Advanced meal planning:

Carbohydrate, Protein and Fat counting

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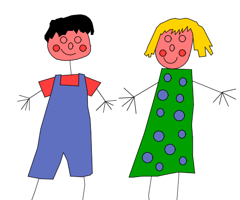
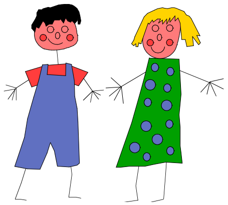




No conflict of interest to declare

What is new?

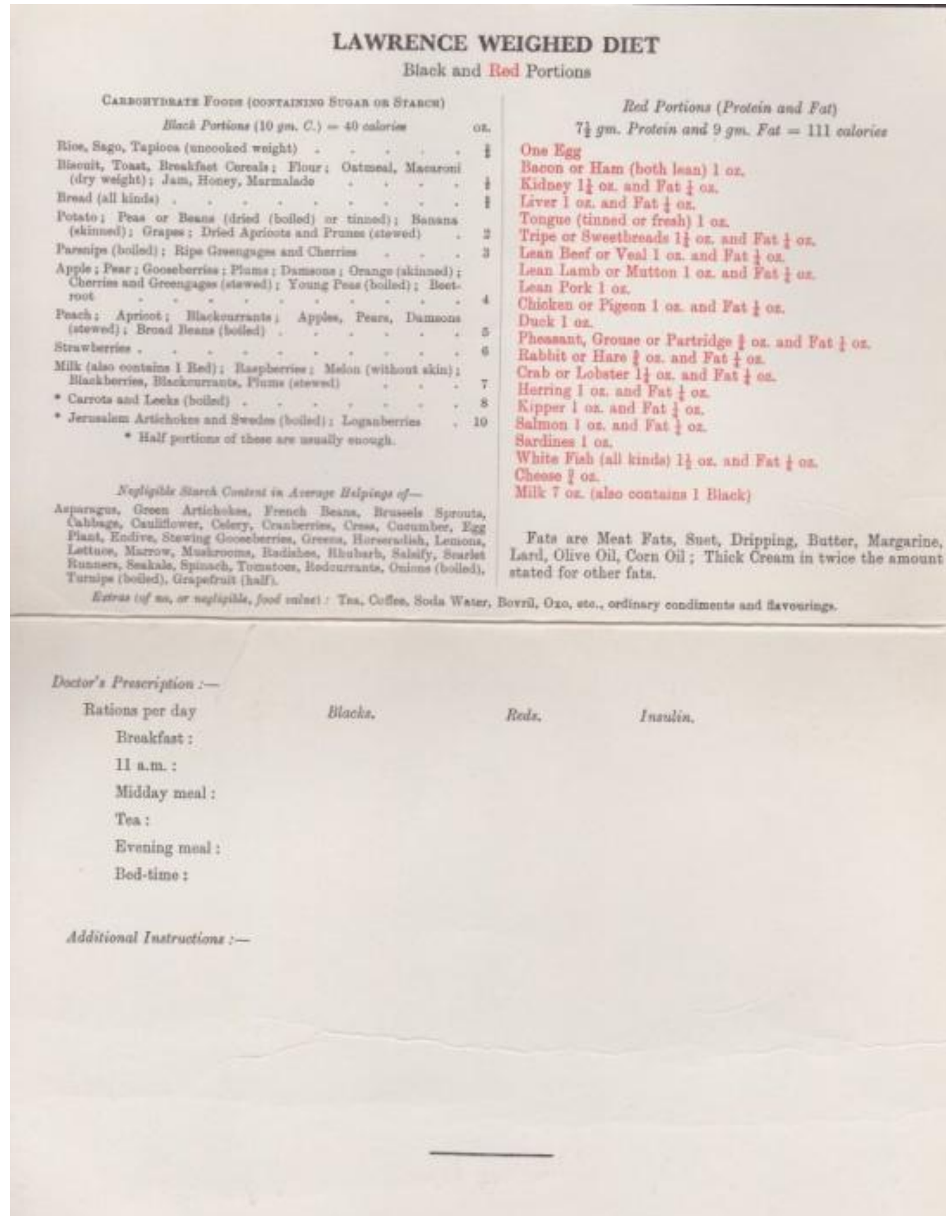
1963

Diet card for doctor to complete "diet prescription"

Black portions = 10g carbohydrate

Red portions = 7.5g protein and 9 g fat = 111 kcals.

Image courtesy of http://www.diabetes-stories.com/index.asp



LAWRENCE WEIGHED DIET

Black and Red Portions

CARBOHYDRATE FOODS (CONTAINING SUGAR OR STARCH)

Black Portions (10 gm. C.) = 40 calories	oz.
Rice, Sago, Tapioca (uncooked weight)	½
Biscuit, Toast, Breakfast Cereals; Flour; Oatmeal, Macaroni (dry weight); Jam, Honey, Marmalade	½
Bread (all kinds)	¾
Potato; Peas or Beans (dried (boiled) or tinned); Banana (skinned); Grapes; Dried Apricots and Prunes (stewed)	2
Parsnips (boiled); Ripe Greengages and Cherries	3
Apple; Pear; Gooseberries; Plums; Damsons; Orange (skinned); Cherries and Greengages (stewed); Young Peas (boiled); Beetroot	4
Peach; Apricot; Blackcurrants; Apples, Pears, Damsons (stewed); Broad Beans (boiled)	5
Strawberries	6
Milk (also contains 1 Red); Raspberries; Melon (without skin); Blackberries, Blackcurrants, Plums (stewed)	7
* Carrots and Leeks (boiled)	8
* Jerusalem Artichokes and Swedes (boiled); Loganberries	10

* Half portions of these are usually enough.

Negligible Starch Content in Average Helpings of—

Asparagus, Green Artichokes, French Beans, Brussels Sprouts, Cabbage, Cauliflower, Celery, Cranberries, Cress, Cucumber, Egg Plant, Endive, Stewing Gooseberries, Greens, Horseradish, Lemons, Lettuce, Marrow, Mushrooms, Radishes, Rhubarb, Salsify, Scarlet Runners, Seakale, Spinach, Tomatoes, Redcurrants, Onions (boiled), Turnips (boiled), Grapefruit (half).

Red Portions (Protein and Fat)

7½ gm. Protein and 9 gm. Fat = 111 calories

One Egg
Bacon or Ham (both lean) 1 oz.
Kidney 1½ oz. and Fat ¼ oz.
Liver 1 oz. and Fat ¼ oz.
Tongue (tinned or fresh) 1 oz.
Tripe or Sweetbreads 1½ oz. and Fat ¼ oz.
Lean Beef or Veal 1 oz. and Fat ¼ oz.
Lean Lamb or Mutton 1 oz. and Fat ¼ oz.
Lean Pork 1 oz.
Chicken or Pigeon 1 oz. and Fat ¼ oz.
Duck 1 oz.
Pheasant, Grouse or Partridge ¾ oz. and Fat ¼ oz.
Rabbit or Hare ¾ oz. and Fat ¼ oz.
Crab or Lobster 1½ oz. and Fat ¼ oz.
Herring 1 oz. and Fat ¼ oz.
Kipper 1 oz. and Fat ¼ oz.
Salmon 1 oz. and Fat ½ oz.
Sardines 1 oz.
White Fish (all kinds) 1½ oz. and Fat ½ oz.
Cheese ¾ oz.
Milk 7 oz. (also contains 1 Black)

Fats are Meat Fats, Suet, Dripping, Butter, Margarine, Lard, Olive Oil, Corn Oil; Thick Cream in twice the amount stated for other fats.

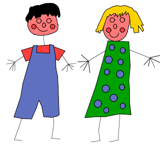
Extras (of no, or negligible, food value): Tea, Coffee, Soda Water, Bovril, Oxo, etc., ordinary condiments and flavourings.

Doctor's Prescription:—

Rations per day	*Blacks.*	*Reds.*	*Insulin.*
Breakfast:			
11 a.m.:			
Midday meal:			
Tea:			
Evening meal:			
Bed-time:			

Additional Instructions:—

Carbohydrate, protein and fat counting with bolus calculators and different bolus options

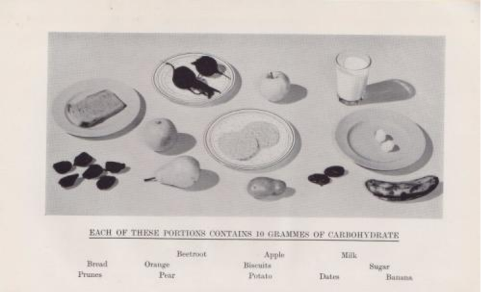


1963
Black and red portions

Dietary Management Full Circle!

Carbohydrate counting and insulin dose adjustment

Carbohydrate exchanges



Free diet based on high fibre healthy eating

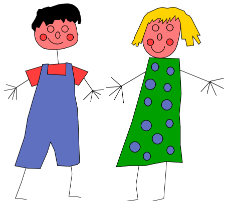
Glycaemic index

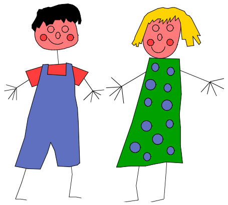
What have we learnt so far?

Taking a single aspect of diet in isolation and focusing all diet education on that one aspect – not effective

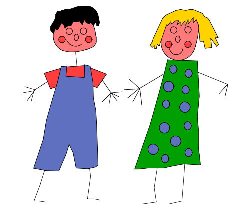
There is an increasing body of evidence for some benefits of each aspect of dietary management

Experience tells us dietary education should be simple and for the individual





Carbohydrate counting



DIABETICMedicine
DOI: 10.1111/j.1464-5491.2009.02669.x

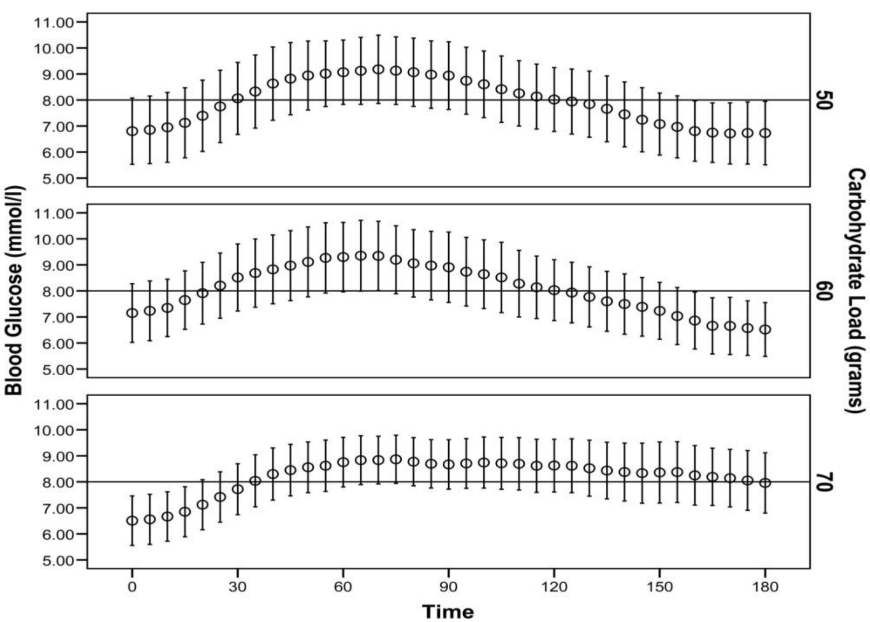
Original Article: Treatment

Children and adolescents on intensive insulin therapy maintain postprandial glycaemic control without precise carbohydrate counting

C. E. Smart*†, K. Ross‡, J. A. Edge‡, C. E. Collins†, K. Colyvas§ and B. R. King*

*Department of Paediatric Endocrinology, John Hunter Children's Hospital, †School of Health Sciences, Faculty of Health, University of Newcastle, Newcastle, NSW, Australia; ‡Department of Endocrinology and Diabetes, Oxford Children's Hospital, Oxford, UK and §School of Mathematical and Physical Sciences, Faculty of Science and Information Technology Newcastle, University of Newcastle, NSW, Australia

Accepted 31 December 2008

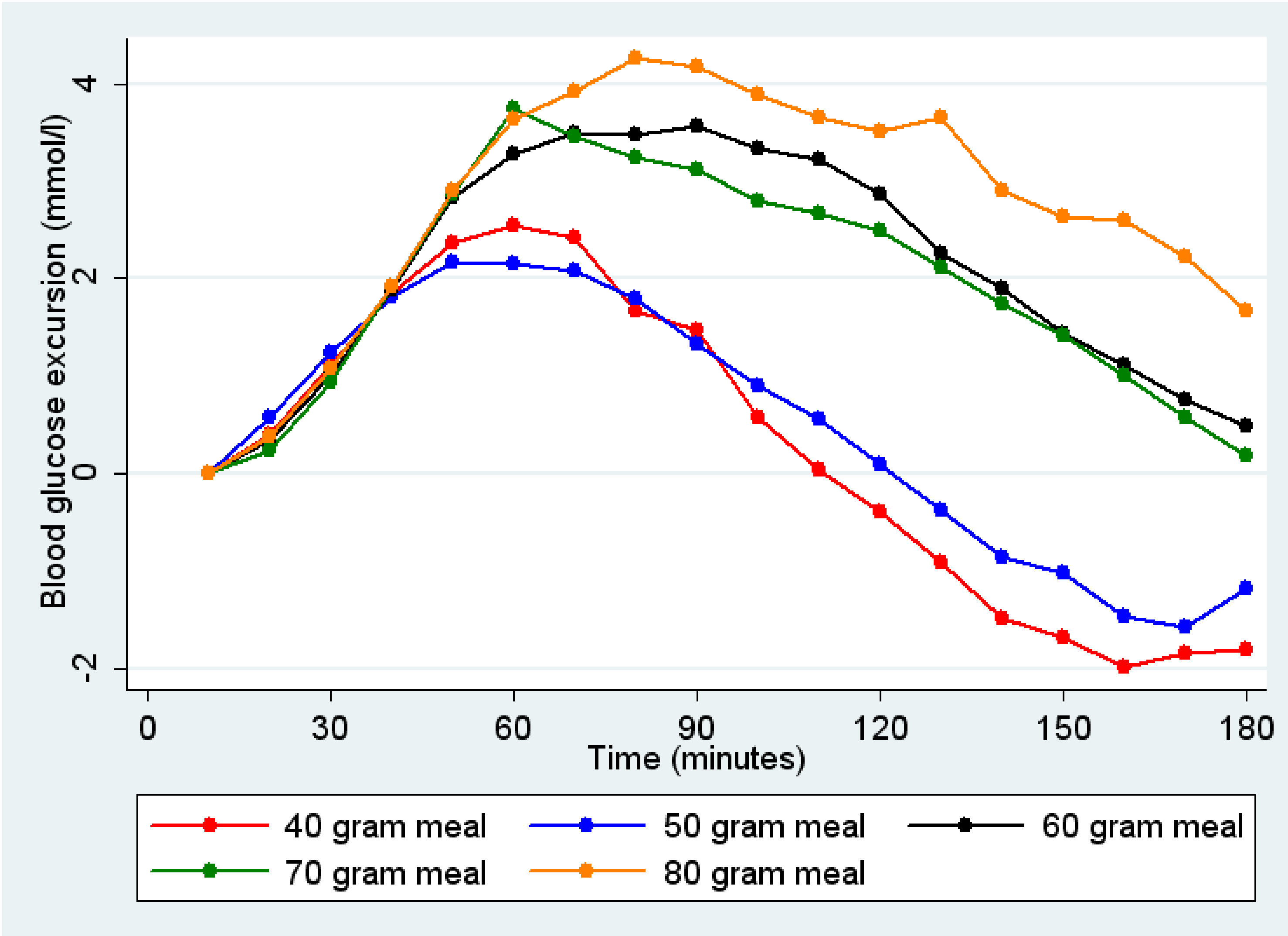


Three standardised lunches with variable carbohydrate of 50g, 60g and 70g. with Insulin dose based on individual ICR for 60g carbohydrate. Sensor recorded post prandial blood glucose analysed.

Conclusion:

A single meal-time insulin dose will cover a 10g range in carbohydrate amounts without deterioration in postprandial control

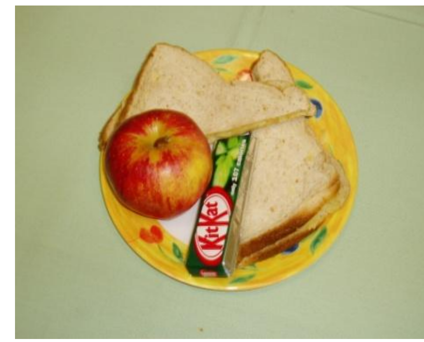
Second study – 40g to 80g meals
Mean postprandial glucose excursions for 37 children

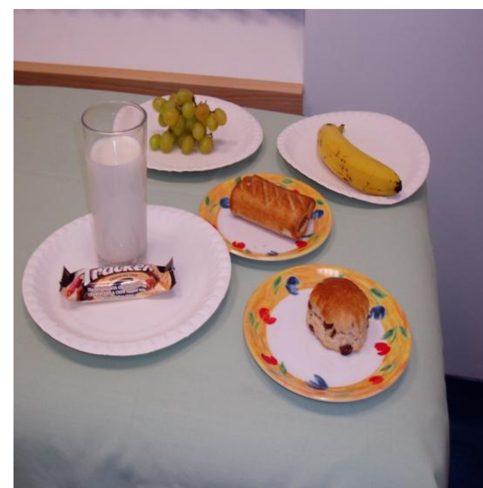


Can children with type 1 diabetes and their caregivers estimate the carbohydrate content of meals and snacks?

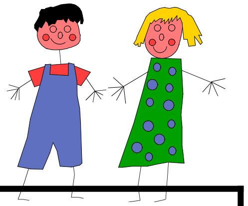
C.E. Smart, K. Ross et al, Diabetic Medicine 2010: 27, 348-353

17 different meals and snacks displayed
Independently estimated carbohydrate values using method they had been taught
Oxford – Gram counting or Carbohydrate portions (10 – 15g)
Newcastle – 15g carbohydrate exchanges



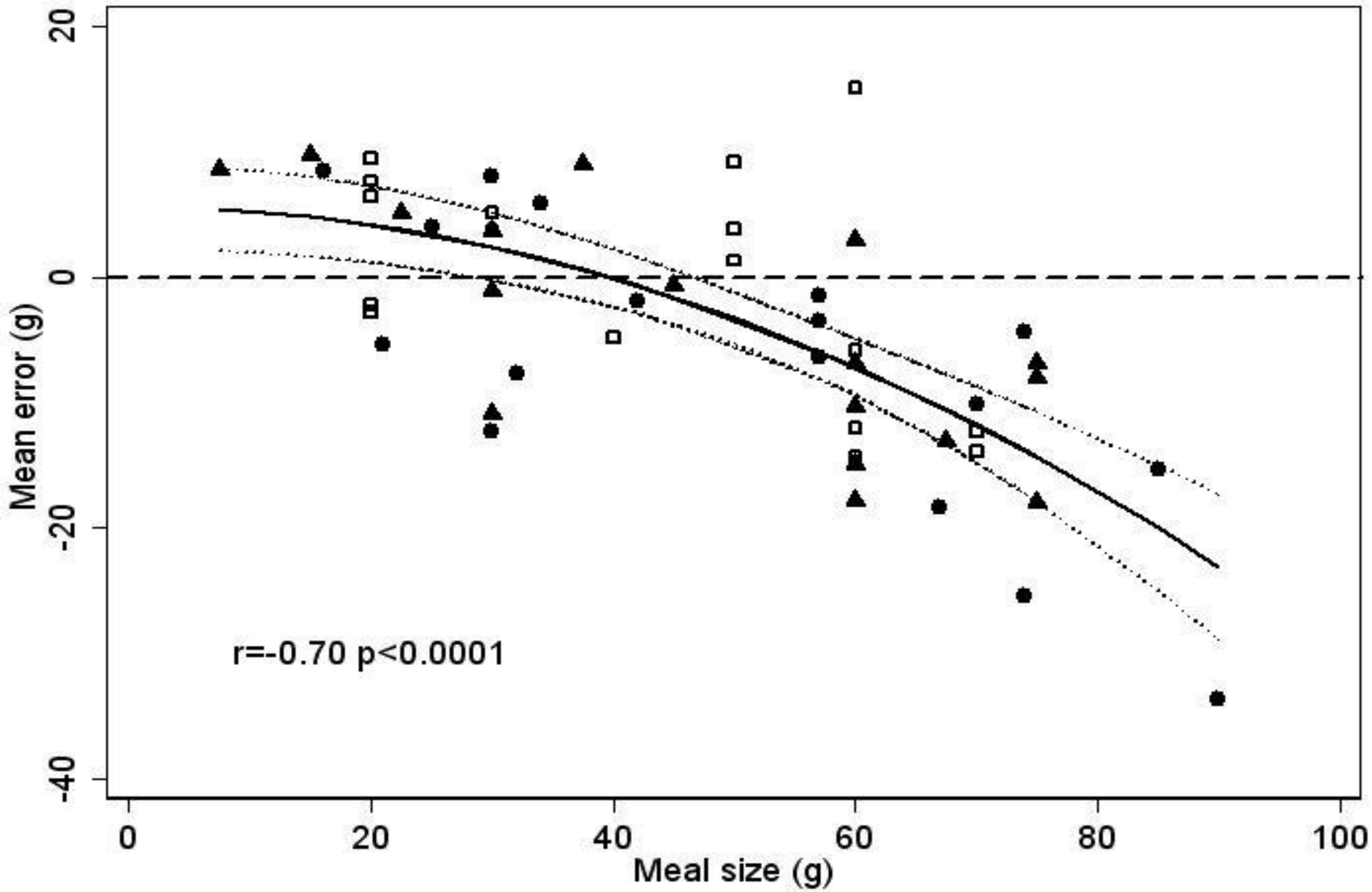


Results



	Grams (Oxford UK)	Portions (Oxford UK)	Exchanges (Newcastle Aus)	Total
Total number of meals estimated	1208	506	1736	3450
No. of meals within 7g or 0.5 portions or exchanges	435 (36%)	166 (33%)	877 (51%)	1478 (43%)
No of meals within 12g or 1 portion or exchange	762 (63%)	361 (71%)	1407 (81%)	2350 (68%)

Mean Gram Error (g) by Meal Size and CHO Estimation Method

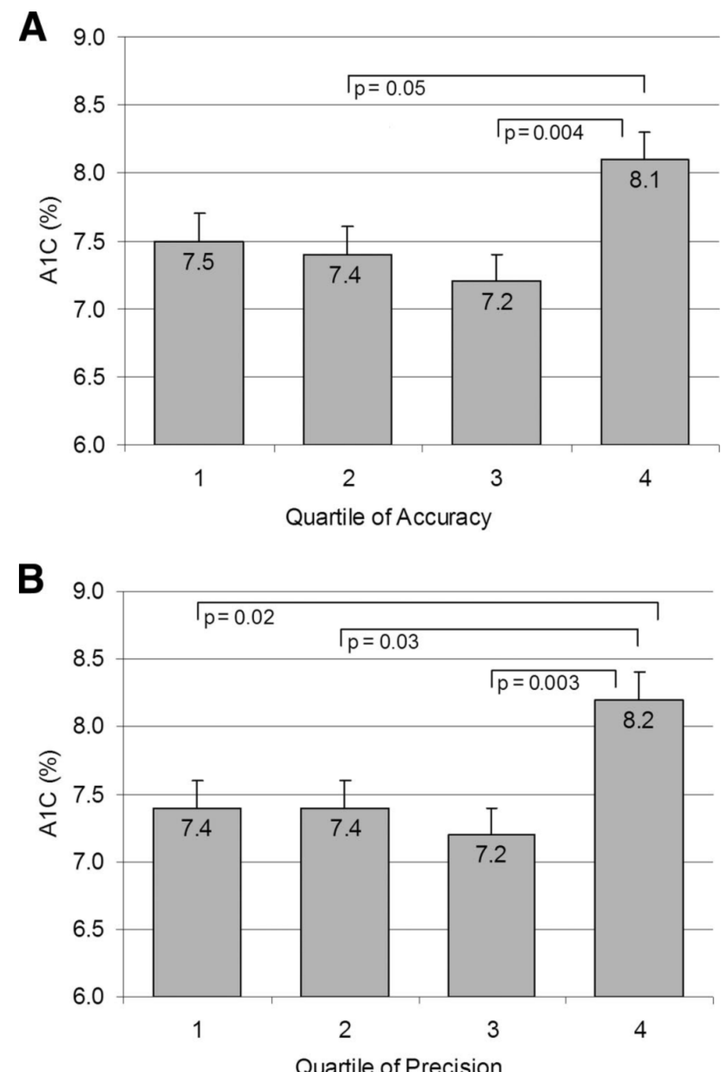


Gram increments 10g Portions 15g Exchanges
- Predicted value - - Upper and Lower 95% CI

Impact of Carbohydrate Counting on Glycemic Control in Children With Type 1 Diabetes

Mehta S. N. et al
Diabetes Care Vol 32; 6, June 2009

Group 1 - underestimation
Group 2 and 3 – most accurate
Group 4 – overestimation



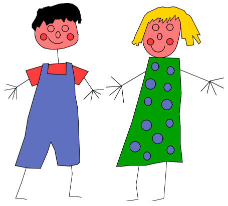
67 youth (70% CSSI) - Mean age 9.1 years
Telephone interview parents (2.7 per family)

1) Estimates of carbohydrate content for meals consumed during last 24hrs
2) Diet recall for analysis by Nutrition data software

Accuracy defined as ratio of estimated carbohydrate content to calculated carbohydrate content

Conclusion:
Parental carbohydrate counting knowledge was associated with lower HbA1c.
Precision was associated with 0.8% lower HbA1c
Also;
Lower HbA1c associated with more frequent blood glucose monitoring

Carbohydrate counting



Counting carbohydrate to an accuracy of 10g maintains post prandial blood glucose control

Consistency / Precision in counting carbohydrate alongside regular blood glucose monitoring can optimise HbA1c

- Use of smart meters, bolus calculators will assist this

BUT:

Carbohydrate counting does not control glycaemic excursion immediately following a meal.

Glycaemic index

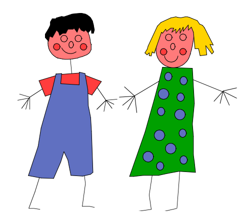
Low <55

Medium
55 - 70

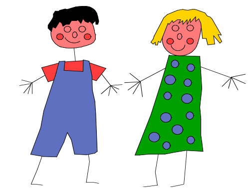
High >70

Choosing Low-GI foods in place of conventional or high GI foods has a small but clinically useful effect on medium term glycaemic control.

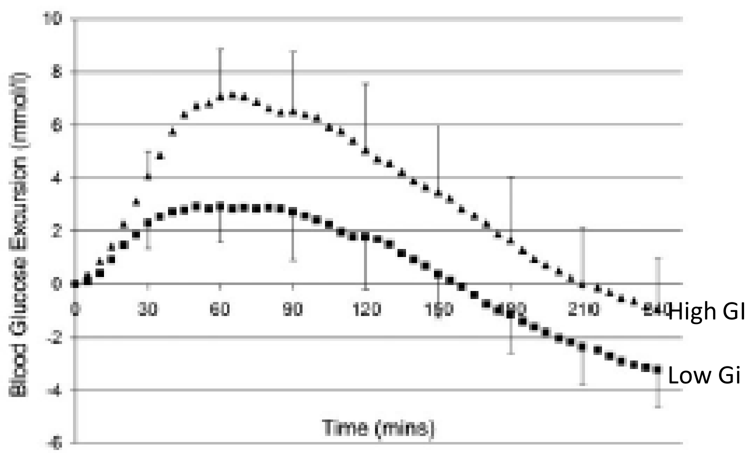
Meta-analysis of RCT’s using Low GI diets in management of diabetes.
Brand-Miller J. et al – Diabetes Care, vol 26, 8 August 2003

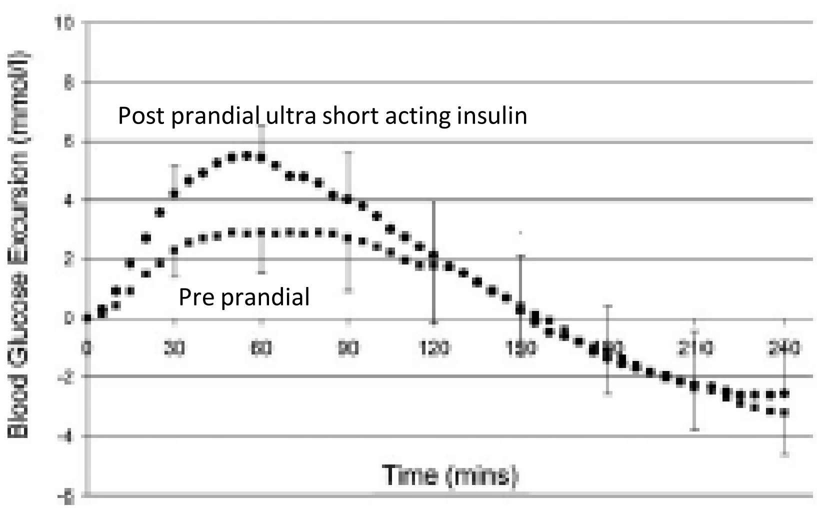


Influence of and Optimal Insulin Therapy for a Low-Glycemic Index Meal in Children With Type 1 Diabetes Receiving Intensive Insulin Therapy



Ryan R. L. et al. Diabetes Care, Vol 31; 8 August 2008





20 subjects, mean age 13.6 years
4 days study – test breakfasts

The 30 – 180 min postprandial glucose excursion was significantly lower for the low GI meal (Low GI white bread, apple juice = 54) than the high GI meal (regular white bread and energy drink = 71) with pre prandial ultra short acting insulin
The largest difference is 4.2 mmol/l at 60 mins ($p<0.0001$)

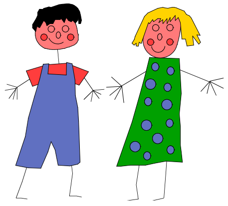
At 60 mins the blood glucose excursion was 2.5 mmol/l lower for the low GI meal with pre prandial insulin administration v post prandial insulin administration.

Effect of Varying Glycemic Index Meals on Blood Glucose Control Assessed With Continuous Glucose Monitoring in Youth With Type 1 Diabetes on Basal-Bolus Insulin Regimens

Nansal T. R. et al. Diabetes Care, Vol 31; 4 April 2008

20 youths (65% on pumps)
I day Low GI diet – peaches, kidney beans, brown basmati rice (40)
I day High GI diet – cornflakes, white bread, mashed potato (64)

Low GI diet - significantly lower mean daytime blood glucose levels
- no difference in night-time parameters
- greater amount of carbohydrate consumed per unit of insulin
- greater frequency of mild hypoglycaemia
- reasses ICR for Low GI meals



Optimizing Postprandial Glycemia in Pediatric Patients With Type 1 Diabetes Using Insulin Pump Therapy

Impact of glycemic index and prandial bolus type

O'Connell M.A. et al. Diabetes Care, vol 31, 8; August 2008

20 young people on CSS1 and 10 healthy non-diabetic young adult controls
Open cross over study to examine four different meal and bolus combinations
Standard (100%) or dual wave bolus (50%:50% over 2 hours)

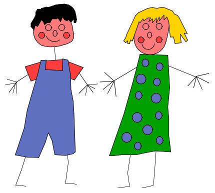
2 days Low GI meal – spaghetti bolognaise, apple (34)

2 days High GI meal – Boiled potato, bolognaise and watermelon (76)

Use of dual wave bolus instead of a standard bolus resulted in a 47% lower AUC for low GI meal

Pre meal bolus type had no effect on post prandial AUC for High GI meal

Conclusion:
Use of dual wave with low GI meals can optimise post prandial glycaemia.



Practicalities of using Glycaemic index

- Low Glycaemic index meals – reduce post prandial blood glucose levels
- Limiting food choice to only low GI options = restrictive
- Effect of mixed meals = Glycaemic Load = complex calculations

Glycaemic Load – calculated $\dfrac{\text{GI x carbohydrate per portion}}{100}$

Coco Pops

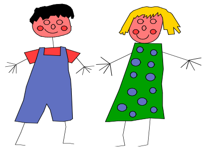
GI of 77 and food portion containing 33 g of carbohydrates has a GL of (77x33/100) =25

Pasta

GI of 41 and food portion containing 62g of carbohydrate has a GL of (41x62/100) = 25

So, Options?

1. incorporate low GI into healthy eating advise
2. Develop better understanding of benefit of lowering GI
3. Practical tips on how to lower GI of meals
4. For CSSI - encourage greater use of dual wave bolus options for lower GI meals



FAT AND PROTEIN

Increasing body of evidence that fat and protein contribute to glycaemia

- Delayed gastric emptying
- Increased free fatty acids and possible link to insulin resistance

Adult studies –
Wolpert et al: Diabetes Care, Vol 36; April 2013
Adults using closed loop had increased insulin requirements for 5 – 10 hours after a high fat of meal of equivalent carbohydrate content v low fat meal

ICR for high fat meal = 1 unit per 9g carbohydrate
ICR for low fat meal = 1 unit per 13g carbohydrate

Carstensen et al: Diabetologia (2010) 53; Supplement 1
Effects of standardised evening meals with standard or dual wave bolus for carbohydrate only and carbohydrate with fat/protein units on the nocturnal blood glucose levels of type 1 diabetes patients (CGMS for 12 hours)

Bolus for carbohydrate and fat/protein units resulted in blood glucose levels within target range for a greater proportion of time

Both Fat and Protein Increase Postprandial Glucose Excursions in Children with Type 1 Diabetes and the Effect is Additive

Carmel Smart, Elizabeth Davis, Bruce King, Patrick McElduff, Megan Evans, Susan O'Connell, Prudence Lopez, Timothy Jones

Diabetes Care, Volume 36, December 2013; 3897-3902

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Telethon Institute for Child Health Research

Princess Margaret Hospital for Children

Meal A	Meal B	Meal C	Meal D
Standard CHO	Standard CHO	Standard CHO	Standard CHO
Low Fat	High Fat	Low Fat	High Fat
Low Protein	Low Protein	High Protein	High Protein

Recruitment Period

Run-in Period

Monday Insert CGM Sensor

Tues/Wed/Thurs/Fri Mornings A, B, C, D

1. Fasting BGL → 2. Insulin bolus or injection → 3. Test meal A,B,C or D

4. No snacks/activity (5 hrs)

Lunch → Usual activities and insulin

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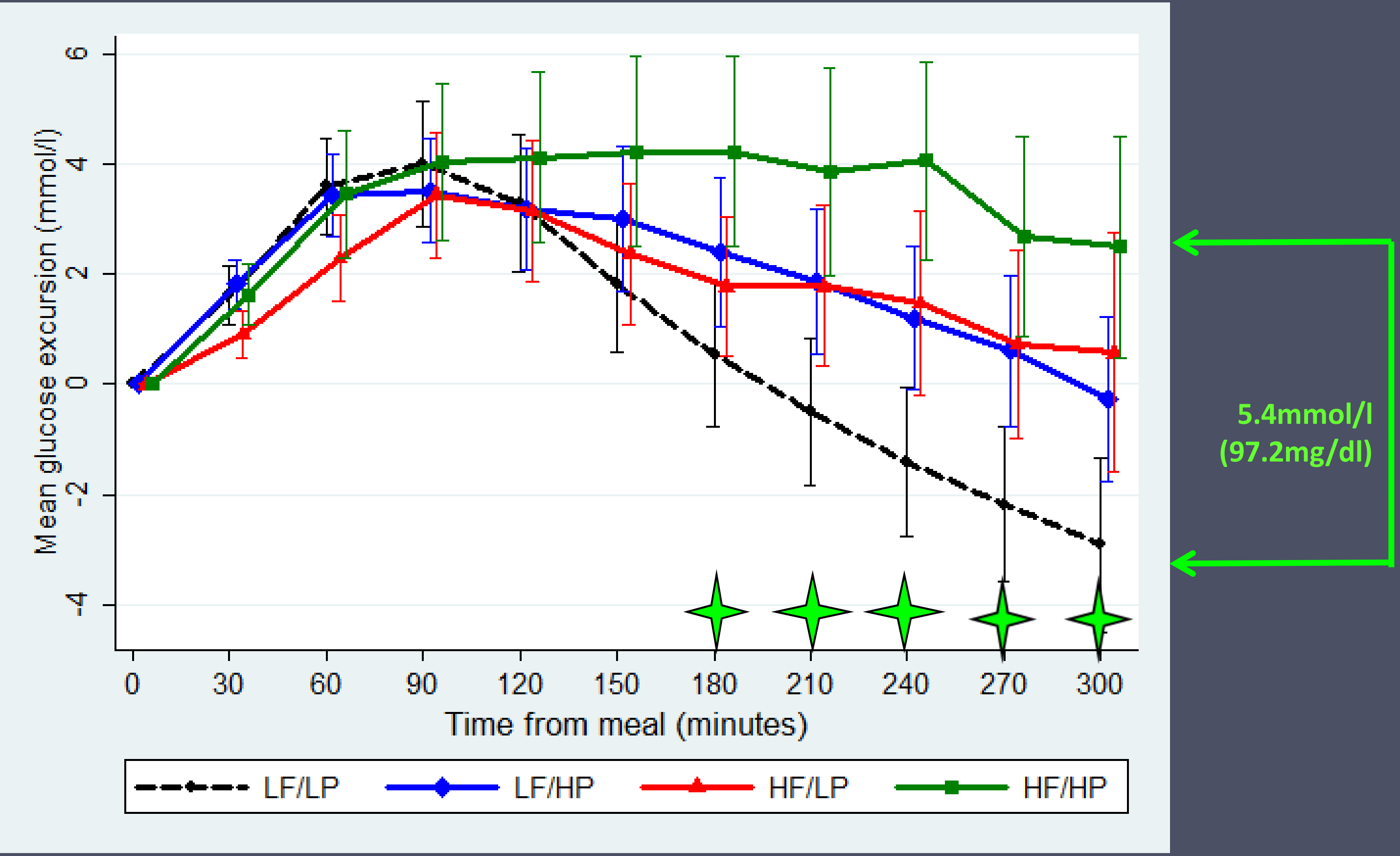
Mean Postprandial Glucose Excursions for all Meal Types



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Impact of Fat and Protein

- The effect was additive at all time points after 150 min
- At 180 mins glucose excursion was
  - **LF/HP 2.4** mmol/L
  - **HF/LP 1.8** mmol/L
  - **HF/HP 4.2** mmol/L

Hypoglycemic Events (n=29)

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

Conclusions

- Meals high in protein or fat cause hyperglycemia
- Protein and fat have an additive impact
- Protein may have protective effect on hypoglycemia
- Protein and fat should be considered in prandial insulin dose and distribution

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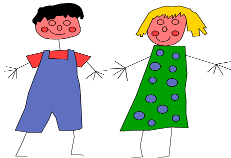
Ewa Pankowska Group

Department of Paediatrics The Institute of Mother and Child, Warsaw, Poland.

Patients using at least one dual/square wave bolus per day calculated for meal carbohydrate and fat and protein had lowest HbA1c
Pediatric Diabetes 2009: 10; 298 – 303

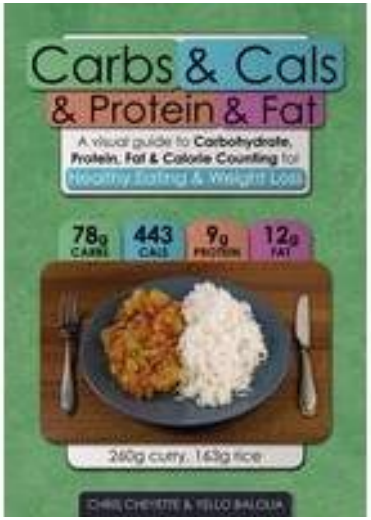
A mixed meal elevates postprandial glycaemia after 4 – 6 hours and that a dual wave bolus calculated for carbohydrates, fat and protein is effective in controlling postprandial glycaemia
Diabetes Technology and Therapeutics, Vol 14, No 1 2012

Use of a software package (*Diabetics*) to calculate bolus for carbohydrate , fat and protein improved post prandial BG levels when compared to manual calculations
Pediatric Diabetes 2012: 13: 534-539



Fat and Protein units!!

(Pankowska et al; Paediatric Diabetes 2009



Calculate insulin for carbohydrate

- Eg 1 unit per 10g
- Add on 1 unit per 100Kcals from Fat and Protein

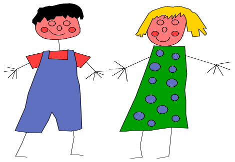
So: Thin and crispy Cheese and Tomato Pizza (Half)

387 calories - 54.8g carbohydrate
18.2g protein = 73 calories
10.5g fat = 94.5 calories

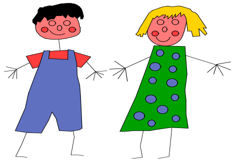
So, 55g carbs = 5.5 units insulin

73 + 94 = 167 calories from fat and protein = 1.7 units
Total dose for meal = 7.2 units.
Deliver as extended wave or mulitwave over 3.5 hours

(1 FPU = 3hrs, 2FPU = 4hrs, 3FPU = 5 hrs, >3FPU = 8hrs



Simplify ?



Just count fat! – Use 10 kcals per gram!

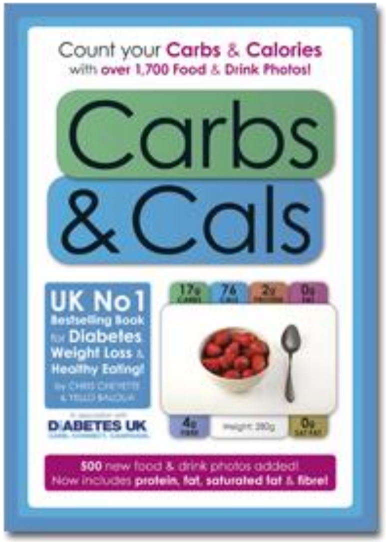
So – would divide carbohydrate by 10 and fat by 10 to get number of units of each!

Cheese and tomato pizza:
54.8g carbohydrate = 5.5 units
10.5g fat = 1 unit - deliver over 3 hours - Close enough??

OR - Teach calorie counting

Total kcals in a meal – carbohydrate kcals (g cho x 4) = F/P kcals
Divide F/P kcals by 100 = FPunits!

Cheese and tomato pizza:
54.8 g carbohydrate = 5.5 units
54.8 x 4 = approx 200 cals
387 – 200 = 187 cals from fat and protein
divide by 100 = 1.8units



FOOD INSULIN INDEX – the alternative?

Based on actual insulin response to isoenergetic portions of single foods

Values relate to reference food eg: Bread = FII value = 100

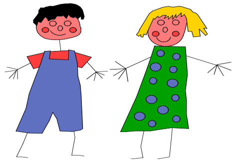
Would allow prediction of potential insulin requirement for mixed meals following calculation of weighted average FII

All foods would have a value.

However – very limited food data yet available

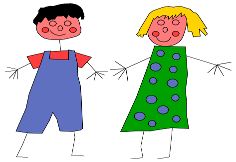
Food insulin index: physiologic basis for predicting insulin demand evoked by composite meals
Bao J, Jong V, Atkinson F, Petocz P, Brand-Miller J.

Am J Clin Nutr 2009; 90 986-92



Summary

1. Precise and consistent carbohydrate counting with correct ICR’s and regular blood glucose testing is a good start towards good glycaemic control
2. We can improve post prandial glycaemia during the day by greater use of Glycaemic index education
3. Introduce the concept of Fat/Protein units for evening meals to target evening and nocturnal glycaemia – possibly using a simplified system?
4. Await further research to inform the best system of insulin dose adjustment for Fat and Protein
5. Develop teaching material and experience to implement Fat and Protein counting
6. Await the development of technologies to assist the implementation of more advanced and complex meal insulin dosing



Carbohydrate, Fat and protein counting

THANK YOU