Nutrition management of non-insulin dependent diabetes mellitus[1]

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ABSTRACT Non-insulin dependent diabetes (NIDDM) represents a heterogeneous group of conditions, but in management requires particular emphasis on nutritional optimization of carbohydrate control if oral agents and insulin are to be avoided. Nevertheless, the first nutritional priority is that essential nutrient intake be adequate and the second that the desirable weight for height relationship be achieved and maintained. Nutritional modification of risk factors, other than hyperglycemia, for macrovascular disease in diabetes, putatively hyperinsulinemia, hyperlipidemia, hypertension, elevated free fatty acid concentrations, platelet function and coagulation factors, is also required. The nutritional management of blood glucose requires attention to total macronutrient and micronutrient composition. As far as carbohydrate is concerned, it is not simply percentage contribution to energy, but absolute amount of carbohydrate, monomeric components, physical changes brought about by food preparation, relation to other nutrients, frequency of consumption background food intake and rapidity of any change in food intake. Pharmacological effects of dietary fiber may be different to effects when found naturally in food, where dietary fiber may serve as a useful marker for desirable food in the diabetic diet, irrespective of intrinsic activity. Improvement in blood glucose control may be achieved not only through an increase in high carbohydrate, high dietary fiber food intake, but also through a reduction in relative fat intake, alteration in quality of ingested fat or relative increase in protein intake. In the final analysis, food intake pattern, rather than a nutrient, food or even meal orientation to nutritional advice for the diabetic is required. Above all, change must be effected within the individual's food culture and exercise should be encouraged for nutritional flexibility.

NIDDM heterogeneity

The majority of diabetics, greater than 95% (1), in developed and developing countries, do not require insulin to prevent acute diabetic complications and can therefore be regarded as NIDDM. In developed countries, such diabetics are now classified according to WHO criteria as type 2, of whom the majority are obese (80 to 90%) and the remainder lean. For NIDDM in Asia, a different pathogenesis may be at work, perhaps related to undernutrition and/or the ingestion of certain food toxins.

Despite the likely heterogeneity of NIDDM, from a management point of view this grouping is useful since it implies that management will depend on attention to food intake, physical inactivity and emotional stress, which can all influence blood glucose, and

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on the use of oral medication (sulphonylureas and biguanides).

However, much of the revision of thinking about nutritional management of NIDDM is occurring in western countries (2) and it should not be presumed that these approaches can be extrapolated to Asia. Indeed, we already know that Asian communities have a relatively greater contribution to energy intake from carbohydrate (60 to 80%) of the order thought desirable now by western diabetologists. We may also need to be realistic about the extent to which diet alone can improve blood glucose control.

Individualization

Loss of physiological reserve, in the way insulin secretion and peripheral action relate to a glucose load, is intrinsic to NIDDM. Nevertheless, this does not mean dietary inflexibility as evidenced by the clinical experience of patient-determined changes in food intake without significant change in blood glucose control and by unavoidable retention of different food cultural patterns in multicultural societies like Australia, but with similar levels of control from diabetic of one culture to diabetic of another culture.

Factors which make individualization of nutritional management inevitable include variations in level of physical activity and differences in cultural, social and economic background. Where risk factor profiles for chronic complications of diabetes are synergistic with hyperglycemia, greater attention to nutritional management of the hyperglycemia would be required.

The method of instruction about nutritional management will also depend on the patient's educational background. Even in a country like Australia, with compulsory education until the age of 15, degrees of print literacy vary greatly.

Given the considerable need for individualization, it would seem preferable not to prescribe diets, but rather to elicit the food intake pattern of the individual and modify it step by step. Greater collaboration between health professionals and patient can be expected in this way.

Nutritional priorities

Good clinical management almost always involves the weighing up of risk-benefit ratios and assignment of priorities. The area of nutritional management is no exception. Nutritional considerations include : (a) the adequacy of essential nutrient intake, (b) weight control, (c) maintenance of as near normal blood glucose as possible, (d) minimization of risk factors for macrovascular disease, and (c) the sociocultural role of food.

The nutritional management of blood glucose itself is multifaceted including macronutrient, micronutrient, and food toxin considerations.

Macronutrient considerations

Each macronutrient have its own effects on blood glucose whereas, in the past, *carbohydrate* composition has been focussed on exclusively. It has been presumed that a knowledge of the carbohydrate content of a food would allow prediction of blood glucose response. In fact, the way in which carbohydrate behaves depends on *the proportion of energy* contributed by it (3), *absolute amount of carbohydrate* (4), *monomeric components* such as glucose, fructose and galactose (5), *food preparation* (6, 7), *relation to other nutrients* (8, 9, 10), *The time course of change in relative contribution of carbohydrate to energy intake* (3), and *the frequency of ingestion of carbohydrate.*

It is thus clear, that from the carbohydrate point of view alone, it would be necessary to know, for example, the proportions of glucose, fructose and galactose, the particle size of the food, and its viscosity. These factors, and others, will affect the rate of assimilation of glucose and its rate of rise and fall in blood after a meal. One factor which would not appear to be important, provided exocrine pancreatic function is

intact, is the chain length of the carbohydrate (11). Insulin sensitivity is also influenced by the background carbohydrate intake, whether low or high, and it is therefore not enough to know the acute effects of a particular carbohydrate load. Changing insulin sensitivity evolves over days and weeks. Nevertheless, at a given insulin sensitivity, where insulin secretion cannot match the glucose load, the greater the dose of administered carbohydrate, the greater the rise of blood glucose. Therefore, while it can be said that a higher proportion of energy from carbohydrate will lead to greater insulin sensitivity, on a particular occasion a greater carbohydrate load will lead to a relatively greater blood glucose. The way to cope with this problem is to encourage the ingestion of carbohydrate in smaller quantities throughout the day.

The 'glycemic index' (5) has been developed to allow a food rather than a carbohydrate macronutrient approach to nutritional management of diabetes. It is an advance on former thinking, inasmuch as it considers the effect of a food or meal on blood glucose, but it does not allow for the evolution of changing assimilation of carbohydrate or of insulin sensitivity with time, nor does it allow for other nutritional consequences of the intake of that food or meal.

The acute effects of *fat* in delaying gastric emptying (12) and therefore blood glucose response (13, 14), have been known for a long time. However, the longer term effects of an increase in fat intake through relative hyperinsulinemia (15, 16), need closer scrutiny. Moreover, the quality of the fat, whether it is polyunsaturated and whether the essential fatty acids are of the ω - 3 or ω - 6 series may also be important in the determination of glucose tolerance.

It may well be that an increase in carbohydrate contribution to energy is not the only way to improve blood glucose control. There is now some evidence that a higher *protein intake* may also assist blood glucose control (16-19). The difficulty with these studies is that for Japanese and for Aboriginal Australians, an increase in protein intake may be accompanied by a change in the quality of fat towards ω - 3 fatty acids, in contrast to the increase in saturated fat intake which generally accompanies an increase in protein intake in European developed societies.

The effects of *ethanol* increasing the likelihood of hypoglycemia through a reduction in gluconeogenesis are will known. Carbohydrate which accompanies the ingestion of ethanol will modify the blood glucose response. It is for this reason that the use of ethanol by diabetics is generally recommended in moderation and with meals.

There is no doubt that *dietary fiber* in isolation and used in pharmacological doses can have a favorable effect on the blood glucose response following a carbohydrate load. However, there is doubt about the extent to which these effects of dietary fiber can be realised acutely when it comes in food (20). Nevertheless, the longer term effects of dietary fiber intake changes may allow lower insulin responses (21, 22).

Micronutrient considerations

It seems likely that some micronutrients can also modify blood glucose. For example, in gestational diabetes, *vitamin* B_6 has been shown to improve control (23). *Dehydroascorbic acid,* derived from ascorbic acid, may actually impair glucose tolerance (24). In malnutrition diabetes, *zinc deficiency* and *chromium deficiency* may be contributory (25, 26).

Food toxins

Amongst food toxins which may adversely affect blood glucose control, are *ethanol* insofar as abuse may lead to pancreatic damage, *toxic products of soil microorganisms* such as streptozotocin, and *cyanogenetic glycosides* derived from cassava (27).

Nutritional management of risk factors for macrovascular disease

This has to be considered in its own right. Although it is clear that *hyperglycemia,* even as impaired glucose tolerance short of definite diabetes mellitus by WHO criteria, constitutes a risk factor for macrovascular disease, it is not certain that this represents a cause and effect relationship (28). Often this hyperglycemia will be accompanied by *hyperinsulinemia* and there is evidence that this may be important independently (29-33). *Hypercholesterolemia, hypertriglyceridemia* and *low high density lipoprotein* (HDL) concentrations also require nutritional management (34-37).

A number of nutritional factors including *sodium, potassium magnesium, energy, ethanol, fat and dietary fiber* now appear to be important in the management of, at least, *mild hypertension (38-51).* Elevation of *free fatty acids* in their own right may also be important (52). *Platelet function* and *coagulation factors* can also be influenced by diet (34, 53, 54).

Nutritional management orientation

It should now be clear that for the overall nutritional management of the diabetic, and even for the management of blood glucose alone, it is insufficient to take a nutrient or even a food or meal orientation. It is necessary to bear in mind the overall food intake pattern.

Nutrition and other modalities of management

for NIDDM, it seems likely that regular physical exercise will be as important, or at least the corollary of, nutritional management (55). This is because appetite is more appropriate with a greater level of physical activity, excess adiposity is better controlled, muscle mass is preserved, and insulin-sparing achieved.

Those involved in the management of diabetes are also well aware that situations of emotional stress not uncommonly lead to elevations in blood glucose and these should not be confused with the effects of diet. However, it must also be said that, at times of emotional stress, attention to diet may be less good.

Insofar as improvement of control through nutritional means, physical exercise and stress management decreases the use of oral agents, this would appear a good thing. There is no certainty that oral agents improve life expectancy or decrease complication rates. What they do accomplish, is a reduction in blood glucose, glycosuria, osmotic diuresis and associated polyuria and polydipsia. For the elderly, nutritional management is preferred to oral agents since adverse drug effects are more common in this age group. Oral agents also interact with other medications such as warfarin. In those who abuse alcohol, there are significant interactions between oral agents and alcohol.

It so happens that the emphasis on foods high in carbohydrate and dietary fiber, currently practised by diabetologists in developed countries, attends also to the problem of the adequacy of essential nutrient intake and the reduction in risk for atherosclerotic vascular disease. To this extent, the currently advocated nutritional management of diabetes corresponds to the prudent diet recommended for the population at large. This, however, does not preclude subtle therapeutic manipulation of the diabetic diet, with further improvement in blood glucose control, which should be possible as a greater understanding develops in relation to food intake patterns and overall diabetic control. In the meantime, with blood glucose monitoring being more accessible, exploration of different dietary alternatives is the individual diabetic should allow considerable progress in the nutritional management of NIDDM. The approach of individualization is even more relevant in Asia where NIDDM may be particularly heterogeneous and where high carbohydrate food intake patterns are already the norm.

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