition education of children and adolescents on insulin pump therapy in Australia ................................................................. 176
Appendix B: Carbohydrate knowledge questionnaires of displayed real foods (Australian and UK versions) ................................................................. 180
Appendix C: Evidence of acceptance of paper: “In children using intensive insulin therapy, a 20 gram variation in carbohydrate amount significantly impacts on postprandial glycaemia.” .............................................................................. 189
Appendix D: Permission letters regarding copyright of published papers .......... 192
Table of Figures

Figure 2:1 Framework of Literature Review ........................................................................30

Figure 3:1 Number of patients with type 1 diabetes (< 18 yrs of age) at each center and the number on insulin pump therapy. ...........................................................................73

Figure 3:2 Issues covered in nutrition education sessions at insulin pump commencement .........................................................................................................................74

Figure 3:3 Issues covered in nutrition education sessions after insulin pump commencement .........................................................................................................................75

Figure 4:1 The relationships between mean gram error (A) and mean absolute gram error (B) by meal size and carbohydrate estimation method in 102 children and adolescents with type 1 diabetes on intensive insulin therapy and 110 primary caregivers who estimated 17 standard meals and snacks. There was no relationship between error and method of carbohydrate counting (● Gram increments □ 10 gram Portions ▲ 15 gram exchanges) (p>0.05). ........................................91

Figure 5:1 The variations in the reported, mean, minimum and maximum weights of slices of bread within and between 11 different loaves available in Australia. (♦) Reported weight; (▲) Mean weight; (●) Minimum weight; (■) Maximum weight ...................................................................................................................100

Figure 6:1 Mean postprandial glucose levels for meals of 50, 60 and 70grams of carbohydrate for 14 children on multiple daily injection therapy (MDI) and 17 children on insulin pump therapy (Pump). There was no difference between the insulin therapy groups at any time point for comparable carbohydrate loads (Repeated-measures ANOVA p>0.05). The error bars represent 95% CI’s. ....................112

Figure 6:2 Mean postprandial glucose levels for 31 children on intensive insulin therapy. There was no difference between the 50 and 60gram and 60 and 70gram carbohydrate loads up to 150 minutes (p>0.05). There was a significant difference between the 60 and 70gram loads from 150 to 180 minutes (p<0.03). The error bars represent 95% CI’s. .........................................................................................................113

Figure 7:1 Postprandial glucose excursions for 34 children after meals containing 40g, 50g, 60g, 70g and 80g carbohydrate with an insulin dose calculated for 60 gram carbohydrate. .................................................................................................................124
**Table of Tables**

Table 2:1 Recommendations for carbohydrate intake for different insulin regimens ..........................................................................................................................................................35

Table 4:1 Demographic characteristics of children and adolescents by carbohydrate counting method ................................................................................................................................................90

Table 4:2 Mean absolute gram error of children and adolescents with type 1 diabetes and caregivers (n=212) by carbohydrate counting method and meal type .......................................................................................................92

Table 5:1 The variation in carbohydrate (CHO) contents between the minimum, maximum and the reported (a) slices of bread across 11 loaves (b) .........................................................................................................101

Table 6:1 Macronutrient composition for 50, 60 and 70 gram Carbohydrate Test Meals ........................................................................................................................................................................109

Table 6:2 Clinical characteristics of subjects by Insulin Therapy Group (Insulin Pump and Multiple Daily Injections (MDI)). ........................................................................................................................................111

Table 6:3 Mean preprandial BGL, one and two hour postprandial BGLs, peak BG excursion, time to peak BGL and two hour AUC above baseline for each test meal for 31 children and adolescents on intensive insulin therapy ........................................................................................................114

Table 7:1 Macronutrient composition for 40, 50, 60, 70 and 80 gram Carbohydrate Test Meals ...............................................................................................................................................................................121
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.