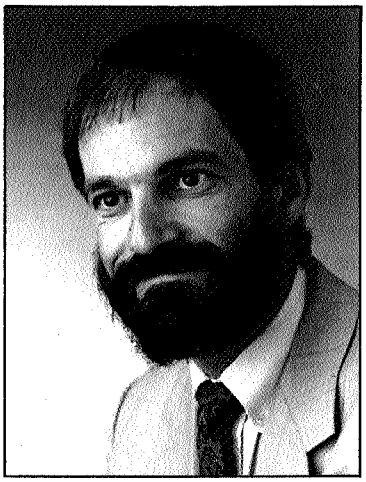
DIETARY MANAGEMENT OF THE HYPERLIPIDAEMIC PATIENT



Martijn B Katan is Associate Professor of Human Nutrition at Wageningen University, and Nutrition Foundation Professor at Nijmegen University School of Medicine, The Netherlands.

Dietary treatment is necessary in the management of all forms of primary hyperlipidaemia, either as the sole approach or, in some cases, in combination with drug therapy. Lipid-lowering diets have been developed, the nutrient content, palatability and cost of which makes them suitable for lifelong use [1,2]. In overweight patients, such a diet is combined with restriction of energy intake until a target body weight is attained, while for patients whose plasma lipid response proves inadequate a more rigorous version of the diet may be introduced. These lipid-lowering diets are appropriate for patients with hypercholesterolaemia and for most hypertriglyceridaemic patients. However, rare forms of hypertriglyceridaemia, particularly the chylomicronaemia syndrome ("Type I" hyperlipoproteinaemia) and severe familial hypertriglyceridaemia ("Type V"), may require a different diet, characterized by very low fat content.

The general lipid-lowering diet (either in isocaloric or in weight-reducing form) is no more nor less than a healthy eating pattern, designed to help reduce the risk of several common diseases, including coronary heart disease (CHD). For the individual care of hyperlipidaemic patients dietary instruction is best provided by a professional dietitian, whose skills are necessary to ensure the nutritional adequacy of the diet, to individualize the diet to the patient's taste, energy needs and specific metabolic disorder and to promote compliance. A dietitian can also spot and correct overzealous patients who eliminate too many foods from their diet thus endangering their intake of essential nutrients. Access to trained dietitians is not always available. General dietary guidelines will then have to be provided by the physician, who should be able to offer qualitative and quantitative advice to mildly hyperlipidaemic patients. In this situation the physician has an indispensable role in motivating the patient to comply with the diet and to explain the reasons for its use, but if an adequate plasma lipid response is not observed referral to a dietitian is suggested.

Nutritional change is seldom attained after a single session of instruction. Several months should be allowed for learning the diet, which involves altering habits and preferences, cooking techniques and food purchasing. Some authorities on behaviour modification advocate stepwise changes in eating patterns, emphasising in turn meat and fish, dairy products and other food groups. Trends in plasma lipid levels can only be discerned from serial measurements. A single cholesterol measurement should never be accepted as evidence of the success or failure of the diet. Repeated assessment and supplementary counselling are mandatory and will often enhance the plasma lipid response.

Nutrients influencing plasma lipid levels

Dietary fats

Plasma lipid levels are influenced by several nutritional factors. The most important single dietary cause of elevated plasma cholesterol is a high intake of saturated fatty acids with a carbon chain length of 12-16 (see Box). These are present in meats, dairy products such as butter, cheese and milk (except for the low-fat varieties), certain vegetable fats such as coconut fat (used in artificial cream and in coffee whiteners) and hydrogenated fats present in hard margarines. Saturated plant fats are widely used for deep-fat frying and for production of margarines and baked goods. The labelling of food products as "containing vegetable fats or oils" can therefore be misleading. Substitution of dietary saturated fats by unsaturated fatty acids (see Box), particularly linoleic acid derived from seed oils such as sunflower oil, reduces plasma cholesterol and triglyceride levels by reducing low density (LDL) and very low density lipoproteins (VLDL). When modest amounts of such oils are included in the diet effects on high density lipoprotein cholesterol (HDL-cholesterol) are usually slight or absent. Plasma cholesterol levels are also reduced when saturated fat is replaced by carbohydrate.

When embarking on a lipid-lowering diet it is usual to advise a substantial reduction in saturated fat intake, e.g. from 18% of dietary energy to 8-10%, along with a modest supplementation of n-6 polyunsaturated fat, e.g. from 3-5% to 6-10% of dietary energy. Energy balance is maintained, in patients of acceptable body weight, by increasing intake of foods providing complex carbohydrates (legumes and beans, bread, rice, pasta, potatoes).

While the safety of increased polyunsaturated fat consumption has been questioned, the suggested increase of dietary n-6 polyunsaturated fats undoubtedly enhances the lipid-lowering effect of the diet. Dietary trials of coronary

Keys' Formula

The effect of changes in dietary lipids has been quantified by Professor Ancel Keys and colleagues of the University of Minnesota. Expressed in SI units, the equation reads:

$$\Delta \text{Serum Cholesterol (mmol/l)} = 0.035\,(2\Delta S - \Delta P) + 0.08\Delta\sqrt{\text{chol/MJ}}$$

Δ = change

S = % of energy provided by saturated fatty acids (especially lauric, myristic and palmitic acid)

P = % of energy from polyunsaturated fatty acids

chol/MJ = cholesterol intake in milligrams per megajoule

Dietary changes		Composition of the resulting diet				Predicted change in cholesterol (mmol/l)
		Fat (% of energy)			Cholesterol (mg/day)	
In	Out	Total	Sat.*	Poly.*		
None (basal diet)		38	15	6.5	240	–
25g of olive oil	30g of butter	38	11	7.0	170	− 0.4
25g of olive oil	Potatoes and bread	47	16	7.1	240	0.0
Two eggs	Cheese and meat	37	13	6.7	710	+ 0.1
Two eggs	Toast and jam	42	16	6.8	760	+ 0.4

* sat. = saturated fatty acids; poly = polyunsaturated fatty acids.

Table 1. The effect on cholesterol of added foodstuffs, if different foods are replaced. For every food added to the basal diet, some other food has to be left out so as to keep total calorie intake constant. The predicted change in serum cholesterol was calculated from Keys' formula (see Box). The basal diet provided 10 MJ (2400 kcal) per day.

heart disease prevention have included increased use of n-6 polyunsaturates, and have shown significant reductions in coronary disease without significant increases in non-cardiovascular disease. An inverse relation has repeatedly been shown between CHD and the consumption of linoleic acid. The marked increase in the use of such oils by the U.S. population has been accompanied by, and may have contributed to, a demonstrable fall in average plasma cholesterol and a 40% reduction in coronary mortality in recent decades, with no increase in malignant diseases.

Other dietary fatty acids have recently been under scrutiny for their effects on plasma lipid metabolism. The n-3 polyunsaturated fatty acids present in fish oils (see Box) markedly reduce elevated triglyceride levels when fed at intakes of 15-30 g oil per day. Such a high intake is not achieved by consumption even of fatty fish, but normal intakes of fish such as mackerel or salmon do produce lowering of plasma triglyceride levels. The effect of fish oil on plasma LDL-cholesterol (the "bad" cholesterol) is equivocal.

When oils rich in oleic acid, such as olive oil or "new" rapeseed oil, are used in a western diet, they will tend to replace saturated fats such as butter or cooking fats, so that plasma cholesterol will fall in line with the reduced intake of saturated fats (Table 1). Moderate use of olive oil or other monounsaturated oils is entirely compatible with a lipid-lowering diet and is in conformity with the high intakes formerly characteristic of Mediterranean countries in which CHD death rates were low. Since animal fats contain both oleic acid and saturated fatty acids, restriction of the former will decrease oleic acid intake; inclusion of monounsaturated oils in a lipid-lowering diet will tend to redress this loss.

Dietary cholesterol

Despite occasional controversy, there is abundant evidence that high dietary cholesterol intake increases plasma cholesterol. Restriction of dietary cholesterol should be part of a lipid-lowering diet because dietary cholesterol and saturated fat reinforce each other's effect on plasma levels of LDL, the major atherogenic lipoprotein.

Dietary fibre

Some, but not all, forms of dietary fibre directly reduce plasma cholesterol levels. Soluble, gel-forming "fibres" such as pectins and gums, present in fruit, vegetables and oats, have a moderate cholesterol lowering effect, while wheat fibre is ineffective. Wholewheat bread and other natural high-fibre foods do, however, tend to substitute for foods rich in fat, and may therefore have an indirect effect in lowering plasma cholesterol.

Very importantly, most or all of the effects of individual nutrients on cholesterol and triglyceride levels are additive, permitting their combination into a therapeutic diet of considerable effectiveness. Such a diet need not be unattractive. Many aspects of it have for centuries been part of the diet of Mediterranean countries and the Orient. Greek, Italian and Chinese haute cuisine can produce exquisite dishes that are naturally low in saturated fat and cholesterol.

The nutrient composition of a standard lipid-lowering diet is shown in Table 2. In some patients in whom this diet fails to achieve an acceptable reduction in plasma cholesterol, a more stringent version of the diet, containing less saturated fat and cholesterol, is sometimes effective. It should be noted that the dietary changes listed also have the potential to lessen CHD risk through mechanisms unrelated to plasma lipid concentrations. An increase in the ratio of polyunsaturated fatty acids (of the n-3 and n-6 series) to saturated fatty acids influences haemostatic mechanisms, tending to reduce liability to thrombosis. Blood pressure also tends to be lowered by such diets, even in the absence of weight loss.

Controlling overweight

The high risk of CHD in obesity appears to be due in part to

Protein, % total food energy	12
Carbohydrate, % total food energy	60
Saturated fatty acids, % total food energy	10*
Monounsaturated fatty acids, % total food energy	10
Polyunsaturated fatty acids, % total food energy	8
Fibre, g/day □ +	35
Cholesterol, mg/day +	<250**

* 7% for resistant hypercholesterolaemia

** < 100 mg/day for resistant hypercholesterolaemia

\+ At an energy intake of 10 MJ (2400 kcal) per day; use proportionally more or less if energy intake differs.

□ At least 50% of the fibre to be provided by vegetables, legumes, fruits and oats.

Table 2. Nutrient composition of standard diet for hypercholesterolaemia and endogenous hypertriglyceridaemia

its association with hyperlipidaemia and with low levels of HDL-cholesterol, with glucose intolerance and with hypertension. These risk factors are usually ameliorated by weight reduction. In addition, obesity, especially of truncal distribution, is a risk factor in its own right. Unfortunately, obesity is highly resistant to treatment and perseverance on the part of the doctor and dietitian is required.

In many patients, even moderate degrees of weight reduction result in reductions of plasma lipid levels. The preferred goal of weight reducing schedules is to achieve a body mass index (weight/height^2) in the range 20-25 kg/m^2. As well as the direct benefits of treating obesity, responsiveness to lipid-lowering drugs is enhanced by treatment of overweight.

The desirable rate of weight loss is 0.5-1 kg per week. To help commit the patient to a programme of weight control it is often helpful for the doctor and patient jointly to agree target body weight. Exercise appropriate to the age, cardiorespiratory status and level of fitness of the patient should be undertaken on several days each week. Crash diets and special preparations are of little value, because the weight lost is easily regained when the patient resumes his usual diet. Also, an appreciable part of the weight lost during the first days of such regimes is glycogen and body water rather than fat. Of much greater benefit is a modest, sustained reduction in caloric intake that provides retraining in eating habits for life.

Practical aspects of dietary treatment of hyperlipidaemia

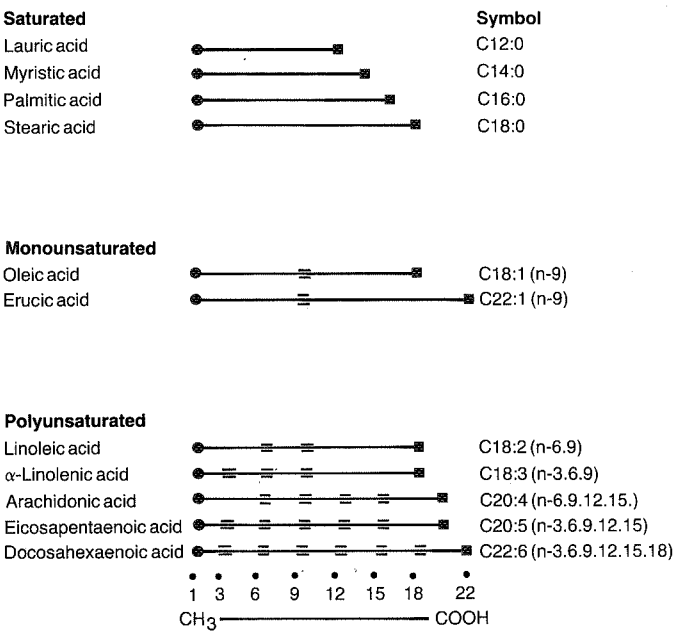
The lipid-lowering diet is recommended for indefinite use; it may be reduced in energy content in the overweight patient.

Nomenclature of fatty acids

Fatty acids are based on a 'backbone' of carbon atoms, which are linked together. Where all these links are single bonds, the acid is described as 'saturated'. So, palmitic acid would be described as C16:0. This shows that it has 16 carbons in its backbone, all linked by single bonds.

Where any of the carbon-carbon links is a double bond, the number after the colon reflects this fact. Thus, oleic acid is described as C18:1(n-9). This shows that it has an 18 carbon backbone, with *1* double bond that appears at carbon *9*, counting from the methyl (CH_3) end of the chain. As there is only one double bond, the molecule is described as 'monounsaturated'. If there are two or more such bonds, the description 'polyunsaturated' is applied. Linoleic acid is such a molecule. It is annotated as C18:2(n-6,9) — i.e. it has an *18* carbon backbone with *2* double bonds which occur at carbons *6* and *9*.

The oils found in fish are unsaturated, but of a different type to those described above. The first double bond in a fish oil fatty acid occurs at the third carbon of the backbone; as a class they are therefore called omega-3 (n-3) fatty acids. As an example, docosahexaenoic acid is annotated as C22:6(n-3,6,9,12,15,18), indicating that it has a *22* carbon backbone, with *6* double bonds, the first of which occurs at carbon *3*.



It includes several components:

- Increased consumption of foods providing complex carbohydrate and soluble forms of fibre; these include legumes (beans and peas), cereal products (bread, rice, pasta, oat-based breakfast cereals), root vegetables such as potatoes, leafy vegetables and fruit.

- Decreased use of foods with a high content of saturated fatty acids. Intake of saturated fatty acids needs to be reduced to <10% of food energy, so that total intake of fat decreases to <30% of energy. If the ensuing reduction of plasma cholesterol is inadequate, saturated fat may be reduced to 7% of food energy. Saturated fatty acids are substantial components of butter, hard margarine, cream, full-fat milk, cheeses (except the low-fat varieties), sausages and processed meats, red meats except for the leaner cuts, baked goods, many snack foods, and shortening.

- A lower intake of cholesterol (< 250 mg/day), which may be further reduced to 100 mg/day if the initial response is inadequate. Reduced intake of animal foods, intended to restrict intake of saturated fat, will also decrease cholesterol intake; other cholesterol-containing foods that need to be limited are egg yolk, liver and other offal. Complete elimination of eggs and liver is undesirable, however, as they are valuable sources of vitamins and other nutrients. A well-balanced diet contains both animal and plant foods; the aim is to lower animal fat, not animal foods *per se.*

- Substitution of skimmed and/or low-fat milk and their products for whole milk and high-fat milk products. Milk fat, present in whole milk and yoghurt, cheese, butter and cream, is more hypercholesterolaemic than other animal fats because it is very low in linoleic acid (1-2%) and very high in cholesterol (270 mg/100 g, compared to 60-80 mg/100 g in lard, beef fat and tallow). As milk *fat* provides little in the way of essential nutrients there is no hazard in reducing its intake. On the other hand, low-fat dairy products are a rich source of calcium, and they also provide vitamins B2 and B12 and high-quality proteins, so they should not be eliminated.

- A greater use of all types of fish, chicken, turkey, veal and game, many of which are low in saturated fatty acids. The moderate use of lean red meat is allowable. These, together with legumes such as beans and lentils, and low-fat milk products, produce a satisfactory protein intake. Fatty fish contain n-3 polyunsaturated fatty acids that reduce plasma triglyceride. Fish is also a good source of vitamin D and iodine, the intake of which is marginal in many people.

- Introduction of margarines based on unhydrogenated polyunsaturated oils (sunflower or corn oils) as spreads and use of such oils, and monounsaturated oils such as olive oil, for cooking. The optimal intakes of polyunsaturated fatty acids (particularly linoleic acid) and of fish oil preparations or of oils providing monounsaturated fatty acids, such as olive oil, have yet to be determined. A widely held view is that the ratio of polyunsaturated fatty acids to saturated fatty acids should increase towards, but should not exceed, 1.0.

- There is no need to deny the moderate use of alcoholic drinks to a patient who has normal triglyceride levels. However, alcohol is an important source of calories and many people underreport its use. Also, intakes of four or more drinks per day are associated with hypertension. Sugar as such has no major influence on serum lipids, but it too is a major source of calories. In addition, many sweet foods are also high in saturated fat and cholesterol and low in fibre. A cholesterol-elevating effect of certain types of coffee has been reported but the data are too preliminary for clinical application. There is no good evidence that lecithin preparation, gamma linolenic acid, garlic, vitamin E or other vitamin preparations are of value in the treatment of hyperlipidaemia.

A substantial reduction in serum cholesterol (15-25%) and triglyceride (20-40%) can be attained by the diet described, especially when body weight is in, or can be reduced towards, the desirable range. There is some individual variation in response, and for patients with familial hypercholesterolaemia diet is inadequate as the sole therapeutic approach. However, dietary treatment will often suffice in patients with plasma cholesterol up to 7-7.5 mmol/l (270-289.5 mg/dl) or with mild hypertriglyceridaemia (< 6 mmol/l (< 231 mg/dl)).

A rare disorder, the chylomicronaemia syndrome, causes gross hypertriglyceridaemia, which is dealt with by severe reduction (to 10-25% of dietary energy) of the dietary intake of all natural fats. Moderate use of medium chain triglyceride is permitted.

Summary

The preferred approach to management of hyperlipidaemia is dietary modification and in a majority of patients this is sufficient in itself. Dietary manipulation is also a necessary component of the management of patients with disorders requiring drug treatment because it lowers the required drug dose. The fat-modified, high-fibre diet, with or without initial weight reduction, is thus the mainstay of lipid-lowering therapy. A very-low-fat diet is used to avert pancreatitis in patients with the chylomicronaemia syndrome.

Martijn B Katan
Wageningen Agricultural University,
The Netherlands.

Further Reading

1. Study Group, European Atherosclerosis Society. The recognition and management of hyperlipidaemia in adults: A policy statement of the European Atherosclerosis Society. *Eur Heart J* 1988; **9:** 571-600.

2. The Expert Panel. Report of the National Cholesterol Education Program Expert Panel on Detection. Evaluation and Treatment of High Blood Cholesterol in Adults. *Arch Intern Med* 1988; **148:** 37-69.

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