Debate: how low can you go?

The low-down on the low carbohydrate debate in type 1 diabetes nutrition

As a means of representing relevant issues to the diabetes community, *Diabetes Voice* will be providing a forum in which experts can examine controversial issues and provide an argument supporting their point of view. The low carbohydrate debate marks the first in a series of many more to come.

Since the advocacy of intensive insulin therapy following the Diabetes Control and Complications Trial, people living with type 1 diabetes have been subjected to broad nutrition and dietary advice, with varying opinions on the recommended total daily intake of carbohydrate. Current American Diabetes Association (ADA) guidelines suggest a flexible range of carbohydrate, protein, and fat tailored to meet individual preferences, emphasizing the need to monitor

and match insulin to carbohydrate intake as a means for achieving glycaemic control below or around an HbA_{1c} of 7%. More rigorous goals (<6.5%) are recommended for healthy younger people who have been recently diagnosed.

While low carbohydrate diets are recommended for weight loss as an effective short-term (up to two years) measure, there is less clarity regarding the utilization of very low (>30 g/day), or low carbohydrate (30-105 g/day) intake on a permanent basis. According to the ADA guidelines, the moderately low recommended daily allowance (RDA) for carbohydrate intake (130 g/day) is 'an average minimum requirement'. Many people complain that maintaining even a moderately low carbohydrate diet is counterproductive, making glycaemic

control difficult to achieve, especially when considering the targets for post-prandial excursion (1h post meal: ≤140 mg/dl (7.8 mmol/l) or 2h post meal: ≤120 mg/dl (6.7 mmol/l)). Many people with type 1 diabetes, especially those on insulin pump therapy, have opted out of a diet based on 50%-60% carbohydrate intake, and an 'underground movement' has prompted some endocrinologists with large numbers of type 1 patients to support their efforts.

We have asked two experts with opposing views to weigh in and answer the question:

Can a nutritional regimen based on low carbohydrate intake provide safe and more effective glycaemic control for healthy type 1 diabetes glycaemic management?

YES

Franziska Spritzler

The optimal carbohydrate intake for nutritional management of diabetes is a hotly debated topic among healthcare professionals and people with diabetes, including those with type 1. Severe carbohydrate restriction was prescribed for this population until 1922, when the discovery of exogenous insulin made possible the consumption of carbohydrate-containing foods, although often with less than ideal glycemic control.

While carbohydrates are the only macronutrient with any discernible impact on blood glucose levels, carbohydrate restriction is currently not considered an acceptable long-term option for diabetes management by most clinicians. The American Diabetes Association has stated that there is no one diet that suits every person, but the majority of dietitians and other healthcare professionals continue to recommend a moderate-to-high-carbohydrate, low-fat diet for people with diabetes. Arguments against carbohydrate restriction include the following: low-carbohydrate diets lack fibre and various micronutrients; diets high in fat, particularly saturated fat, increase the risk of heart disease; and eating fewer than 130 g of carbohydrate per day is unhealthy because this does not meet the glucose needs of the central nervous system (CNS). However, these claims need to be examined.

Fibre and all micronutrient needs can be met on a well-formulated low-carbohydrate diet without supplementation. Despite the oft-repeated message that saturated fat increases heart attack risk, this has never been proven; on the contrary, a recent meta-analysis of 21 studies of saturated fat and heart

disease led researchers to conclude that there is a lack of evidence to support an association between the two.[1] Consuming fewer than 130 g of carbohydrate daily poses no risk to health because most of the CNS and the body's other organs can safely use ketone bodies as a fuel source.[2] The few structures requiring glucose can meet needs via gluconeogenesis even with limited carbohydrate intake.

An inability to accurately estimate the amount of carbohydrate consumed coupled with varying rates of insulin absorption results in difficulty matching carbohydrate intake to insulin dosage. By reducing the carbohydrate content of meals significantly, there is less potential for inaccuracy, and blood glucose response becomes more predictable. For instance, dosing mealtime insulin for a vegetable omelet calculated at 10 g of carbohydrate rather than its actual value of 13 g carries considerably less chance of postprandial excursion than dosing for a meal of whole grain pasta, chicken, and vegetables estimated at 45 g that actually contains 70 g. Overestimating the amount of carbohydrate in the pasta meal and bolusing a larger dose of insulin places a person at high risk for hypoglycemia, a more urgent concern.

Research on low carbohydrate diets in type 1 patients is limited, but what exists is encouraging. Recent studies from Sweden in which individuals were instructed to consume 70-90 g of carbohydrates per day for up to four years found a significant decrease in HbA_{1c}, dramatic reduction in hypoglycemic episodes, and improvement in lipid profiles in those with good adherence.[3,4] For the motivated patient,

following a similar eating pattern or one containing even fewer carbohydrates could result in finally achieving healthy blood glucose levels, thereby reducing risk for microvascular and macrovascular damage.

A frequent criticism of carbohydrate restriction is that it is unsustainable long term. The number of people with type 1 diabetes who currently follow a low-carbohydrate diet is unknown, but data from online diabetes communities and anecdotal reports suggest it is fairly large and that the majority find it pleasurable, easy to follow, and practical. One well-known proponent, Dr. Richard K. Bernstein, has been consuming a very-low-carbohydrate diet (30 g/day) for more than 40 years. Still practicing medicine at age 78, he maintains normal blood glucose, HbA_{1c}, and lipid values and has virtually no diabetes-related complications.

A well-balanced low-carbohydrate diet – one containing 30-100 g of carbohydrate and a balance of protein, fat, and plants – can be a safe and effective method of attaining desirable blood glucose control and should be offered as an option for people with type 1 diabetes. Although not every person will want to limit carbohydrates in this way, dietitians and other healthcare professionals should support the efforts of those who do rather than try to discourage them. Of course, being followed and monitored by a physician, Certified Diabetes Educator, or other healthcare practitioner well-versed in carbohydrate restriction would be an important component of diabetes management. My hope is that in the near future, all people with diabetes will be afforded this opportunity.

NO

Carolyn Robertson

Ignoring the possible threat of weight gain or cardiovascular risk factors for the type 1 diabetes patient, the negative consequences of maintaining a low carbohydrate diet are evident when you review normal physiology. A number of tissues—mainly the brain, red blood cells and nerves – depend solely on glucose as fuel. These tissues cannot synthesize glucose, store more than a few minutes' supply, or concentrate glucose from circulation. When additional glucose is required, glycogen stores are utilized. However, this supply is limited by the daily intake of carbohydrate and by a limited capacity to store glycogen. The brain requires about 100 g of glucose daily and will typically deplete the liver's supply of glycogen by the end of an overnight fast.[5] Gluconeogenesis functions as the secondary system to assure a continued supply of glucose. The liver's glucose contribution assures that the brain can function regardless of the dietary actions of the individual. A low carbohydrate diet (less than 100 g/day) forces the system to use proteins and fats to create less efficient alternative fuels and potentially toxic by-products called ketoacids. This creates a situation where the body is releasing glucose into the blood stream in a totally unpredictable manner. Without predictability, the blood glucose control of a person who depends on insulin becomes unstable.

Without endogenous insulin, individuals with type 1 diabetes must calculate the time and the amount of insulin required to accommodate the differing sources of glucose. By using specific information - the amount, type and quality of carbohydrate; the blood glucose of the moment; the level of activity and the presence of confounding variables (amount of sleep, stress, infection, hormones etc.) - it is possible to determine how much exogenous insulin is needed.[6,7,8] Though challenging, the required insulin dose can be estimated to achieve near normal glucose levels after a meal. Non-dietary (i.e. endogenous) sources of glucose create an insulin-dosing problem since it is near impossible to predict when or how much glucose the liver will release. The person taking insulin is forced to either take insulin proactively and risk a low blood glucose level if the liver does not make its contribution or wait until the blood glucose rises before taking additional insulin. In both cases, blood glucose control is likely to be erratic.

Assume three different daily carbohydrate intakes for a person dependent upon insulin: more than 100 g/day; less than 30 g/day; and something in between 30 and 99 g/day. When the intake is over 130 g/day, the glycogen stored by the liver is sufficient to meet the needs of the brain for fuel. Gluconeogenesis, the production of glucose by the liver into systemic circulation, occurs but mostly at night or if there is an unexpected need for glucose (activity, stress for example).

With low carbohydrate intake, gluconeogenesis must supply the short fall. If the actual daily intake is less than 20 to 30 g/day of carbohydrate, gluconeogenesis is activated continuously and the liver releases a consistent amount of glucose. The insulin dose required to manage this glucose is mostly basal

and only small amounts are needed at meal times. However, this degree of carbohydrate restriction is extremely difficult to follow 100% of the time. Most people with diabetes cannot manage this tight regime, and their blood glucose control suffers.

A meal plan with a dietary carbohydrate intake between 30 g but less than 100 g/day is even more difficult to manage for a person dependent on insulin. The liver's contribution to the blood glucose pool is mixed and occurs from both glycogenolysis, glycogen release by the liver, and gluconeogenesis. Since there is no way to predict the liver's contribution, there is no way to anticipate the dose of insulin needed to prevent elevations and to avoid an excessive fall of glucose. The person with type 1 diabetes is forced to react after the blood glucose levels have changed. Instances of hypoglycaemia and hyperglycaemia occur unrelated to food or fasting.

To summarize, a meal plan that consists of less than 100 g/day will result in blood glucose patterns that are erratic. It is almost impossible to design an effective insulin plan that anticipates the peaks and valleys of the resulting blood glucose levels. A low carbohydrate plan is not a good strategy for people with type 1 diabetes largely because they lack effective biological feedback, or the capacity to recognise a change in the liver's rate of glucose secretion. Low carbohydrate plans for the dietary management of type 1 diabetes lead to erratic blood glucose control frustrating both the person living with diabetes and the diabetes team.

Franziska Spritzler and Carolyn Robertson

Franziska Spritzler is Clinical Dietitian at Department of Veterans Affairs and Certified Diabetes Educator, Los Angeles, USA.

Carolyn Robertson is a Clinical Nurse Specialist who is certified as a diabetes educator (CDE) as well as board certified in Advanced Diabetes Management.

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