UNIT NO. 6

NON-PHARMACOLOGICAL TREATMENT OF HYPERLIPIDEMIA

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INTRODUCTION

The 'lag-time' effect of risk factors for cardiovascular disease means that present mortality rates are the consequence of previous exposure to behavioural risk factors such as inappropriate nutrition, insufficient physical activity and increased tobacco consumption. Overweight, central obesity, high blood pressure, dyslipidemia, diabetes and low cardio-pulmonary fitness are among the biological factors contributing principally to increased cardiovascular disease risk. Unhealthy dietary practices include the high consumption of saturated fats, salt and refined carbohydrates, as well as low consumption of fruits and vegetables, and these tend to cluster together.

This unit's focus is on non-pharmacological treatment of hyperlipidemia, with emphasis on diet-related measures.

OBJECTIVES

At the end of the session, the participant should be able:

- to identify key diet-related factors in hyperlipidemia
- to set realistic dietary (food and nutrient) goals for patients with hyperlipidemia.

DIET RELATED FACTORS IN HYPERLIPIDEMIA

Dietary Cholesterol

Cholesterol in the blood and tissues is derived from two sources: diet and endogenous synthesis. Dairy fat and meat are major sources. Egg yolk is particularly rich in cholesterol but unlike dairy and meat does not provide saturated fatty acids. Dietary cholesterol raises plasma cholesterol levels. Although both HDL and LDL increase, the effect on the total/HDL ratio is still unfavourable, but small. Observational evidence on an association of dietary cholesterol intake with cardiovascular disease is contradictory. The upper limit for dietary cholesterol intake has been prescribed, in most guidelines, to be 300 mg/day. However, there is no requirement for dietary cholesterol and it is advisable to keep the intake as low as possible. If intake of dairy fat and meat are controlled then there needs to be no severe restriction of egg yolk intake, although some limitation remains prudent.

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Dietary Fats

The relationship of dietary fats to cardiovascular disease was initially considered to be mediated mainly through the atherogenic effects of plasma lipids (total cholesterol, lipoprotein fractions and triglycerides). The effects of dietary fats on thrombosis and endothelial function as well as the relationship of plasma and tissue lipids to the pathways of inflammation have been more recently understood. Similarly the effects of dietary fats on blood pressure have also become more evident through observational and experimental research.

Fatty acids are grouped into three classes – saturated fatty acids (SFA), monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA). While such a classification is useful in providing a structural grouping, it tends to oversimplify the effects of dietary fats. Individual fatty acids, within each group, are now known to have differing effects on lipids, lipoproteins and platelet-vascular homeostasis.

SFA and MUFA can be synthesised in the body and hence are not dietary essentials. PUFA can be subdivided into n-6 PUFA and n-3 PUFA, derived from linoleic acid (LA) and alpha-linolenic acid (ALNA) respectively. These are essential fatty acids, since they cannot be synthesised in the body.

Saturated fatty acids raise total and LDL cholesterol, but individual fatty acids within this group, have different effects. Myristic and palmitic acids have the greatest effect and are abundant in diets rich in dairy products and meats. Stearic acid has not been shown to elevate blood cholesterol and is rapidly converted to oleic acid in vivo. Major sources of SFAs are animal fat, ghee, butter, coconut and palm oils.

When substituted for SFA in metabolic studies, both MUFA and n-6 PUFA lower plasma total and LDL cholesterol concentrations. PUFAs are somewhat more effective than MUFAs in this respect.

The only nutritionally important MUFA is oleic acid, which is abundant in olive and canola oils, and also in nuts. The most important PUFA is linoleic acid, which is abundant especially in soybean and sunflower oils. The most important n-3 PUFAs are eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) found in fatty fish, and alpha linolenic acid found in plant foods. The very long chain n-3 EPAs and DHAs powerfully lower serum triglycerides, but they raise serum LDL cholesterol. Their effect on coronary heart disease is probably mediated through pathways other than serum cholesterol (such as blood pressure, cardiac function, arterial compliance, endothelial function, vascular reactivity and cardiac electrophysiology, as well as potent anti platelet and anti inflammatory effects).

Trans fatty acids (TFA) are geometrical isomers of cis-unsaturated fatty acids that adapt a saturated fatty acid-like configuration. Partial hydrogenation, the process used to increase shelf-life of PUFAs creates TFAs and also removed the critical double bonds in essential fatty acids. Metabolic studies have demonstrated that TFAs render the plasma lipid profile even more atherogenic than SFAs, by not only elevating LDL cholesterol to similar levels but also by decreasing HDL cholesterol. Several large cohort studies have found that intake of TFAs increases the risk of coronary heart disease. Most TFAs are contributed by industrially hardened oils, and deep fried fast foods and baked goods are major sources.

In summary:

- SFA raises LDL cholesterol; it is the strongest predictor of CHD
- PUFAs have a greater total cholesterol lowering effect compared with MUFAs, but when taken in high doses, they appear to have adverse health effects
- n-6 PUFAs lower total blood cholesterol and LDL cholesterol
- n-3 PUFAs lower blood triglycerides, platelet aggregation, blood pressure, alters lipoprotein metabolism and increase bleeding time
- MUFA lowers the total cholesterol but the effect is less than that of PUFAs. MUFA does not appear to have adverse health effect
- TFAs may have a greater effect than SFAs on the increased risk of CHD
- A high dietary cholesterol intake raises total blood cholesterol and LDL cholesterol.

Dietary Fibre

Dietary fibre is a heterogeneous mixture of polysaccharides and lignins that cannot be degraded by the endogenous enzymes of vertebrate animals. Water-soluble fibres include pectins, gums, mucilages and some hemicelluloses. Insoluble fibres include cellulose and other hemicelluloses. Most fibres reduce plasma total and LDL cholesterol.

Carbohydrates and Energy

The relationship of dietary carbohydrates to CVD appears to be mediated through indirect mechanisms: contribution to total energy and its effect on overweight and obesity; influence on central obesity; effects on plasma lipids, especially triglycerides and effects on glycaemic control. The balance between carbohydrates and fat as sources of energy as well as the fibre component of the diet are also areas of interest while considering this relationship. Epidemiologically, high carbohydrate intakes are associated with low plasma cholesterol and variable plasma triglyceride concentrations. The effect of a high carbohydrate diet on HDL cholesterol and thereby on the total to HDL cholesterol ratio as well as on the particle size of LDL are matters of interest while considering the influence on vascular function and risk of CVD.

High carbohydrate diets appear to reduce HDL cholesterol levels and increases the fraction of small dense LDL, both of which may impact adversely on vascular disease. This dyslipidemic pattern is consistent with the elevation of plasma triglycerides. There is as yet no clear evidence that the risk of CVD is altered independently by the carbohydrate levels in the diet, but such evidence is in fact theoretical because replacement of carbohydrates automatically implies an increase in the intake of fat or protein. As carbohydrates produce higher triglycerides and lower HDL than both fat and protein it is convenient to ascribe this effect to carbohydrates. In persons with hypertriglyceridemia, an increase of carbohydrate may be especially noxious because it reinforces the symptoms of the 'metabolic syndrome, i.e. high triglycerides, low HDL, and small dense LDL. Substitution by a high MUFA or polyunsaturated fatty acids diet appears to have beneficial effects on plasma triglycerides and HDL cholesterol and may provide an alternative.

Total daily energy intake relates to CVD through effects on body mass index. This relationship is determined by the levels of regular daily physical activity. Age and activity related levels of energy intake, intended to avoid overweight and obesity, would have beneficial effects on the risk of CVD by influencing key mediators like blood pressure, blood lipids and glucose tolerance.

PHYSICAL ACTIVITY

Regular aerobic exercises increases HDL cholesterol, enables weight loss, improves cardiovascular fitness and reduces risk for CHD. It is now recognised that for health benefits, one should engage in moderately intense activities for about 30 minutes per day on most days a week. For most people, greater health benefits can be obtained by engaging in physical activity of more vigorous intensity or of longer duration. This cardio respiratory endurance activity should be supplemented with strength-developing exercises at least twice a week for adults. Pre exercise screening is important in reducing the risk of patients having undetected conditions that may deter physical exercise.

OTHER FACTORS

Besides dietary factors related to blood lipids, there are other factors related to CHD risks in general (Table 1). The evidence on the impact of these diet related factors on risk on CHD is also shown in Table 1.

Table 1. Summary of Strength of Evidence on Lifestyle Factors and Risk of Developing Cardiovascular Diseases

Evidence**	Decreased risk	No relationship	Increased risk
Convincing	Regular physical activity Linoleic acid Fish and fish oils (EHA and DHA) Vegetables and fruits (including berries) Potassium Low to moderate alcohol intake (for coronary heart disease)	Vitamin E supplements	Myristic and palmitic acids Trans fatty acids High sodium intake Overweight High alcohol intake (for stroke)
Probable	Linolenic acid Oleic acid Dietary fibre (NSP) Wholegrain cereals Nuts (unsalted) Plant sterols/stanols Folate	Stearic acid	Dietary cholesterol Unfiltered boiled coffee
Possible	Flavonoids Soy products		Fat rich in lauric acid Impaired fetal nutrition Beta-carotene supplements
Insufficient	Calcium Magnesium Vitamin C		Carbohydrates Iron

Footnotes. EPA, eicosapentaenoic acid; DHA, docosahexaenoic acid; NSP, non-starch polysaccharides

*** Convincing evidence: Evidence is based on epidemiological studies showing consistent associations between exposure and disease, with little or no evidence to the contrary. The available evidence is based on a substantial number of studies including prospective observational studies and where relevant, randomized controlled trials of sufficient size, duration and quality showing consistent effects. The association should be biologically plausible.*

*** Probable evidence: Evidence is based on epidemiological studies showing fairly consistent associations between exposure and disease, but where there are perceived shortcomings in the available evidence or some evidence to the contrary, precluding a more definite judgement. Shortcomings in the evidence may be any of the following: insufficient duration of trials (or studies); insufficient trials (or studies) available; inadequate sample sizes; incomplete follow-up. Laboratory evidence is usually supportive. Again, the association should be biologically plausible.*

*** Possible evidence: Evidence is based mainly on the findings from case-control and cross-sectional studies. Insufficient randomized controlled trials, observational studies or non-randomized controlled trials are available. Evidence based on non-epidemiological studies, such as clinical and laboratory investigations, is supportive. More trials are required to support the tentative associations, which should also be biologically plausible.*

*** Insufficient evidence: Evidence is based on the findings of a few studies which are suggestive, but are insufficient to establish an association between exposure and disease. Limited or no evidence is available from randomized controlled trials. More well-designed research is required to support the tentative associations.*

MULTIFACETED LIFESTYLE APPROACH TO REDUCE RISK OF CHD

The ATP III report recommends a multifaceted lifestyle approach to reduce risk for CHD. This therapeutic lifestyle changes (TLC) approach. This is the similar approach recommended in the MOH's CPG on Lipids[2] locally:

The following diet emphasize intake of fruits, vegetables, grains, cereals and legumes as well as skinless poultry, fish, lean meat and low fat dairy products. To lower TG, it is important, in addition to the above measures, to restrict the intake of alcohol and simple carbohydrates (e.g glucose, sucrose). For details on primary and secondary prevention of CHD, refer to ref 3.

Table 2. Dietary Therapy of Hypercholesterolemia

Nutrient	Recommended Intake
Total fat	25-35% of total calories
Saturated fat	<7% of total calories
Polyunsaturated fat	Up to 10% of total calories
Monounsaturated fat	Up to 10% of total calories
Carbohydrate	60% of total calories (mainly from complex carbohydrates)
Dietary fibre	10 gm/1000 kcal per day
Protein	~ 15% of total calories
Cholesterol	<200 mg/day
Total calories	Enough to achieve and maintain a body mass index (BMI) of 18.5 to 25 kg/m2

Commencement of TLC depends on the risk assessment. Please refer to CPG on Lipids and other units in this module for the assessment criteria, treatment plan and goals for different risk levels.

LEARNING POINTS

- The 'lag-time' effect of risk factors for cardiovascular disease means that present mortality rates are the consequence of previous exposure to behavioural risk factors such as inappropriate nutrition and insufficient physical activity
- Overweight, central obesity, high blood pressure, dyslipidemia, diabetes and low cardio-pulmonary fitness are among the biological factors contributing principally to increased CHD risk
- The ATP III report recommends a multifaceted lifestyle approach to reduce risk for CHD. This therapeutic lifestyle changes (TLC) approach. This is the similar approach recommended in the MOH's CPG on Lipids[2] locally
- Both guidelines emphasize intake of fruits, vegetables, grains, cereals and legumes as well as skinless poultry, fish, lean meat and low fat dairy products. To lower TG, it is important, in addition to the above measures, to restrict the intake of alcohol and simple carbohydrates (e.g glucose, sucrose). For details on primary and secondary prevention of CHD, refer to ref 3
- Regular aerobic exercises increases HDL cholesterol, enables weight loss, improves cardiovascular fitness and reduces risk for CHD. It is now recognised that for health benefits, one should engage in moderately intense activities for about 30 minutes per day on most days a week.

RECOMMENDED READINGS

1. Diet, Nutrition and the Prevention of Chronic Disease. Report of a joint WHO/FAO consultation. WHO Technical Report Series 916. WHO, Geneva 2003.
2. Clinical Practice Guidelines on Lipids. MOH Clinical Practice Guidelines 7/2001.
3. Dietary Management and Physical Activity for Cardiovascular Diseases, Diabetes Mellitus, Hypertension and Hypercholesterolemia. Health Promotion Board, Singapore. 2003.
4. Prescribing Exercise. A handbook for medical practitioners. Joint publication of the Singapore Medical Association and the Singapore Sports Council. Eds. Zhao C, Chia J, Teh KC, Goh LG. August 2003. Singapore.
5. Expert Panel on Detection, Evaluation and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). Third Report of the National Cholesterol Education Program (NCEP). NHLBI, NIH, 2001.