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Welcome to
Allied Health Telehealth Virtual Education

Counting the Carbs, Fats and Protein in Type 1 Diabetes
—Translating the Research into Clinical Practice

Dr Carmel Smart, PhD
Senior Specialist Paediatric Endocrine and Diabetes Dietitian
Hunter New England Clinical Research Fellow
John Hunter Children’s Hospital

Please complete your online evaluation at https://www.surveymonkey.com/r/TranslatingResearch
Presentation Objectives

- What matters in Nutrition Management of Type 1 Diabetes
- Clinical studies examining:
  - Accuracy required in carbohydrate counting
  - Glycaemic effects of fat and protein
- Translating this evidence into clinical practice – Calculating the meal-time insulin dose

WHAT IS TYPE 1 DIABETES?

- Autoimmune disease of beta cells of pancreas
- Beta cell destruction → inability to produce insulin → absolute insulin deficiency → requirement for exogenous insulin
- Cause unknown
  - Interaction between genetic predisposition and environmental triggers

The pancreas sits behind the stomach

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WHAT IS TYPE 1 DIABETES?

- Represents approximately 10% of all diabetes in Australia
- Onset may occur at any age
- Typically begins in childhood
- Peak age at diagnosis 10-14 years

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TYPE 1 DIABETES INCIDENCE BY AGE


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Rising Incidence of T1D

Clinical Management in 2016

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The John Hunter Children’s Hospital

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Recommended Staff Ratios

<table>
<thead>
<tr>
<th>ISPAD per 100 patients</th>
<th>JHCH per 100 patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doctor</td>
<td>1.0</td>
</tr>
<tr>
<td>Nurse Educator</td>
<td>1.0</td>
</tr>
<tr>
<td>Dietitian</td>
<td>0.5</td>
</tr>
<tr>
<td>Social Worker</td>
<td>0.2</td>
</tr>
<tr>
<td>Psychologist</td>
<td>0.3</td>
</tr>
<tr>
<td>Doctor</td>
<td>0.3</td>
</tr>
<tr>
<td>Nurse Educator</td>
<td>0.5</td>
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<tr>
<td>Dietitian</td>
<td>0.25</td>
</tr>
<tr>
<td>Social Worker</td>
<td>0.2</td>
</tr>
<tr>
<td>Psychologist</td>
<td>0.0</td>
</tr>
</tbody>
</table>

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**Glycaemic Targets**

<table>
<thead>
<tr>
<th>Age group</th>
<th>HbA1c (%)</th>
<th>BGL before meals (mmol/L)</th>
<th>BGL Post meals (mmol/L)</th>
<th>Bedtime (mmol/L)</th>
<th>Nocturnal (mmol/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADA(20)</td>
<td>&lt;7.5%</td>
<td>6.0-10.0</td>
<td>5.0-10.0</td>
<td>6.2-11.1</td>
<td>6.2-11.1</td>
</tr>
<tr>
<td>0-6 years</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7-12 years</td>
<td>&lt;7.5%</td>
<td>5.0-7.2</td>
<td>5.0-10.0</td>
<td>5.0-8.3</td>
<td>5.0-8.3</td>
</tr>
<tr>
<td>13-19 years</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>adults</td>
<td>&lt;7.5%</td>
<td>3.9-7.2</td>
<td>&lt;16.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISPAD(19)</td>
<td>All age groups</td>
<td>&lt;7.5%</td>
<td>5.0-8.0</td>
<td>5.0-10.0</td>
<td>6.7-10.0</td>
</tr>
<tr>
<td>NICE(21)</td>
<td>Children and young people</td>
<td>&lt;7.5%</td>
<td>4.0-8.0</td>
<td>&lt;10.0</td>
<td></td>
</tr>
<tr>
<td>adults</td>
<td>&lt;7.5%</td>
<td>4.0-7.0</td>
<td>&lt;9.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>APEG/ADIS(15)</td>
<td>Infants and young children</td>
<td>&lt;7.5%</td>
<td>5.0-10.0</td>
<td>6.0-12.0</td>
<td></td>
</tr>
<tr>
<td>Young people</td>
<td>&lt;7.5%</td>
<td>4.0-7.0</td>
<td>5.0-10.0</td>
<td>6.0-10.0</td>
<td>5.0-8.0</td>
</tr>
<tr>
<td>Adults</td>
<td>&lt;7.0%</td>
<td>3.9-9.7</td>
<td>5.0-10.0</td>
<td></td>
<td>&gt;3.6</td>
</tr>
</tbody>
</table>

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**Average HbA1c by Year (JHCH)**

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### Insulin Regimens and Dietary Management

<table>
<thead>
<tr>
<th></th>
<th>MDI</th>
<th>Insulin Pumps</th>
<th>Twice Daily</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexibility in meal times</td>
<td>✓</td>
<td>✓ ✓ (Routine important!)</td>
<td>X</td>
</tr>
<tr>
<td>Flexibility in carbohydrate quantity</td>
<td>✓</td>
<td>✓ ✓</td>
<td>X</td>
</tr>
<tr>
<td>Can skip main meals</td>
<td>X</td>
<td>✓ (Not advised!!)</td>
<td>X</td>
</tr>
<tr>
<td>Snacks can be large</td>
<td>Only if extra injection</td>
<td>✓</td>
<td>X</td>
</tr>
</tbody>
</table>

### Insulin: Carbohydrate Ratio

- Allows adjustment of the insulin dose for the amount of carbohydrates in the meal
- Carbohydrate amount can be measured in grams, portions in grams, portions (10g) or exchanges

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Eating Routines: Main meals and small snacks

Meal Routines for MDI

- DAFNE participants found that imposing a meal structure helped improve glucose readings
- Forward planning meals assisted carbohydrate counting
- Initial education by Educators should focus on promotion of routines to assist with implementation of flexible MDI and carb counting

Rankin et al Diab Med 2012

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In 550 children and adolescents with type 1 diabetes (2-19 years) on intensive therapy a routine meal pattern was associated with lower blood glucose levels. Overby et al, Diabetologia 2007

What about snacking?

Norwegian study reported more than 2 snacking events associated with higher HbA1c, higher intake of added sucrose and more time watching TV. Overby et al Ped Diab 2008

More snacking events worsened glycaemic control and less healthy dietary and leisure habits.
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**The Grazers!**

- Supervision of finger prick and insulin dose
- Discuss carbohydrate amounts
- Promote nutritious family foods
- Teaching opportunity

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**Meal Routines are Important (for all the family)**

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Background- Meal Time Insulin

- **Carbohydrate counting** current standard of practice
- Recent focus on impact of fat and protein
- Growing call to consider fat and protein when calculating meal time insulin

Carbohydrate Counting

- Can count carbohydrate in
  - Grams
  - Portions = 10 grams CHO
  - Exchanges = 15 grams CHO
- **Differ in complexity and what food is counted**

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Carbohydrate Counting

- Based on assumption that CHO is the only macronutrient which significantly raises BGL's
- Assumes a linear association between CHO and insulin

Our studies demonstrated that insulin covers a range in CHO amount

A strict emphasis on carbohydrate quantity over quality may lead to unhealthy eating practices

Mehta et al Diab Care 2009

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How accurately do children need to count carbohydrate to maintain optimal control?

- 36 well controlled children (9-17 years) on MDI or CSII from two centres (Newcastle, Australia and Oxford UK)
- 3 days with CGMS
- 3 standardised lunches – variable carbohydrate amount (50, 60 and 70g)
- Same insulin dose for each lunch (based on an individualised dose for 60g CHO)

Smart et al Diabetic Medicine 2009

A single meal time insulin dose covers a ± 10g range in CHO quantity

Smart et al, Diab Med 2009: 26:279-85

Please complete your online evaluation at https://www.surveymonkey.com/r/TranslatingResearch
Small inaccuracies in carbohydrate intake at a meal (<10 grams) do not increase risk of hypoglycaemia or hyperglycaemia

What is the impact of a 20 gram variation in carbohydrate on blood glucose control?

- 37 well controlled children (mean HbA1c= 7.2%) on MDI or CSII from JHCH, Newcastle, NSW
- 5 days with CGMS
- 5 standardised meals – variable carbohydrate amount (40, 50, 60, 70 and 80g)
- Same insulin dose for each meal (based on an individualised dose for 60g CHO)

40g CHO  60g CHO  80g CHO

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Inaccuracy of 20g CHO causes Hypoglycaemia and Hyperglycaemia

Insulin dose given for 60g CHO Test Meal

• 40g CHO Test Meal
  • 1 in 3 children (31%) had hypoglycemia (p<0.003)

• 80g CHO Test Meal
  • More likely to cause BGLs ≥ 12mmol/l (p<0.001)

Smart et al Diab Med 2012;29:21-4

Hypoglycaemia or hyperglycaemia for inadequate or excessive carbohydrate intake (>15g cho) usually occurs 2–2½ hours after the meal, not immediately.

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Bolus Before Meals

It is possible to safely bolus before meals for all age groups, including toddlers using multiple daily injections.

Insulin Before Eating

- Insulin takes time to act
- Even if you don't know exactly how much will be eaten, giving insulin before food is more important
- Meal routines help with predicting food intake
- Giving insulin afterwards makes it more likely it is forgotten

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Timing of insulin delivery

Timing of insulin delivery

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Carbohydrate Counting: Can People count Carbs?

- Can people with T1D educated in routine clinical practice count carbohydrate?

Children aged 8-18 years on intensive therapy and their caregivers recruited from two paediatric diabetes centres – Newcastle, Australia and Oxford, UK

Child and parent completed questionnaire independently using a method of carbohydrate counting they had been taught.

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4/08/2016

Conclusions

Teaching CHO counting in gram increments did not improve accuracy compared with CHO portions or exchanges.

Large meals tended to be underestimated and snacks overestimated.

Re-measure carbohydrate amounts at least every three months.

Smart et al. Diab Med 2010

40g Carb 60g Carb

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When Should We Teach Carb Counting?

Principles reinforced from diagnosis

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Team Approach

10 Essential Habits for a Healthy and Happy Person with Diabetes

- **HYDRO/EXERCISE**

1. Start before you are at a meal. Lose and lower with applicable fluids. Take your meals regularly every day.
2. Check BG at least 1-2 times a day and overnight, last 3-4 times a week. Avoid all meals to a meal.
3. Use the test strips to test BG levels: between 3.5-7.0
4. Eat for your health, BG control is important for life.
5. Keep your BG control at a normal level throughout all meals.

- **MEDICATIONS**

1. Take your medication as prescribed. Keep your BG control at a normal level throughout all meals.
2. Always consult your healthcare provider before starting any new medication.
3. Avoid taking any medication without consulting your healthcare provider. Always consult your healthcare provider before starting any new medication.
4. Regular exercise is important for a healthy lifestyle and for maintaining good BG control.
5. Basic habits should be changed for an adult with type 2 diabetes. This includes changing eating habits, exercise levels, and overall lifestyle.

- **THE PLAN**

1. Visit your Diabetes Team regularly. See your Doctor every 3 months and Diabetes Educator, Dietitian and Social Worker at least once a year.
2. Please complete your online evaluation at [https://www.surveymonkey.com/r/TranslatingResearch](https://www.surveymonkey.com/r/TranslatingResearch)
Beyond CHO Counting

Clinical evidence suggests other macronutrients should be considered in insulin dosage and delivery

Pizza causes late, sustained postprandial hyperglycemia

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Both Dietary Protein and Fat Increase Postprandial Glucose Excursions in Children With Type 1 Diabetes, and the Effect Is Additive

Study Aim:
To examine the **separate** and **combined** effects of high protein and high fat meals, all with the same carbohydrate amount, on postprandial glycaemia in children using intensive insulin therapy.

Glucose Excursions for a Low Fat versus High Fat Meal

![Graph showing glucose excursions for low fat (LF) and high fat (HP) meals.](image)

- **3.5mmol/L**
- **63mg/dL**
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**Glucose Excursions for a Low Protein versus High Protein Meal**

![Graph showing glucose excursion](image1)

- Mean glucose excursion (mmol/L)
- 2.6 mmol/L
- 47 mg/dL

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**Glucose Excursions for a High Fat, High Protein Meal versus Low Fat, Low Protein Meal**

![Graph showing glucose excursion](image2)

- Mean glucose excursion (mmol/L)
- 5.4 mmol/L
- 97 mg/dL

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Hypoglycaemic Events

- Difference in hypoglycaemia between meal types (P=0.003)
- Reduction in hypoglycaemia after HP meals (Odds ratio = 0.16; P<0.0001)
- No reduction in hypoglycaemia after HF meals (Odds ratio = 0.50; P=0.08)

Clinical Translation

- Encourage healthy and balanced eating
- Most relevant meal to act on is evening meal
- If BGLs high 3-5 hours after eating does not mean inaccurate carbohydrate counting
- If wish to eat a high fat/high protein meal consider after a day of increased activity

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Research: Care Delivery

Influence of dietary protein on postprandial blood glucose levels in individuals with Type 1 diabetes using intensive insulin therapy

M. A. Paterson¹,², C. E. M. Smart³,⁴, P. E. Lopez¹,², P. McElhuff¹, J. Attia¹, C. Morley⁵ and B. R. King⁶,⁷,⁸
¹Hunter Medical Research Institute, School of Medicine and Public Health, University of Newcastle, Callaghan, NSW, ²Faculty of Health, School of Medicine, University of Newcastle, ³University of Newcastle, ⁴Department of Paediatric Endocrinology and Diabetes, John Hunter Children’s Hospital, ⁵University of Newcastle, and ⁶Pet Diabetes Management Centre, Newcastle, NSW, Australia

Study Aim:

To examine the effects of protein alone (independent of CHO and fat) on postprandial glycemia in people with type 1 diabetes using intensive insulin therapy.

Protein only meals had no impact on postprandial BGL’s in the first 120 mins

20g CHO ONLY

Protein ONLY

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75 and 100g protein meals increased BGL’s at 300 mins

2.0 mmol/L
36 mg/dL

What is the impact of Protein with CHO on blood glucose levels?

Study Aim:
To determine the effects of protein plus carbohydrate with NO FAT on postprandial glycemia in individuals with type 1 diabetes using intensive insulin therapy.

ATTD OR-Abstract 2016
Paterson MA, Smart CE, Lopez P, McElduff P, Moreby C and King BR.
If you experience connection problems 10 minutes prior to or during the session, please phone the HNE Telehealth Help Desk on 02 4985 5400 and select option 1.

30-60 mins: Dose response trend towards lower postprandial excursions with increasing protein.

180 -300 mins: Dose response trend towards higher postprandial excursions with increasing protein.

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Clinical Translation

- Large quantities of protein, equivalent to a large T-bone steak, cause delayed BGL rise.

- 5g protein alone equates to rise from ~1g CHO.

- Protein with CHO results in dose dependant changes in post-prandial glycemia.

- Impact of protein with CHO becomes clinically significant from ~25g protein.

What insulin dosing strategies work best for fat and protein?

1. Give additional insulin
2. Tailor bolus timing and delivery pattern.

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Insulin dosing for fat and protein

- Dose response when eaten as part of a mixed meal
- Insulin-to-carbohydrate ratio covers some fat and protein
- Individualised insulin-to-fat and insulin-to-protein ratios
- In practice currently we advise % insulin dose increments

High Fat and High Protein Meals
> 20g Fat and/or > 25g Protein

Please complete your online evaluation at https://www.surveymonkey.com/r/TranslatingResearch
If you experience connection problems 10 minutes prior to or during the session, please phone the HNE Telehealth Help Desk on 02 4985 5400 and select option 1

Clinical recommendations for high fat, high protein meals for pump therapy

- Tailor bolus type and delivery pattern = Combo bolus in 60:40% split over 2.5-3hrs (manuscript under review)

- Additional insulin = Increase dose by 20% initially, up to 35-40%. Beyond 160% → Significant hypoglycemia

Lopez P, Evans M, King BR, Jones T, Bell K, McElduff P, Davis E and Smart CE
ISPAD Abstract (Best Poster) 2015

- Individually adjust based on BG monitoring or CGM

Clinical recommendations for high fat, high protein meals for multiple daily injections

- Small correction bolus later in evening

- Additional insulin (approx 10-20%) 60-90 mins after meal

- Try pre-prandial regular insulin

- Approaches have not been investigated in clinical trials

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4/08/2016

Take Home Messages

- It is possible to introduce flexible insulin dosing with limited resources and achieve good outcomes
- Can use a simple carb counting method ie 15gm exchanges
- Flexible dosing does not imply grazing diet
- Gain team agreement on BGL targets and communicate same with your clinic. Specialist Dietitian key member.
- Supervision at meals/injections essential
- Always bolus before meals even for small children
- Fat and protein also impact BGLs

Thank you!

- The children and young people with Type 1 diabetes and their families who participated in these studies
- The Diabetes Team at the John Hunter Childrens Hospital

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Granting Bodies

- Diabetes Australia Research Trust Grant
- JDRF Grant
- Australasian Paediatric Endocrine Group (APEG) Grant
- John Hunter Children's Hospital Charitable Trust Grant
- Hunter New England Health Clinical Research Fellowship

Please complete your online evaluation at https://www.surveymonkey.com/r/TranslatingResearch