

Carbohydrate counting: Successful dietary management of type 1 diabetes

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Article points

1. Carbohydrate counting is a logical and involved process that is essential to facilitate successful insulin dose management in type 1 diabetes.
2. Multidisciplinary led group education is an ideal format to actively involve patients in the teaching and learning process.
3. People with diabetes who are willing to invest time and effort in their education can benefit from confidence in self-management skills, flexible diet and lifestyle with more predictable blood sugar levels.
4. Insulin dose adjustment is key to the management of diabetes but there is opportunity still to address other nutritional factors such as fat and the glycaemic index.

Key words

- Carbohydrate counting
- Blood glucose management
- Insulin

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If diet is the cornerstone of management for people with type 1 diabetes, then the understanding of carbohydrate intake and associated insulin adjustments are like the bricks and mortar that create glycaemic stability. Strict carbohydrate meal plans were abandoned in the 1990s but with the advancement of insulin therapies it is possible, in the author's experience, to more successfully match carbohydrate intake with insulin doses in order to mimic physiological insulin production. This article describes the evolution, principles and the practice of carbohydrate counting.

Carbohydrate counting is not a new concept. Soon after the discovery of insulin, Joslin recognised that the total glucose value of the diet could be used to determine required insulin doses (Joslin, 1927).

The 1980s

In the 1980s people with type 1 diabetes were expected to follow rigid meal plans with precisely controlled and often restricted carbohydrate portions (Nutrition Sub-Committee of the British Diabetic Association's Medical Advisory Committee, 1982). Many healthcare professionals still remember the 10 g 'exchange' system where the distribution of carbohydrates had to match inflexible twice-daily insulin regimens which were recommended at the time (Nutrition Sub-Committee of the British Diabetic Association's Medical Advisory Committee, 1982). This lost favour with the professionals and people with type 1 diabetes when new emphasis was placed upon leading a varied and 'normal' lifestyle

which includes different meal times, varying food choices and physical activities which do not complement a fixed-insulin action. In the author's opinion, accurate insulin dose adjustments were hard to achieve because of inaccurate blood glucose testing systems and the unpredictable nature of insulins available at the time; blood glucose testing systems were also time consuming by today's standards.

The 1990s

In the 1990s healthy eating was promoted to increase awareness among people with type 1 diabetes of the nutritional factors impacting on co-morbid risk factors of, for example, heart disease and hypertension (Nutrition Subcommittee of the British Diabetic Association's Professional Advisory Committee, 1992). Interest also turned to the glycaemic index (GI), which defines the variability of blood glucose responses to different carbohydrates of equal value in grams. Low GI diets improve some short-term outcomes in people with type 1 diabetes

treated with soluble insulin (Lafrance et al, 1998) and compare favourably against prescribed carbohydrate regimens in children (Price et al, 1993). The association between low-GI diets and improved cardiovascular risk factors and metabolic syndrome symptoms supported the argument against carbohydrate prescriptions (Frost and Dornhorst, 2000). Unfortunately, for those with type 1 diabetes, advice on healthy eating alone failed to make significant direct improvements to their glycaemic control (Heller, 1999).

The 2000s: Where there's technology, there's a way

As there was a move towards 'healthy' diets new insulin therapies also emerged. Rapid-acting insulin analogues have a quick but short duration of action that more closely resembles the body's natural glycaemic response to different carbohydrate loads than older insulins (King, 2003). In addition, basal insulin analogues allow individuals to achieve stable blood glucose levels independent of meals and meal insulin (King, 2003).

Such developments allow people with type 1 diabetes to enjoy a more 'normalised' flexible diet in that they can choose what and when they eat (according to food preference and appetite; Connor et al, 2003). Also, better blood glucose testing systems help people to monitor their blood glucose levels more accurately and thus make better self-management decisions (Diabetes Control and Complications Trial [DCCT] Research Group, 1993). These are elements of what is known as intensive insulin therapy.

Published evidence has highlighted the improvements in glycaemic control and health outcomes when the principals of intensive insulin therapy are applied (DCCT Research Group; 1993; Muller et al, 1999). Also, the re-introduction of insulin pump use in the UK has highlighted the need for insulin boluses to reflect carbohydrate intake (Everett and Kerr, 2000). Evidence from UK-based studies has demonstrated

significant improvements in glycaemic control, self-management skills, quality of life and dietary freedom for people with type 1 diabetes following intensive education in carbohydrate counting and insulin dose adjustment (Dose Adjustment For Normal Eating [DAFNE] Study Group, 2002; Everett et al, 2003).

In the USA, Australia and in insulin pump literature, carbohydrate servings are described in 15g portions. A recent consensus by UK-based centres involved in intensive insulin therapy (Type 1 Network meeting held in Oxford on 20 November 2003 involving a number of healthcare centres. Contact the author on emma.jenkins@rbch.nhs.uk for further information) advocates the continuation with 10g carbohydrate portions (so-called 'CPs') in the UK, in keeping with past descriptions (such as the 'exchange' system of the 1980s) which used 10g CPs, and in order to keep the maths simple for the individual. However, the size of food portions have increased over the years: therefore, the CP values of portions may also have changed.

Taking the right steps

A step-by-step process of carbohydrate counting is shown in *Table 1*. People with diabetes need to know which foods contain

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1. The re-introduction of insulin pump use in the UK has highlighted the need for insulin boluses to reflect carbohydrate intake.
2. A well-balanced diet should be encouraged for everyone with type 1 diabetes, there should be no restrictions on carbohydrate intake as long as the carbohydrate load is matched by the correct insulin dose.

Table 1. Carbohydrate counting and insulin dose adjustment, a step-by-step process.

1. Record blood glucose level.
2. Choose food and drink.
3. Calculate the carbohydrate value (carbohydrate portion [CP]) of the chosen foodstuffs.
4. Consider factors which may influence blood glucose responses, for example, fat content, glycaemic index, number of courses in the meal, any planned exercises.
5. Determine the insulin dose required according to the insulin:CP ratio and factors mentioned above.
6. Consider the need for correcting insulin doses according to pre-meal blood glucose levels.
7. Take insulin and enjoy meal. Insulin can be taken before, during or after the meal. The dose can also be split.
8. Record blood glucose response to the meal at the next pre-meal and occasionally 2 hours post-meal.

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1. Acceptable errors are made when eating out at restaurants but individuals can be taught precise correction doses to lower raised blood glucose levels to target.
2. Carbohydrate counting has become the acceptable way to manage type 1 diabetes in the UK.

Table 2. Reasons to consider delaying or splitting insulin doses.
<ul style="list-style-type: none"> ● Glycaemic index <i>Low glycaemic index foods such as porridge are more slowly digested</i> ● Total carbohydrate intake <i>Meals containing more than six carbohydrate portions are more slowly digested</i> ● Fat intake <i>High fat meals are more slowly digested</i> ● Gastroparesis ● Number of courses <i>Injection can be performed with the main course then another with or after the dessert</i> ● Hypoglycaemia <i>This must be treated before eating a meal. Insulin may then be delayed until the end of the meal</i>

carbohydrates and the CP value of their servings. Information is obtained from a variety of sources: reference tables, food labels, by weighing food, handy measures (spoons, cups, etc), and from comparing food photographs. This, initially, requires time and effort but with practise most people become familiar with their own food portions.

In the author’s opinion, a well-balanced diet should be encouraged for everyone with type 1 diabetes, there should be no restrictions on carbohydrate intake as long as the carbohydrate load is matched by the correct insulin dose. The emphasis is on understanding the CP value of food but consideration can still be made of the GI

Table 3. Some advantages of group education for people with type 1 diabetes, in the author’s experience.
<ul style="list-style-type: none"> ● Peer support ● Sharing experiences (vicarious learning) ● More efficient use of teaching resources ● More efficient use of staffing resources ● Greater opportunities for interactive teaching ● Less emphasis on didactic teaching ● Improved patient–healthcare professional relationship

and fat content, for example.

Meals eaten at restaurants are often the most difficult to assess. Sometimes it is a matter of guesswork. It is hard to get it right all of the time. Acceptable errors are made but individuals can be taught precise correction doses to lower raised blood glucose levels to target.

The insulin ratio

Fast-acting (meal-time) insulin doses are determined by using a ratio described as units of insulin per CP, mostly commonly as 1 unit per 10g of carbohydrate. This can be adjusted by half-unit increments and the general range is 0.5–3 units per CP. Some people use a different ratio for different meals according to variations in insulin sensitivity and daily activity levels. Insulin can be taken before a meal, during a meal, after a meal or as a split dose (*Table 2* shows reasons to consider delaying or splitting the doses). The effectiveness of an individual’s insulin:CP ratio is determined by monitoring his or her blood glucose response, ideally under controlled circumstances such as avoiding times following hypoglycaemia or exercise.

Looking for the best setting

Carbohydrate counting has become the acceptable way to manage type 1 diabetes in the UK (National Institute for Health and Clinical Excellence [NICE], 2003). Education tends to take place in group settings over a number of days either consecutively or spread over a number of weeks: examples include the DAFNE programme and the Bournemouth Type 1 Intensive Education (BERTIE) programme from Bournemouth Diabetes Centre (Everett et al, 2003). In the author’s experience many centres in the UK have adopted the group educational approach for teaching intensive insulin therapy. The actual timetabling and structure vary according to local resources and needs. NICE have outlined key criteria that centres should be working toward in order to achieve the provision

of structured education programmes for type 1 diabetes (NICE, 2003): they need to have a structured, written curriculum; they need to have trained educators; they need to be quality assured; they also need to be audited. There are many advantages to group education (see *Table 3* for examples), in particular the opportunity to share experiences and provide peer support.

An exciting journey for healthcare professionals

Education of type 1 diabetes for healthcare professionals provides them with exciting opportunities to extend their knowledge and educational skills. In the author's opinion it is not possible for a dietitian to effectively educate on carbohydrate values without making reference to insulin dose adjustments and vice versa for the diabetes specialist nurse. Is the role of the 'diabetes educator' emerging?

A type 1 diabetes network was set up in 2003 to provide a forum for centres to work towards establishing core teaching principles, course content and outcome measures, share and standardise patient resources, and also to support new centres that are keen to establish their own education programmes in order to meet the NICE criteria (Dyson et al, 2006).

What difference will you see in the person with diabetes?

People with type 1 diabetes who have attended an educational course on

carbohydrate counting and related insulin dose adjustment will hopefully be more confident in self-management skills and enjoy a more flexible lifestyle according to personal preferences. They should be more able to predict and interpret their glycaemic control. They, hopefully, will not be working with fixed insulin doses, but will be able to vary their insulin doses meal-by-meal according to its content and their lifestyle using insulin:CP ratios. Hopefully they will be educated to understand and question all aspects of their diabetes management. However, the author has concerns based on personal observations that individuals who enjoy a greater dietary freedom will gain weight, but this has not been formally identified and there are also good reasons for weight loss being achieved (see *Table 4*).

Conclusion

Fundamentally, carbohydrate influences blood glucose levels but carbohydrate counting is part of the whole process of insulin dose adjustment and management of blood glucose levels for people with type 1 diabetes. For those willing to invest time and effort into training and learning about diabetes, the potential benefits are an increase in self-management skills and the confidence to experiment with food and exercise. The advantages of group-based type 1 diabetes education are for both the person with diabetes and healthcare professional alike. ■

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1. People with type 1 diabetes who have attended an educational course on carbohydrate counting and related insulin dose adjustment will hopefully be more confident in self-management skills and enjoy a more flexible lifestyle according to personal preferences.
2. Knowledge of carbohydrate portions is still important so that the diet is more regulated (some people do have a naturally regular diet) to match the action of these insulins.

Table 4. Reasons why people with type 1 diabetes who enjoy a greater dietary freedom may gain or lose weight.

Gain weight	Lose weight
<ul style="list-style-type: none"> ● Eating more or larger servings of foodstuffs ● Eating food with a higher calory content than normal (for example, chocolate and biscuits) ● Forgetting about healthy eating principles – concentrating on carbohydrates only ● Efficient glucose storing with better insulin match ● Higher total dose of insulin 	<ul style="list-style-type: none"> ● Less total insulin ● Fewer snacks ● Skipping meals or eating smaller portions ● Eating to hunger rather than to treat hypoglycaemic events ● Treat hypoglycaemic events appropriately ● Feel well, therefore can do more exercise and burn more calories

‘For those willing to invest time and effort into training and learning about diabetes, the potential benefits are an increase in self-management skills and the confidence to experiment with food and exercise. The advantages of group-based type 1 diabetes education are for both the patient and healthcare professional alike.’



Photograph showing patients learning to estimate carbohydrate portions as part of their group education.

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