

**Table 1-4**

**Serum LDL-Cholesterol Levels in U.S. Children and Adolescents (mg/dL)\***

**White Males**

Age (Years)	N	Overall Mean	Percentiles						
			5	10	25	50	75	90	95
5-9	131	95	65	71	82	93	106	121	133
10-14	284	99	66	74	83	97	112	126	136
15-19	298	97	64	70	82	96	112	127	134

**White Females**

Age (Years)	N	Overall Mean	Percentiles						
			5	10	25	50	75	90	95
5-9	114	103	70	75	91	101	118	129	144
10-14	244	100	70	75	83	97	113	130	140
15-19	294	99	61	67	80	96	114	133	141

\* All values have been converted from plasma to serum. Plasma value x 1.03 = serum value.

Note: The number of children ages 0-4 who had LDL- and HDL-cholesterol measured was too small to allow calculation of percentiles in this age group. However, note that the percentiles for total cholesterol (Table 1-3) for ages 0-4 and 5-9 are similar.

Source: The LRC Prevalence Study (North America) (NHLBI 1980).

**Table 1-5**

**Serum HDL-Cholesterol Levels in U.S. Children and Adolescents (mg/dL)\***

**White Males**

Age (Years)	N	Overall Mean	Percentiles						
			5	10	25	50	75	90	95
5-9	142	57	39	43	50	56	65	72	76
10-14	296	57	38	41	47	57	63	73	76
15-19	299	48	31	35	40	47	54	61	65

**White Females**

Age (Years)	N	Overall Mean	Percentiles						
			5	10	25	50	75	90	95
5-9	124	55	37	39	48	54	63	69	75
10-14	247	54	38	41	46	54	60	66	72
15-19	295	54	36	39	44	53	63	70	76

\* All values have been converted from plasma to serum. Plasma value x 1.03 = serum value.

Note: The number of children ages 0-4 who had LDL- and HDL-cholesterol measured was too small to allow calculation of percentiles in this age group. However, note that the percentiles for total cholesterol (Table 1-3) for ages 0-4 and 5-9 are similar.

Source: The LRC Prevalence Study (North America) (NHLBI 1980).

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**Table 1-6**

**Serum Triglyceride Levels in U.S. Children and Adolescents (mg/dL)\***

<b>Males</b>									
Age (Years)	N	Overall Mean	Percentiles						
			5	10	25	50	75	90	95
0-4	238	58	30	34	41	53	69	87	102
5-9	1253	30	31	34	41	53	67	88	104
10-14	2278	68	33	38	46	61	80	105	129
15-19	1980	80	38	44	56	71	94	124	152

<b>Females</b>									
Age (Years)	N	Overall Mean	Percentiles						
			5	10	25	50	75	90	95
0-4	186	66	35	39	46	61	79	99	115
5-9	1118	30	33	37	45	57	73	93	108
10-14	2087	78	38	45	56	72	93	117	135
15-19	2079	78	40	45	55	70	90	117	136

\* All values have been converted from plasma to serum. Plasma value x 1.03 = serum value.

Source: The LRC Prevalence Study (North America) (NHLBI 1980).

age, for both sexes, the 75th percentile for total cholesterol is roughly 170 mg/dL, and for LDL-cholesterol about 110 mg/dL. The 95th percentile for total cholesterol is roughly 200 mg/dL, and for LDL-cholesterol about 130 mg/dL (NHLBI 1980).

## H. TRACKING

Whether cholesterol levels in childhood are good indicators of levels in adulthood is an important question. Several studies have shown that childhood rank order of cholesterol is maintained over time (known as "tracking"), although not as consistently as rank order of height and weight is maintained (Clark et al. 1967; Clarke et al. 1978; Frerichs et al. 1979; Laskarzewski et al. 1979; Freedman et al. 1985a). Thus, children whose cholesterol levels are observed to be high tend in general to have high levels as adults; however, many will have levels that are not as high as would have been predicted from their childhood levels.

Several studies have related childhood cholesterol levels to later young adult levels (Orchard et al. 1983; Freedman et al. 1985a; Lauer et al. 1988a). One study (Lauer et al. 1988a) examined data on children 5 to 18 years of age who were observed to have cholesterol levels greater than the 90th percentile at a single measurement. At 20 to 30 years of age, 43 percent of these individuals were observed to have levels greater than the 90th percentile (about 4 times the percent expected), 62 percent greater than the 75th percentile (about 2 to 3 times the percent expected), and 81 percent greater than the 50th percentile (about one and one-half times the percent expected) (Lauer et al. 1988a). Of children whose cholesterol levels were greater than the 90th percentile on two occasions, 75 percent had higher than desirable levels ( $\geq 200$  mg/dL), and 25 percent had desirable ( $< 200$  mg/dL) levels at ages 20 to 25 years (Lauer and Clarke 1990). Because 200 mg/dL is approximately the 75th percentile for adults in their twenties, this

percentage of individuals with levels at or above 200 mg/dL is about three times the percentage expected for the general population.

According to the criteria established by the NCEP Adult Treatment Panel, adults (20 years of age and above) require individual intervention if they have high-risk-LDL-cholesterol ( $\geq 160$  mg/dL). Adults with borderline-high-risk-LDL-cholesterol (130 to 159 mg/dL) may require individual intervention if they also have CHD or two or more other CHD risk factors (NCEP 1988). In the tracking study cited above, it is important to note that quite a few children with cholesterol levels greater than the 90th percentile on two successive examinations did not qualify for individual intervention when they became adults in their twenties (Lauer and Clarke 1990). This was because either their adult LDL-cholesterol levels were below 130 mg/dL or, despite having LDL-cholesterol levels 130-159 mg/dL, they had fewer than two other CHD risk factors. This indicates that although children with high cholesterol levels have a greater risk of having elevated adult cholesterol levels than the general population, quite a few of these children will have adult levels that do not require individual intervention.

#### **I. INTERACTIONS WITH OTHER RISK FACTORS**

The risk of elevated blood cholesterol levels in adults is compounded by the presence of other risk factors that independently influence the occurrence of CHD and, moreover, tend to aggregate in individuals. Even in children and adolescents, obesity is associated with increased total cholesterol and triglyceride levels and blood pressure, and cigarette smoking is correlated with higher VLDL and LDL and with lower HDL (Lauer et al. 1975; Hennekens et al. 1976; Glueck et al. 1981; Craig et al. 1990). Family history of cardiovascular disease is associated with high levels of cholesterol in childhood (Schrott et al. 1982; Moll et al. 1983; Freedman et al. 1986; Lee et al. 1986). Children and adolescents identified as being potentially at risk on the basis of a

single risk factor, such as elevated blood cholesterol or high blood pressure, may well have other risk factors such as obesity or smoking that should be addressed.

**J. SUMMARY: SIGNIFICANCE OF CHOLESTEROL LEVELS IN CHILDREN AND ADOLESCENTS**

The foregoing evidence can be summarized as follows:

- Children and adolescents in the United States have higher blood cholesterol levels and higher intakes of saturated fatty acids and cholesterol than their counterparts in many other countries. In addition, U.S. adults have higher blood cholesterol levels and higher rates of CHD morbidity and mortality than adults in these other countries.
- Autopsy studies demonstrate that early coronary atherosclerosis or precursors of atherosclerosis often begin in childhood and adolescence.
- High blood total cholesterol, LDL-cholesterol, and VLDL-cholesterol levels, and low HDL-cholesterol levels, are correlated with the extent of early atherosclerotic lesions in adolescents and young adults.
- Children and adolescents with elevated blood cholesterol, particularly LDL-cholesterol levels, frequently come from families in which there is a high incidence of CHD among adult members.
- High blood cholesterol aggregates in families as a result of both shared environments and genetic factors.

- Children and adolescents with high cholesterol levels are more likely than the general population to have high levels as adults.

The panel concluded that strategies to lower blood cholesterol levels in children and adolescents should be developed.

## **K. STRATEGIES FOR INTERVENTION**

There are two approaches to lowering cholesterol levels in children and adolescents: a public health (or population) approach and an individualized approach. The panel recommends a strategy that combines the two.

### **1. The Population Approach**

The population approach aims to lower the average population levels of blood cholesterol in children and adolescents by encouraging the adoption of a low saturated fatty acid, low cholesterol eating pattern. An advantage of this approach is that even a relatively small reduction of mean total and LDL-cholesterol levels in children and adolescents, if carried into adulthood, could substantially decrease the incidence of CHD. It would also reduce the number of adults who have high-risk cholesterol levels (Rose 1985; NCHS-NHLBI Collaborative Lipid Group 1987). Furthermore, the population approach can improve nutrition in general and help prevent obesity, which is associated with hypertension and other conditions such as diabetes. Indeed, the population approach has the potential to prevent a variety of chronic diseases including certain forms of cancer. Also, this approach will influence food providers, conveying a secondary benefit to all children and adolescents eating away from home. Finally, there is a potential for blunting

the age-related increases in total and LDL-cholesterol levels that occur in industrialized countries. The population approach is presented in section II.

## **2. The Individualized Approach**

The second approach is to identify and treat individual children and adolescents with very high cholesterol levels including those with genetically determined elevations. This has the advantage of identifying those who are at highest risk of having elevated blood cholesterol levels as adults and who require special attention from health professionals to attain more healthful lifestyles and lower blood cholesterol levels. The individualized approach is presented in sections III and IV.

The population approach serves as the principal means for preventing CHD because it can affect all American children and adolescents in a variety of settings. For a smaller number of children, those at higher risk of developing CHD as adults, the individualized approach is needed. The two approaches complement each other, creating an effective synergy.

## **II. THE POPULATION APPROACH: NUTRITION RECOMMENDATIONS FOR HEALTHY CHILDREN AND ADOLESCENTS**

### **A. INTRODUCTION**

The nutrition recommendations in this section are intended to lower average population levels of blood cholesterol in children and adolescents in order to reduce the incidence of adult CHD and generally to improve health. The recommendations are consistent with those of the NCEP Report of the Expert Panel on Population Strategies for Blood Cholesterol Reduction (NCEP 1990b). They also are compatible with the Dietary Guidelines for Americans issued by the U.S. Department of Agriculture and the Department of Health and Human Services (USDA/DHHS 1990), as well as with recommendations of the American Heart Association (Weidman et al. 1983), the U.S. Surgeon General (DHHS 1988), the National Cancer Institute (NCI 1987), and the National Research Council (NRC 1989a). Dietary recommendations for children with high levels of blood cholesterol are described in section IV.

### **B. RECOMMENDATIONS AND RATIONALE**

#### **1. Recommendations**

The following recommendations for nutrient intakes are for healthy children and adolescents. As toddlers over 2 years of age begin to eat with the family, they may safely make the transition to this eating pattern (see "Toddlers," page 2-7). Because food intake varies from day to day, these recommendations are meant to represent an average of nutrient intake over several days.

- Nutritional adequacy should be achieved by eating a wide variety of foods.

- Energy (calories) should be adequate to support growth and development and to reach or maintain desirable body weight.
  
- The following pattern of nutrient intake is recommended:
  - Saturated fatty acids--less than 10 percent of total calories.
  - Total fat--an average of no more than 30 percent of total calories.
  - Dietary cholesterol--less than 300 mg per day.

## 2. Rationale

Nutritional Adequacy with a Wide Variety of Foods. No single food item provides all of the essential nutrients in the amounts needed. Choosing a wide variety of foods from all the food groups is the best way to ensure an adequate diet.

Adequate Energy (Calories). Children require sufficient calories for growth as well as maintenance of body functions, and their energy needs depend on height, weight, rate of growth, and level of physical activity. Younger children require a higher caloric intake per unit of body weight than older children and adolescents. Some children and adolescents may need more calories than indicated by the Recommended Dietary Allowances (RDA's) (NRC 1989b), particularly adolescents who participate in athletic activities. An eating pattern that contains about 30 percent of calories from fat can readily provide adequate calories for children over 2 years of age. Excessive calories can lead to obesity and should be avoided.

**Saturated Fatty Acids.** Saturated fatty acids (SFA) raise blood cholesterol levels (NCEP 1990b); therefore, a major dietary emphasis should be on reducing SFA intake. The panel recommends a target of less than 10 percent of calories from SFA.

**Total Fat.** The percentage of calories from total fat intake, independent of the relative content of the individual fatty acids, does not affect the level of blood cholesterol. A sufficiently low SFA intake can be achieved with a fat intake of about 30 percent of calories. A lower fat intake is usually not necessary and, for some children and adolescents, may make it difficult to provide enough calories and minerals for optimal growth and development. The recommended target of no more than 30 percent of calories from fat is a practical approach to controlling SFA intake, yet provides sufficient fat for essential fatty acids and absorption of fat-soluble vitamins and contributes calories for normal growth and development.

Unsaturated fatty acids do not increase blood cholesterol levels. The two major types of unsaturated fatty acids are polyunsaturated and monounsaturated. The panel recommends that up to 10 percent of total calories come from polyunsaturated fatty acids; this includes omega-6 and omega-3 fatty acids (largely derived from vegetable oils and fish, respectively). Monounsaturated fatty acids should provide the remaining 10 to 15 percent of calories from fat.

**Dietary Cholesterol.** It has been estimated that, with a 2,500 calorie diet, blood cholesterol will decrease by about 4 mg/dL for every 100-mg-per-day decrease in dietary cholesterol (Grundy et al. 1988). This response holds even at low intakes of cholesterol, and thus the lower the dietary cholesterol, the lower the blood cholesterol on the average. There appears to be considerable inter-individual variability in the response of blood cholesterol to dietary cholesterol. Based on the observed effects of dietary cholesterol on blood cholesterol levels, the panel

concludes, as have many investigators and expert panels, that high dietary cholesterol intake should be avoided (NCEP 1990b).

### 3. Other Nutrients and Food Components

Carbohydrate. With the reduction in fat intake, the panel suggests that consumption of carbohydrates be increased to about 55 percent of calories. This level should be achieved primarily by increasing foods high in complex carbohydrates, such as pastas, potatoes, many vegetables, legumes, and cereals and breads, especially whole grain. These foods, as well as fruits, which are sources of simple carbohydrates, generally are low in fat and are good sources of dietary fiber, vitamins, and minerals.

Protein. Protein is vital to growth and development. Given the above recommendations for fat and carbohydrate, protein should provide about 15 to 20 percent of caloric intake. Protein from animal sources (meat, poultry, fish, eggs, and many dairy products) contains all the essential amino acids in proportions needed for human growth and tissue repair. Plant proteins (from legumes, bread, cereal, pasta, and grain products) are typically low in one or more of the essential amino acids. Incomplete protein foods can be combined (e.g., brown beans with rice) to achieve a balanced mixture of essential amino acids. These combinations of plant proteins are quite low in saturated fatty acids and total fat.

Fiber. Foods naturally high in fiber provide energy and a variety of nutrients and are low in saturated fatty acids, total fat, and cholesterol. These foods, such as fruits, vegetables, and grains, including oat and wheat cereals, are not a panacea for high blood cholesterol but are nutritious and useful components of a low-SFA, low-fat, and low-cholesterol eating pattern.

#### **4. Eating Patterns**

To meet the recommendations for nutrient intake for healthy children and adolescents, families should adopt eating patterns that include lower amounts of saturated fatty acids, total fat, and cholesterol. The panel makes the following recommendations:

- Eat a greater quantity and variety of fruits, vegetables, grains, breads, cereals, and legumes.
- Eat more low-fat dairy products such as skim or low-fat milk and skim or low-fat milk products.
- Eat moderate amounts of trimmed, lean red meat, poultry without skin, or fish in place of choices high in saturated fatty acids.
- Eat egg yolks only in moderation.
- Use oils, margarines, and shortenings with vegetable oils containing primarily unsaturated fatty acids instead of saturated fatty acids.
- Choose prepared baked goods that have been made with unsaturated vegetable oils and, at most, small amounts of egg yolk.
- Choose "convenience foods" that are low in saturated fatty acids, total fat, and cholesterol.

- In fast food and other restaurants, select menu items that are low in saturated fatty acids, total fat, and cholesterol as well as cooked foods that are baked, boiled, or broiled without fat.

Vegetarian diets are not required to achieve the recommended nutrient intakes. If a vegetarian diet is chosen, consultation with a registered dietitian or other qualified nutrition professional can be helpful. Well-planned vegetarian diets have potential nutritional and health benefits, according to the American Academy of Pediatrics and the American Dietetic Association (AAP 1977; ADA 1988). Individuals following vegetarian plans have been shown to have lower average serum cholesterol levels and blood pressures than non-vegetarians. These findings may be related to the reductions in dietary fat and SFA and lower body weights in vegetarians rather than vegetarianism per se (Jacobs and Dwyer 1988).

Vegetarian diets for children and adolescents require careful attention. Diets must be planned to include adequate calories, protein, iron, calcium, and vitamins B-12 and D (AAP 1977; ADA 1988). Inadequate intakes of calories and nutrients from poorly planned vegetarian diets have caused growth retardation, rickets, vitamin B-12 deficiencies, and hypocalcemia (Jacobs and Dwyer 1988). Dietary deficiencies are most common in vegan diets, which do not include dairy products or eggs. Lactovegetarian and lacto-ovovegetarian diets provide greater opportunities to include calories, protein, and other nutrients needed for growth.

## 5. Summary

The primary goals of the dietary recommendations are to limit intakes of SFA to less than 10 percent of total calories, to provide sufficient calories for growth and development without

promoting obesity, and to limit cholesterol to less than 300 mg per day. These may be achieved more easily if the intake of total fat is restricted to no more than 30 percent of calories.

## **C. NUTRITIONAL ADEQUACY IN CHILDHOOD AND ADOLESCENCE**

### **1. Children and Adolescents**

To ensure that the recommended eating pattern is nutritionally adequate for children and adolescents, the panel developed an example of the pattern and compared its nutrient content to the RDA's (see Appendix C, Table C-1). An eating pattern that conforms to the recommended nutrient intakes generally meets or exceeds the RDA's for all nutrients, including iron, zinc, and calcium. This eating pattern supports normal growth and development; it is anticipated that the suggested changes in eating patterns will bring about a significant decrease in cholesterol levels in children and adolescents.

### **2. Toddlers**

Toddlers 2 and 3 years of age are in a transition period when they gradually assume the eating patterns of the rest of the family. This is a period when some flexibility in applying the panel's recommendations is appropriate. The RDA's for zinc, iron, and calcium are relatively high for children 2 and 3 years of age (NRC 1989b). Foods that supply these nutrients are lean meat (for iron and zinc), low-fat dairy products (for calcium), and fortified or enriched bread and cereal products, beans, and peas (for iron).

It should be noted that the current eating pattern of most U.S. children 2 and 3 years of age does not meet the RDA's for iron and zinc (HNIS 1988). The recommended eating pattern provides more of these minerals than is now typically consumed by this age group.

### 3. Infants

In recommending nutritional strategies for children, the panel excludes the age group of birth to 2 years. The fast growth of infants requires an energy-dense diet with a higher percentage of calories from fat than is needed by older children. Based on current knowledge, it is inappropriate to apply nutrient guidelines for fats, cholesterol, and calories to children under 2 years of age. There is agreement among the American Academy of Pediatrics, the American Heart Association, the NIH Consensus Conference on Lowering Blood Cholesterol, and the NCEP that fat and cholesterol should not be restricted in the diets of infants (Weidman et al. 1983; Consensus Conference 1985; AAP 1986; NCEP 1990b).

Breast milk is recommended as the main source of nutrients during the first 4 to 6 months of life. Infant formula is an acceptable substitute when breast feeding is not possible. Breast milk and infant formula have a caloric density of about 0.7 kcal/ml and provide about 50 percent of calories from fat. The high fat content facilitates meeting the high energy requirements of the young infant, who has a limited capacity for ingestion. After 4 to 6 months of age, pureed and table foods, which typically provide fewer calories from fat than breast milk or formula, are progressively added and gradually replace breast milk or formula in the diet of the infant and young child.

The lactating mother's diet has no effect on the total fat content nor the cholesterol content of breast milk (Jensen et al. 1990). However, the fatty acid composition of breast milk fat is determined, in part, by the mother's diet and, in part, by her body fat stores (Insull et al. 1959). Thus, adoption by lactating women of a diet low in saturated fatty acids, total fat, and cholesterol will have no adverse effects on breast milk composition.

The panel explicitly recommends against feeding skim milk as a significant calorie source to infants. Skim milk provides a very high solute load per calorie from mineral salts and protein. Such a solute load demands water for excretion in the urine, making the infant, who already has a high rate of water turnover, vulnerable to serious dehydration.

#### **D. CHANGES NEEDED IN CURRENT NUTRIENT INTAKE AND EATING PATTERNS**

Children ages 1 to 19 years in the United States have an average dietary intake of 14 percent of total calories from saturated fatty acids; children ages 1 to 11 years average 35 percent of total calories from fat, and those ages 12 to 19 years average 36 percent of total calories from fat. Average daily cholesterol intakes for children and adolescents are 193 mg for ages 1 to 5 years, 255 mg for ages 6 to 11 years, and 296 mg for ages 12 to 19 years. In addition, children and adolescents consume about 6 percent of calories as polyunsaturated fatty acids and 13 to 14 percent of calories as monounsaturated fatty acids (HNIS 1991 [Preliminary data]).

##### **1. Saturated Fatty Acids**

Saturated fatty acids are provided by both animal and plant sources. Survey data indicate that 55 to 60 percent of the SFA intake of adults and children 1 to 5 years of age comes from meat, poultry, fish, and dairy products, and from mixed dishes containing these animal products

as major ingredients (Park and Yetley 1990). While meat, poultry, and fish products are the major contributor to SFA intake of adults, dairy products are the major contributor to SFA intake of children (HNIS 1988; Park and Yetley 1990). Grain products such as bakery goods are other major contributors to the SFA intake of adults and children, accounting for 15 to 20 percent of the total daily SFA intake (Park and Yetley 1990).

The primary method of meeting the recommended SFA intake of less than 10 percent of calories is through more frequent choices of low-fat foods and foods made with low-fat preparation methods. Particularly important are more frequent choices of low-fat dairy products including low-fat and nonfat milk, low-fat cheese, and low-fat or nonfat yogurt, and less frequent choices of whole milk, ice cream, and regular cheeses. Because dairy products are a major source of SFA for children, this change alone can go a long way toward reducing SFA intake without jeopardizing intake of essential nutrients. Selecting low-fat cuts of beef and other meats, poultry without skin, and fish can also help reduce SFA. Low-fat cookies, crackers, and cake should also be selected more frequently. Mandatory nutrition labeling will allow identification of foods that are low in SFA, including commercially prepared bakery products and convenience foods; both of these food categories can contribute substantially to SFA intake, although some lower-SFA products have been introduced. In preparation of food, only small amounts of fat should be used as ingredients. Cooking methods of choice include broiling, grilling, steaming, microwaving, poaching, or baking, instead of frying in fats.

## 2. Total Fat

Dietary fat is provided by both animal and plant sources. About half (45 to 50 percent) of the fat in the diets of adults and children 1 to 5 years of age is provided by meat, poultry, fish, egg, and dairy products, and from mixed dishes containing these products as major ingredients

(Park and Yetley 1990). Grain products such as baked goods are also a major source of fat in the diet of adults and children and account for 20 to 25 percent of the total daily fat intake (Park and Yetley 1990). Because dairy, meat, and grain products are major contributors to both SFA and total fat intake, the eating pattern suggested for reduction of SFA intake also will help to reduce total fat intake to the recommended level of an average of no more than 30 percent of calories from fat.

Lowering total fat to no more than 30 percent of calories requires changes in the amount of both visible and invisible fat eaten. Visible fats include such foods as butter, margarine, vegetable oils, hydrogenated shortening, lard, and salad dressings. Invisible fats that are hidden in food include the butterfat in whole milk, ice cream, and cheese; fat in ground meat; fatty streaks or "marbling" in meat; and fat cooked into food during food preparation, including frying.

### **3. Dietary Cholesterol**

Dietary cholesterol is obtained only from foods of animal origin. These include meat, poultry, fish, egg yolks, and dairy products. Most lean meat, poultry, and fish contain similar amounts of cholesterol per 3-ounce serving. Shrimp and crayfish are somewhat higher in cholesterol content but are low in SFA and total fat. Organ meats (liver, heart, kidney, brains) are a very concentrated source of dietary cholesterol. The recommended cholesterol intake of less than 300 mg per day is achieved by selecting foods low in SFA and cholesterol, because SFA and cholesterol occur together in many foods (e.g., dairy products, meat, and poultry).

### **4. Unsaturated Fatty Acids**

Vegetable oils, such as safflower, sunflower, corn, and soybean oil, contain

polyunsaturated fatty acids. Monounsaturated fatty acids are found primarily in vegetable oils such as olive, canola, and peanut oil. Children and adolescents consume about 6 percent of calories as polyunsaturated fatty acids and 13 to 14 percent of calories as monounsaturated fatty acids (HNIS 1991). Little or no change in proportion of unsaturated fatty acid intake is necessitated by this panel's recommendations.

## **E. IMPLEMENTING THE POPULATION APPROACH**

To implement the recommended eating pattern, it is important to understand 1) the characteristics of young people's current eating patterns, 2) how these patterns should be changed, and 3) what strategies can facilitate the change.

### **1. Characteristics of Children's and Adolescents' Eating Patterns**

#### **a. When Children and Adolescents Eat**

Children usually eat breakfast (HNIS 1984), but the number who skip breakfast increases with age throughout the teenage years. The highest proportion of those skipping breakfast are teenage girls. Snacking is common among children and teenagers, with children 6 to 11 years of age consuming 18 percent and teenagers 21 percent of total calories from snacks. Children ages 1 to 5 years obtained 10 to 22 percent of their food energy and nutrients from snacks in 1986 (HNIS 1988).

#### **b. Where Children and Adolescents Eat**

Changes in family demographics, such as a rising number of single-parent families, dual-

income families, smaller families, and older first-time parents, suggest that today's children will be eating more meals and snacks away from home than did previous generations. Children ages 1 to 5 get about one-fifth of their calories (19 percent), fat (20 percent), saturated fatty acids (20 percent), and cholesterol (17 percent) from food obtained and eaten away from home (HNIS 1985). The proportion of children eating away from home and the proportion of calories and nutrients they consume away from home has increased substantially in recent years (HNIS 1984; National Restaurant Association 1988). Moreover, 1 of every 3 dollars spent on food is for food away from home (DHHS/USDA 1989).

School is the most common but not the only place children and adolescents eat away from home. Fast-food restaurants capture 83 percent of restaurant visits by young people under 18 years of age. Visits by children under 6 to both fast-food and table-service restaurants increased 36 percent between 1982 and 1986 (National Restaurant Association 1988).

School aged children eat some meals and snacks away from home, although most of their intake comes from household food supplies (HNIS 1984). On the other hand, an increasing amount of food consumed at home is not prepared at home. Children are frequent takeout customers. In 1988, more than 50 percent of all their restaurant visits involved off-premises consumption (National Restaurant Association 1988).

**c. What Children and Adolescents Eat Away From Home**

Table 2-1 shows the restaurant foods that are most popular with children and adolescents. Foods most often ordered for children under age 6 include soft drinks, as well as hamburgers and cheeseburgers, french fries, pizza, and ice cream, foods that tend to be high in SFA, total fat, cholesterol, and calories. Young children under the age of 6 years have increased their orders for

Table 2-1

Most Popular Restaurant Foods for Children and Adolescents

Food Item	Percent of Eater Occasions*	
	Children Under 6 Years	Children/Adolescents Between 6 and 17 Years
Soft drink	35	43
Hamburgers/Cheeseburgers	24	24
French fries	33	30
Pizza	18	21
Fried chicken	12	10
Ice cream	9	9
Milk	8	--
Other desserts	8	8
Mexican food	4	4
Juice	3	--
Breads†	--	7
Side-dish salads	--	6

\* Expressed as percent of eater occasions on which food item was ordered. All food items are not represented in each age category; missing values indicated by --.

† Includes all breads, such as biscuits, toast, other side orders of bread.

Adapted from National Restaurant Association's CREST special study, 1988 (National Restaurant Association 1988).

both Mexican and Asian foods. Pizza, french fries, soft drinks, hamburgers, fried chicken, and ice cream are among the items 6- to 17-year-olds are most likely to order (National Restaurant Association 1988).

More healthful fast food selections are becoming increasingly available for children and adolescents; recently, a number of fast-food restaurants have begun providing some selections that are lower in saturated fatty acids and total fat. Examples include broiled skinless chicken sandwiches, fat-free muffins, low-fat or skim milk, low-fat and nonfat frozen yogurt, and vegetable salads with reduced-calorie salad dressing. In addition, 89 percent of fast-food establishments recently surveyed now fry exclusively with vegetable oil or shortening, instead of animal fats (National Restaurant Association 1990).

The characteristics of children's and adolescents' eating patterns described above should be taken into account when planning strategies to help change these patterns.

## **2. Changes Needed in Eating Patterns by Age Group**

Implementing the panel's recommendations requires changes in the current, typical eating patterns of children and adolescents. The kind and degree of changes required vary by age group.

**Toddlers (ages 2 through 3 years).** The recommended eating pattern requires few changes from the typical intake for a child 2 to 3 years of age. Major changes are reductions in saturated fatty acids and total fat from the dairy and meat groups. The resulting eating pattern includes a wide variety of foods from all food groups. Regular, scheduled meal times help sustain a toddler's appetite. Eating patterns for toddlers may include low-fat snacks at midmorning, midafternoon, and bedtime because this age group has a limited capacity for food at any one time.

**Preschool children (ages 4 through 6 years).** Although preschool children generally have lower calorie and nutrient needs per kilogram of body weight than toddlers, the absolute needs of preschool children for protein and most other nutrients are higher than for toddlers. To meet these needs, midmorning, midafternoon, and evening snacks that are low in SFA, total fat, and cholesterol may be needed to supplement regularly scheduled meals.

**Elementary school-age children (ages 7 through 10 years).** The importance of eating all meals, especially breakfast, may have to be reinforced among school-age children. Quick-to-eat foods suggested for breakfast include cereals, fruit, low-fat muffins, and a variety of low-fat dairy products. Low-fat snacks can be brought from home. Making low-fat foods, meals, and snacks available at home helps establish healthful eating patterns and compensate for occasions when low-fat choices are not available.

**Adolescents (ages 11 through 19 years).** Calorie and nutrient needs for this age group vary widely as a result of marked differences in growth rates and differing levels of physical activity. Particular attention has focused on calcium, iron, and zinc. Special attention is required (especially for girls) to include foods that are sources of these nutrients when fats, which provide a high caloric density, are reduced (see **Appendix C, Tables C-4 and C-5**). Because this is a time of establishing independence, low-fat food choices should be available at school, social functions, and fast-food restaurants, as well as at home.

### **3. Strategies to Facilitate Change**

The population approach requires multiple complementary strategies. These include the involvement of parents in the selection and preparation of lower-fat foods. The population approach also will be strengthened by the active participation of health providers; the provision of

school meals lower in SFA, total fat, and cholesterol, and the teaching of nutrition in schools; the involvement of government agencies in public education and labeling regulation; and the development by the food industry of low-SFA, low-cholesterol foods, such as snacks and school meals that are appealing to children. These strategies, undertaken in a broader environment of community-wide efforts aimed at the general population, should be effective in promoting eating pattern changes among the young.

**a. Schools**

Because 95 percent of children in the United States are enrolled in schools, these are excellent places to initiate nutrition intervention efforts (Frank et al. 1987; Simons-Morton et al. 1988). Preschool and childcare centers may provide similar opportunities. During the past decade, a number of chronic disease risk reduction programs have been implemented successfully in schools (Stone 1985).

Areas in which schools can promote healthful eating patterns include the following:

- **School food service.** The panel recommends that school food programs offer more selections low in saturated fatty acids, total fat, and cholesterol. School lunches are served to approximately 60 percent of students attending public schools in the United States. School food programs provide 25 to 40 percent of total daily calories, with 15 to 17 percent of calories from saturated fatty acids (Radzikowski and Gale 1984; Frank et al. 1987; Parcel et al. 1987; Farris et al. 1984). If both breakfast and lunch are eaten, school programs may provide over 50 percent of daily nutrient intake.

In many parts of the country, including New York State, Massachusetts, Texas, Louisiana, and Minnesota, school lunch programs that include low-fat choices have been developed (Nicklas et al. 1989). Several studies of successful changes in school food service to favor heart healthy eating patterns have been reported (Simons-Morton et al. 1988; Nicklas et al. 1989). These programs involve training food service personnel as well as modifying menus and food preparation methods.

Tables 2-2, 2-3, and 2-4 provide suggestions for modifying school breakfast and lunch menus. Modifying school menus to provide an average of less than 10 percent of calories from SFA and no more than 30 percent of calories from fat performs an educational as well as a nutritional function, by influencing food choices at other meals and snacks eaten away from home (Franklin et al. 1988).

Some children, including those from lower socioeconomic groups, derive a substantial proportion of their caloric intake from school meal programs. For such children, care must be taken in modifying school meals to assure that adequate nutrients are supplied through a variety of foods when saturated fatty acids and cholesterol are reduced.

- **Communication and curricula.** The panel recommends that information about the recommended eating patterns and CHD prevention be included at all grade levels. During the past decade, significant advances have been made in nutrition education programs aimed at changing young people's eating patterns (Stone et al. 1989). These programs emphasize behavioral skills training through participatory classroom activities involving appropriate food selections, personal goal setting,

**Table 2-2**

**Foods To Provide To Decrease Saturated Fatty Acid  
and Total Fat Content of School Breakfasts**

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- Serve a variety of cereals
  - Provide a variety of fruits and juices
  - Substitute margarine for butter
  - Serve lower-fat dairy products (skim, 1%)
  - Include whole-grain or enriched muffins and bagels
  - Serve whole-wheat or enriched English muffins, bagels, toast, pancakes, and French toast
  - Make omelettes or scrambled eggs with more egg whites and fewer yolks
  - When serving yogurt, offer nonfat or low-fat plain yogurt, or low-fat flavored or fruit varieties
- 

Source: Adapted from NHLBI-sponsored program: Child and Adolescent Trial for Cardiovascular Health (CATCH 1990).

**Table 2-3**

**Foods To Provide To Decrease Saturated Fatty Acid and Total Fat Content of School Lunches**

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**Milk**

- Low-fat milk (1%)
- Skim milk

**Meat and Meat Alternates**

- Lean cuts of meat, such as round steak, round rump roast, round tip roast, tenderloin roast
- Lean ground beef (85% extra lean) or soy protein added to regular ground beef
- Chicken or turkey without skin, baked, broiled, roasted, or boiled
- Fresh or frozen fish baked, broiled, or poached
- Tuna fish or salmon
- Cooked dry beans and peas, such as Great Northern, kidney, lima, navy, pinto, red, black, and garbanzo beans, black-eyed peas, lentils, and split peas
- Low-fat and part-skim cheeses: farmers, cottage, part-skim ricotta and mozzarella
- Peanut butter

**Bread or Bread Alternate**

- Breads and bread products: bagels, breads, graham crackers, muffins, rolls, and pancakes, including whole grain or enriched products
- Noodles, rice, barley, pasta, and bulgur

**Fruits and/or Vegetables**

- Fresh, frozen, dried, or canned fruit: apricots, cantaloupe, grapefruit, grapes, honeydew melon, peaches, plums, prunes, raisins, tangerines, and strawberries
- Fresh, frozen, or canned fruit juice

### **Fruits and/or Vegetables (cont.)**

- **Fresh, frozen, or canned vegetables and salads:** broccoli, brussel sprouts, cabbage, carrots, cauliflower, corn, green beans, green peas, green pepper, potatoes, lettuce, okra, spinach, sweet potatoes, tomatoes, winter squash, zucchini

### **Fats**

- **Mayonnaise and dressings, including reduced-calorie and modified-fat, light, or low-sodium salad dressings**
- **Margarine or liquid vegetable oils:** canola, corn, cottonseed, olive, peanut, and safflower oils

### **Other**

- **Baked goods low in fat:** Modified cakes and cookies, including angel food cake, fig cookies, ginger snaps, oatmeal cookies, raisin cookies
- **Ice milk, sherbet, low-fat puddings, and low-fat yogurt**

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Source: Adapted from NHLBI-sponsored program: Child and Adolescent Trial for Cardiovascular Health (CATCH 1990). Refer to USDA Menu Planning Guide for School Food Service (Program Aid No. 1260) for general menu planning guidelines.

Table 2-4

**Tips To Reduce Saturated Fatty Acids in Food Preparation and Recipes for School Lunches**

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**Food Preparation**

- Prepare beef, pork, chicken, and fish by baking, broiling, roasting, or stewing, instead of frying
- Trim all visible fat from beef and pork before cooking it
- Defat ground meat by cooking meat and then draining off the fat
- Brown meats in pan lightly brushed with oil
- When preparing stews or soup, start by trimming all visible fat from the meat; when possible, refrigerate the broth and skim off fat with a spoon before reheating and serving
- Bake or roast meat or meat loaf on a meat rack or on crumpled foil so that the fat can drip off and be discarded
- Remove the skin from chicken before serving
- Instead of frying fish, try poaching in milk, tomato juice, or water flavored with a little lemon juice, or baking with bread crumb and herb coating
- When cooking foods such as eggs, french toast, and pancakes, brush the pan with oil just to coat it, or use a non-stick spray made from vegetable oil or a non-stick pan that requires no greasing

**Recipe Modifications**

- Use low-fat or skim milk or nonfat dry milk in place of whole milk in recipes
- In recipes using mayonnaise or sour cream, reduce half the mayonnaise or sour cream with nonfat or low-fat plain yogurt
- Substitute part-skim milk cheeses, such as mozzarella and farmers cheese, for higher-fat cheeses such as Cheddar, American, and Monterey Jack
- For desserts and breads, use margarine instead of butter or shortening
- For fruit cobblers or crisps, reduce the amount of fat by one-fourth
- Substitute powdered sugar for whipped topping on desserts when appropriate
- Use margarine instead of butter for white sauces
- Use defatted ground beef instead of sausage on pizza
- Use low-fat gravy made with broth or soup base that contains little or no fat

- Do not add margarine or butter when making sandwiches; do not spread melted butter or margarine on rolls or bread
- When making toasted or grilled cheese sandwiches, lightly brush only the outside bread with margarine
- Do not add margarine, butter, or sauces to vegetables; try flavoring vegetables with lemon juice or herbs.

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Source: Adapted from the NHLBI-sponsored Child and Adolescent Trial for Cardiovascular Health (CATCH 1990).

snack preparation skills, and cartoon or peer role models (Coates et al. 1981; Perry et al. 1985). They are achieving significant behavioral changes.

Text books and other educational materials should contain information about healthful eating patterns and their importance, and about the use of food labels. Guest speakers--experts and role models--can reinforce the importance of eating for optimum health. Field trips to grocery stores and restaurants are also a useful way of teaching school-age children how to choose appropriate foods.

- **School athletic programs.** The panel recommends that school programs encourage and support the adoption and maintenance of physical activity patterns that can be sustained over a lifetime. Physical educators and athletic coaches should help educate students about the health risks of high blood cholesterol and the principles of a healthful eating pattern. Regular physical activity, at least in adults, appears to contribute to a favorable lipoprotein profile (Wood et al. 1983). Physically active and fit children and adolescents are less likely to be overweight and have more favorable lipoprotein profiles when compared to their sedentary and unfit peers (Fripp et al. 1985; Sallis et al. 1988).
  
- **School programs involving the family.** Health education programs that change family health skills promote longer-lasting changes in eating patterns (Nader et al. 1986; Nader et al. 1989). Particularly promising are activities that can be completed by parents with their children at home (Perry et al. 1989). For example, a home correspondence course was shown to be more successful in reducing fat and sodium in the diets of third-grade students than curriculum alone (Perry et al. 1988). Program options include audiotapes and materials in the family's native

language and can include 1) background and rationale for dietary change, 2) food preparation, and 3) food choices away from home.

**b. Health Professionals**

Physicians, nurses and nurse practitioners, registered dietitians and other qualified nutrition professionals, health educators, pharmacists, and other health professionals can promote the recommended eating patterns in various ways:

- **Well-child care.** Physicians and other health professionals can take advantage of well-child checkups to provide information to patients on the recommended eating patterns and encourage them to follow these recommendations. Educational materials for patients, such as brochures and videotapes, are available from various professional groups and government agencies. Nutrition counseling can be made a regular component of office or practice routine.
  
- **Community education.** Physicians and other health professionals can serve as resources to their communities in developing nutrition education and CHD risk reduction programs. Several research studies have implemented and evaluated multiple strategies with youth as part of community-wide cardiovascular disease prevention programs (Puska et al. 1982; Farquhar et al. 1984; Mittelmark et al. 1986; Perry et al. 1988). Outcomes suggest that multiple components increase the effectiveness of such programs (Vartianen et al. 1986; Perry et al. 1989).  
Currently, the Child and Adolescent Trial for Cardiovascular Health (CATCH) is evaluating health education curricula, parental involvement, and school

environmental changes in order to lower population cholesterol levels in California, Louisiana, Minnesota, and Texas (Perry et al. 1990).

Special attention should be given to communications with specific cultural and ethnic groups and groups with low incomes or educational levels. Shopping and food preparation guidelines, for example, should incorporate cultural and ethnic preferences.

**c. Government**

The panel recommends that government agencies facilitate adoption of the recommended eating patterns through regulatory and other programs.

- **Food labeling.** The development of regulations to improve food labeling should be continued, and educational strategies, such as curricular materials to teach children and adolescents how to read labels, should be developed.
- **Food assistance programs.** Agencies should expand the availability and encourage the selection of low-SFA, low total fat, and low-cholesterol foods appealing to children in subsidized food programs, such as the school lunch program (see Tables 2-2, 2-3, and 2-4).
- **Public education.** Federal, State, and local agencies should provide more nutrition education through print and audiovisual materials, encourage greater mass media attention to nutrition, and continue collaboration among themselves and with voluntary organizations to provide more consistent nutrition statements.

**d. Food Industry**

Both manufacturers and vendors should be encouraged to promote the recommended eating patterns among children and adolescents in the following ways:

- **Nutrition information.** Food companies should provide simple, consumer-oriented nutrition information so that children and adolescents can more readily understand and use it.
  
- **Availability and selection of foods.** Because children and adolescents eat many snacks and meals away from home, the food industry should make more available foods low in SFA, total fat, and cholesterol. Vendors, such as institutional food services, restaurants, and fast-food chains, should label, promote, and expand the selection of these foods. Special emphasis should be placed on foods available in fast-food and takeout restaurants because they account for a large percentage of the meals children eat in commercial establishments. Tables 2-5 and 2-6 provide examples of snack bar and vending machine foods consistent with the recommended eating pattern.

**e. Mass Media**

As critical channels of communication to the public, the mass media should promote the panel's population recommendations. News, educational, and entertainment programming should provide information on a lower saturated fatty acid, lower total fat, and lower cholesterol eating pattern for children and adolescents.

Table 2-5

**Snack Bar Foods Consistent With Recommended Eating Pattern**

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- 1% low-fat or skim milk, low-fat cheese, low-fat or nonfat yogurt (plain or with fruit)
  - Fresh fruits and vegetables
  - Dried fruits
  - Fruit juices and vegetable juices; soda water with fruit juice added
  - Pretzels, popcorn popped in unsaturated oil, bagels, bagel chips (no fat added), baked tortilla chips
  - Chef salads prepared with lean meat or water-packed tuna and low-fat cheese served with low-fat or fat-free salad dressing
  - Sandwiches made with sliced turkey, lean roast beef, lean ham, low-fat cold cuts, and tuna salad prepared with water-packed tuna and reduced-fat mayonnaise or salad dressing
  - Peanut butter\* and jelly sandwiches
  - Hamburgers or sloppy joes made with lean, well-drained ground beef or ground turkey
  - Tacos made with lean, well-drained ground beef and soft corn tortillas with low-fat cheese or a small amount of regular cheese
  - Beef, chicken, or bean chalupa with baked (not fried) corn tortilla and low-fat cheese or a small amount of regular cheese
  - Pizza made with lean, well-drained ground beef and low-fat cheese or a small amount of regular cheese
  - Nachos with baked (not fried) corn tortilla chips and con queso made with low-fat cheese
  - Cookies, cupcakes, and muffins prepared with unsaturated oil or margarine
  - Frozen yogurt (low-fat or nonfat), ice milk, frozen fruit bars, sherbet, fruit sorbets, low-fat pudding pops
- 

\* High in total fat; low in saturated fatty acids

**Table 2-6**

**Vending Machine Foods Consistent With Recommended Eating Pattern**

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- Peanut butter\* and low-fat crackers
  - Cookies and crackers (low-fat)
  - Fresh fruit
  - Raisins and mixed dried fruit
  - Granola bars made with unsaturated fat
  - Snack mixes of cereal and dried fruit with a small amount of nuts and seeds
  - 1% low-fat or skim milk
  - Fruit juice and vegetable juice; soda water with real fruit juice added
  - Low-fat or nonfat yogurt
  - If candy is included, provide fat-free varieties
- 

\* High in total fat; low in saturated fatty acids

### **III. THE INDIVIDUALIZED APPROACH: DETECTION/DIAGNOSIS/EVALUATION**

#### **A. INTRODUCTION**

The individualized approach to cholesterol lowering among children and adolescents focuses on those who appear to be destined to become adults with high blood cholesterol and an increased risk of coronary heart disease (CHD). This approach calls for the cooperative effort of the entire health professional team in order to identify, treat, and monitor individual children and adolescents who have high serum cholesterol levels, with the ultimate objective of preventing formation of atherosclerotic lesions in the coronary arteries. Because tracking of cholesterol levels from childhood to adulthood occurs but is imperfect, the panel sought ways to identify those children and adolescents whose elevated cholesterol levels are likely to indicate significant risk.

The panel reached consensus that an LDL-cholesterol value of 130 mg/dL or higher (95th percentile), when associated with family history of cardiovascular disease or parental hypercholesterolemia, is sufficiently elevated to warrant further evaluation and probable treatment and followup. The panel deliberately targeted the family unit and on the familial aggregation of cardiovascular disease (CVD) and/or inherited lipid problems because hypercholesterolemia in a child from such a family is of clinical significance. Children with parents and grandparents who have premature CVD often have high cholesterol levels. Thus, cholesterol levels in a child are linked to familial CVD (Hennekens et al. 1976; Schrott et al. 1979; Moll et al. 1983; Lee et al. 1986).

**B. CHOLESTEROL MEASUREMENT: RECOMMENDATIONS FOR SELECTIVE SCREENING**

**1. Who Should Have Cholesterol Measurements?**

The panel makes the following recommendations for the detection (selective screening), in the context of continuing health care, of children and adolescents likely to become adults with high blood cholesterol levels and increased risk for cardiovascular disease.

- Screen children and adolescents whose parents or grandparents, at 55 years of age or less, underwent diagnostic coronary arteriography and were found to have coronary atherosclerosis. This includes parents and grandparents who have undergone balloon angioplasty or coronary artery by-pass surgery. The panel believes that adult cardiologists should make a routine practice of referring the offspring of these patients to a source of continuing health care for testing and followup.
  
- Screen children and adolescents whose parents or grandparents, at 55 years of age or less, suffered a documented myocardial infarction, angina pectoris, peripheral vascular disease, cerebrovascular disease, or sudden cardiac death.
  
- Screen the offspring of a parent who has been found to have high blood cholesterol (240 mg/dL or higher).

- For children and adolescents whose parental or grandparental history is unobtainable, particularly those with other risk factors, physicians\* may choose to measure cholesterol levels in order to identify those in need of individual nutritional and medical advice.

The screening of children and adolescents should occur in the context of their continuing health care. Mass screening in poorly controlled circumstances, such as mall screenings, should be discouraged. The National Cholesterol Education Program has recommended that all adults ages 20 and over have their cholesterol measured. Thus an increasing number of parents can be expected to know their cholesterol levels. Screening children and adolescents in the context of continuing health care provides an opportunity for all first-degree family members to have their CVD risk assessed. This opportunity should be provided. The physician caring for the child should arrange for or conduct screening of the parents; parents' siblings may also be included. The family approach can be useful in case-finding due to the high rate of affected family members. It also helps to provide an accurate diagnosis and assessment of CVD risk for individual family members (Hunt et al. 1986).

In particular clinical situations, physicians should exercise professional judgment in deciding whether to measure cholesterol levels in young people. Optional cholesterol testing by the practicing physician may be appropriate in children who are judged to be at higher risk for CVD independent of a family history of premature CVD or parental hypercholesterolemia. For example, adolescents who are overweight, smoke cigarettes, have high blood pressure, or consume excessive amounts of saturated fatty acids, total fat, and cholesterol may also deserve a cholesterol testing at the discretion of their personal physician. In cases where the cholesterol level is tested

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\* In settings where health care practitioners other than physicians are responsible for primary health care of the child, the recommendations pertaining to selective screening are intended to apply to these health care practitioners as well.

for these and other reasons and an elevated cholesterol level is found, the physician should obtain an accurate family history and ascertain the blood cholesterol status of the parents in order to help decide whether individualized treatment of the child or adolescent is appropriate.

Children and adolescents with medical conditions such as diabetes, or those on certain medications such as isotretinoin (Accutane®) or steroids, might also warrant testing. This approach facilitates the detection of higher-risk children.

**a. Rationale**

The first two recommendations, that offspring of parents and grandparents with documented premature cardiovascular disease be screened; are based on a variety of published studies. Abnormal lipid profiles are found in about 50 percent of children of such parents (Hennekens et al. 1976; Lee et al. 1986). Among children with a positive family history of premature atherosclerotic events, about one out of three have elevated plasma lipid or lipoprotein levels (Tamir et al. 1972; Glueck et al. 1974; Chase et al. 1974; Williams et al. 1988).

The panel recognized that a positive family history alone is frequently inadequate to detect all children with an elevated level of LDL-cholesterol ( $\geq 130$  mg/dL) (Halstrup et al. 1985; Meyerson and Santanello 1988; Davidson et al. 1989; Dennison et al. 1989 and 1990; Garcia and Moodie 1989; Griffin et al. 1989). On the other hand, not all children and adolescents with elevated levels will have high LDL-cholesterol levels as adults (Lauer and Clarke 1990). The panel concluded that by focusing on a positive family history of cardiovascular disease and/or known hypercholesterolemia in a parent, those children who are detected will have a familial basis for their elevated LDL-cholesterol, and that this places them at increased risk of accelerated atherosclerosis (Hennekens et al. 1976; Schrott et al. 1979; Moll et al. 1983). Routine cholesterol

screening in such children and adolescents (and young adults) does not appear to be a part of medical practice in this country. The panel strongly believes that it should be.

The recommendation that screening be extended to children who have at least one parent with high blood cholesterol ( $\geq 240$  mg/dL) is based on analyses made by members of the panel specifically for the purposes of this report. Detailed descriptions of these analyses are found in Appendix B. They are summarized briefly here.

Using the Lipid Research Clinics (LRC) data set, the panel examined the implications of cholesterol testing of children based on parental total cholesterol levels and a positive family history of cardiovascular disease. These data are summarized in Table 3-1. As the cutpoint for parental cholesterol is progressively increased from 200 to 300 mg/dL, the percentage of youth who would be screened decreases from 63.5 percent to 13.9 percent (Table 3-1). Of the total of 74 young people aged 0 to 19 from the LRC population with an LDL-cholesterol  $\geq 130$  mg/dL, the number who were identified correctly also decreased from 64/74, or 86.4 percent, to 21/74, or 28.4 percent (Table 3-1). The sensitivity no longer decreased after the parental cutpoint was raised beyond 260 mg/dL (Table 3-1). This is because the parents of offspring who have an LDL-cholesterol  $\geq 130$  mg/dL, and who themselves have a total cholesterol  $\geq 240$  mg/dL, have very high total cholesterol levels; many are above 300 mg/dL. This makes it more likely that this subset represents inherited high blood cholesterol, as compared to the subset of youth with similar LDL-cholesterol levels but no parental high blood cholesterol.

From these analyses, the panel concluded that cholesterol testing in children and adolescents of parents with high total cholesterol can identify a subset of youth likely to have a familial basis for their elevated LDL-cholesterol levels. The panel chose a parental cutpoint for total cholesterol of 240 mg/dL or above, defined by the NCEP's Adult Treatment Panel as a high

**Table 3-1**

**Percentage of All Children Aged 0-19 Who Would Be Screened, and Percentage of Those With LDL-Cholesterol  $\geq 130$  Who Would Be Identified, If the Presence of Cardiovascular Disease or Various Levels of Elevated Total Cholesterol in at Least One Parent Is Used To Select Children for Screening. The Lipid Research Clinics Prevalence Study (N=1,042).**

<b>Parental cholesterol higher than:</b>	<b>Percentage of children who would be screened</b>	<b>Sensitivity for identification of children with LDL-C <math>\geq 130</math> mg/dl (n=74)</b>
200 mg/dL	63.5%	86.5%
220 mg/dL	44.3%	63.5%
240 mg/dL	25.1%	40.5%
260 mg/dL	18.3%	29.7%
280 mg/dL	15.3%	28.4%
300 mg/dL	13.9%	28.4%

level (NCEP 1988). At a parental cutpoint of 240 mg/dL, about 25 percent of the offspring will be tested and about 41 percent of those with LDL-cholesterol  $\geq$ 130 mg/dL will be identified (Table 3-1). The 59 percent who will be missed will be less likely to have a familial basis. This approach provides a balance between the number of youth to be tested and the number to be detected. It also appears to identify a group of children with inherited high blood cholesterol. In contrast, a parental cutpoint of 200 mg/dL would theoretically trigger cholesterol screening for over 60 percent of youth (Table 3-1) and, while about 85 percent of those with high LDL-cholesterol levels would be identified, perhaps half would not have a familial lipid problem. On the basis of these data, the panel concluded that it is wise to test for high cholesterol in all young people whose parents have a total cholesterol exceeding 240 mg/dL.

Before recommending this selective screening approach, the panel carefully considered the advantages and disadvantages of cholesterol screening of all U.S. children (universal screening). The principal advantage of universal screening is its potential to identify all children with high cholesterol levels. However, the panel concluded that there was insufficient scientific and medical evidence to recommend universal screening and that it had certain disadvantages. One of the reasons the panel did not recommend universal screening was that tracking is imperfect in a considerable number of children. That is, although high cholesterol levels in childhood are often associated with high levels in adulthood, this is not true in many cases. In addition, the panel was concerned that universal screening could lead to "labeling" of a large number of children as patients who require individual counseling. This could provoke unjustified anxiety in children and their parents, including many children who would turn out not to have high cholesterol levels as adults, even in the absence of intervention. The panel also recognized that for most children who have high cholesterol, the diet low in saturated fat and cholesterol recommended for the general population is sufficient; only when hypercholesterolemia is more marked are specific medical interventions justified. Another concern of the panel was that the introduction of

universal screening would, in due course, lead to overuse of cholesterol-lowering drugs. Insufficient evidence exists about the safety of drug therapy in childhood, as well as the efficacy of drug therapy in childhood and adolescence to reduce CHD morbidity and mortality in adulthood. The panel strongly holds that such drug use should be held to a minimum. Finally, while pathologic lesions may currently be common in childhood, they are of a low grade of severity and unlikely to cause clinical sequelae for many decades. CHD deaths for the most part occur after 65 years of age. Given the efficacy of medical intervention in middle-aged hypercholesterolemic individuals, there is sufficient opportunity to introduce medical treatment for most individuals at some time in adult life. Although it did not recommend universal screening, the committee agreed that for very high risk hypercholesterolemic children, namely those with a family history of premature cardiovascular disease or familial hypercholesterolemia, it is prudent to initiate treatment at an early stage.

The panel recognizes that many children and adolescents may not know their family histories. Thus physicians and other health professionals concerned with child health care have a special responsibility for the identification of those at high risk and therefore, may choose to measure cholesterol levels in children and adolescents whose parental and grandparental histories are unobtainable, particularly those who have other risk factors.

## **2. Classification of Cholesterol Levels**

The panel agreed that a total cholesterol level of  $\geq 200$  mg/dL or an LDL-cholesterol level of  $\geq 130$  mg/dL (95th percentile), when associated with family history or parental hypercholesterolemia, is sufficiently elevated to warrant further evaluation; these levels are classified as high (Table 3-2). Such cholesterol levels are outside the desirable range even for an adult. While about 5 percent of all American children and adolescents have an LDL-cholesterol

**Table 3-2**

**Classification of Total and LDL-Cholesterol Levels  
in Children and Adolescents From Families With  
Hypercholesterolemia or Premature Cardiovascular Disease**

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<b><u>Category</u></b>	<b><u>Total Cholesterol*</u></b>	<b><u>LDL-Cholesterol*</u></b>
Acceptable	< 170 mg/dL	< 110 mg/dL
Borderline	170-199 mg/dL	110-129 mg/dL
High	≥ 200 mg/dL	≥ 130 mg/dL

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\* To convert cholesterol values in mg/dL to millimoles per liter (mmol/L), multiply by 0.02586. See Table A-1 in Appendix A.

≥130 mg/dL, about half of these, or about 2 percent, will have a positive family history of cardiovascular disease or a parent with a high cholesterol (≥240 mg/dL) (Table 3-1). This subset will most likely have a familial basis (genetic or environmental) for their high LDL-cholesterol levels. Some children and adolescents from such families may have less extreme elevations in total and LDL-cholesterol levels. For these young people, the panel classifies as borderline those total cholesterol levels that are between 170 and 199 mg/dL and LDL-cholesterol levels that are between 110 and 129 mg/dL (Table 3-2). These cutpoints are about the 75th percentile for children and adolescents. Levels below these borderline ranges are classified as acceptable (Table 3-2).

### **3. At What Age Should the Blood Sample Be Obtained?**

The panel recommends that a blood sample be obtained any time after the age of 2 years. The levels of total cholesterol and LDL-cholesterol are reasonably consistent thereafter (with some small decrement during adolescence). In addition, no treatment recommendations are made for any child below 2 years of age. If the levels are acceptable, the measurement should be repeated after 5 years. The followup analyses are necessary because certain familial disorders associated with premature CHD, such as familial combined hyperlipidemia (FCH), have a delayed expression.

### **4. What Should Be Measured?**

For children and adolescents who have at least one parent who has been found to have high blood cholesterol (≥240 mg/dL), the panel recommends the initial screening test be a measurement of total cholesterol. This is appropriate because for these children, an elevated parental total cholesterol (or LDL-cholesterol) is the trigger for screening, and the affected child

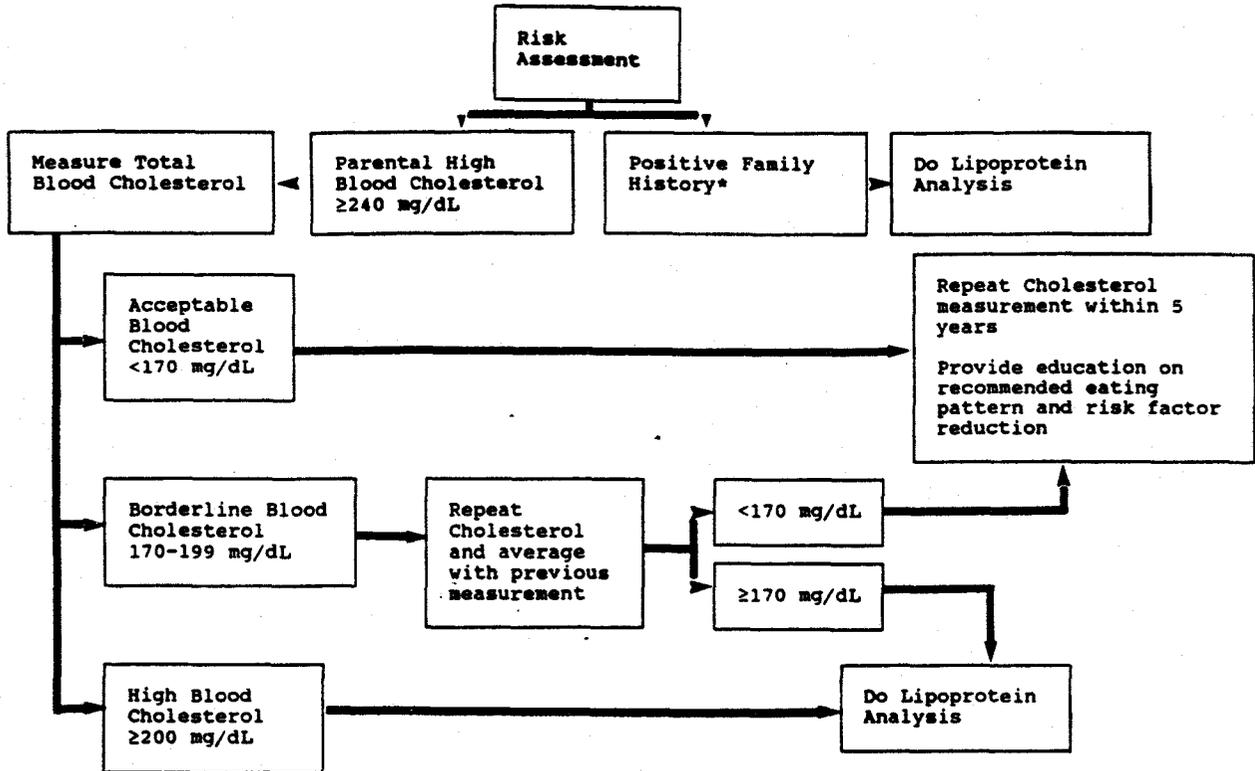
may have an elevated total cholesterol. Starting with measurement of total cholesterol is more convenient and less expensive than a lipoprotein analysis. The child does not have to be fasting for this test. Those children found to have a total cholesterol  $\geq 200$  mg/dL should return fasting for a lipoprotein analysis (Figure 3-1). Those with a total cholesterol between 170 and 199 mg/dL should have a repeat total cholesterol performed. If the average of the two measurements is  $\geq 170$  mg/dL, a lipoprotein analysis is obtained.

For a child or adolescent with a positive family history of cardiovascular disease (as defined earlier), a fasting lipoprotein analysis should be the initial screening test (Figure 3-1). Many of these children have dyslipidemia that requires characterization by lipoprotein analysis. For example, a very low HDL-cholesterol level might not be detected if total blood cholesterol alone was tested, but would be discovered on obtaining a lipoprotein analysis. The total cholesterol, HDL-cholesterol, and total triglyceride levels should be measured following an overnight fast of 12 hours. The LDL-cholesterol level is usually estimated by the following formula:

$$\text{LDL-cholesterol} = \text{total cholesterol} - \text{HDL-cholesterol} - (\text{triglycerides}/5) \text{ (Friedewald et al. 1972)}$$

This formula is not accurate if the child is not fasting, if the triglyceride level is above 400 mg/dL, or if chylomicrons or dysbetalipoproteinemia (type III hyperlipoproteinemia) is present.

**Figure 3-1**  
**Risk Assessment**



\* Defined as a history of premature (before age 55 years) cardiovascular disease in a parent or grandparent

## **5. How Should Cholesterol and Lipoproteins Be Measured?**

### **a. Standardization of procedures**

Ideally, blood should be drawn with the child in the sitting position (being recumbent for more than a few minutes can falsely lower the lipid and lipoprotein results). For the purposes of measurement of total cholesterol alone, a nonfasting sample is adequate. If a lipoprotein analysis or triglyceride level is to be determined, the child should fast (nothing to eat or drink except water) for 12 hours. The child or adolescent should not be tested while actively ill or with an infectious disease; cholesterol should also not be measured in pregnant adolescents. The child should be following his or her usual diet. Medications such as steroids, isotretinoin (Accutane<sup>®</sup>), phenobarbital, or oral contraceptives can alter cholesterol levels, and these effects should be taken into account when measuring lipid levels (See pp. 3-13, 3-14, and 3-14a).

### **b. Laboratory standardization**

The NCEP's Laboratory Standardization Panel has recommended national standardization of cholesterol measurement for accuracy (NCEP 1990a). Its recommendations include goals for precision (how closely two measurements on the same sample agree) that include an intralaboratory coefficient of variation that is  $\leq 5$  percent in 1990 and reaches  $\leq 3$  percent by 1992. For accuracy, that panel recommended that bias (systematic deviation from the true value) should not exceed  $\pm 5$  percent in 1990 and  $\pm 3$  percent by 1992. It also recommended selection of a clinical laboratory whose methods are traceable to the reference method of the Centers for Disease Control and which participates in a program of external standardization to ensure that the goals for precision and accuracy are met. The use of enzymatic micromethods for cholesterol should be subject to the same criteria of accuracy.

**6. How Many Measurements Should Be Obtained?**

The lipoprotein analysis should be repeated at least once to derive an average level before beginning intervention (Figure 3-2). Because lipoprotein levels vary within individuals, the average of two measurements is more likely to be an accurate indication of lipoprotein levels than is a single reading.

**7. How Should Abnormal Values Be Interpreted?**

This panel recommends the definitions found in Table 3-2 for acceptable, borderline, and high total and LDL-cholesterol levels in children and adolescents from families with inherited cholesterol problems or premature cardiovascular disease. The meaning of a borderline or high value in a child whose parents do not have high cholesterol or a family history of premature CVD is less clear at the present time.

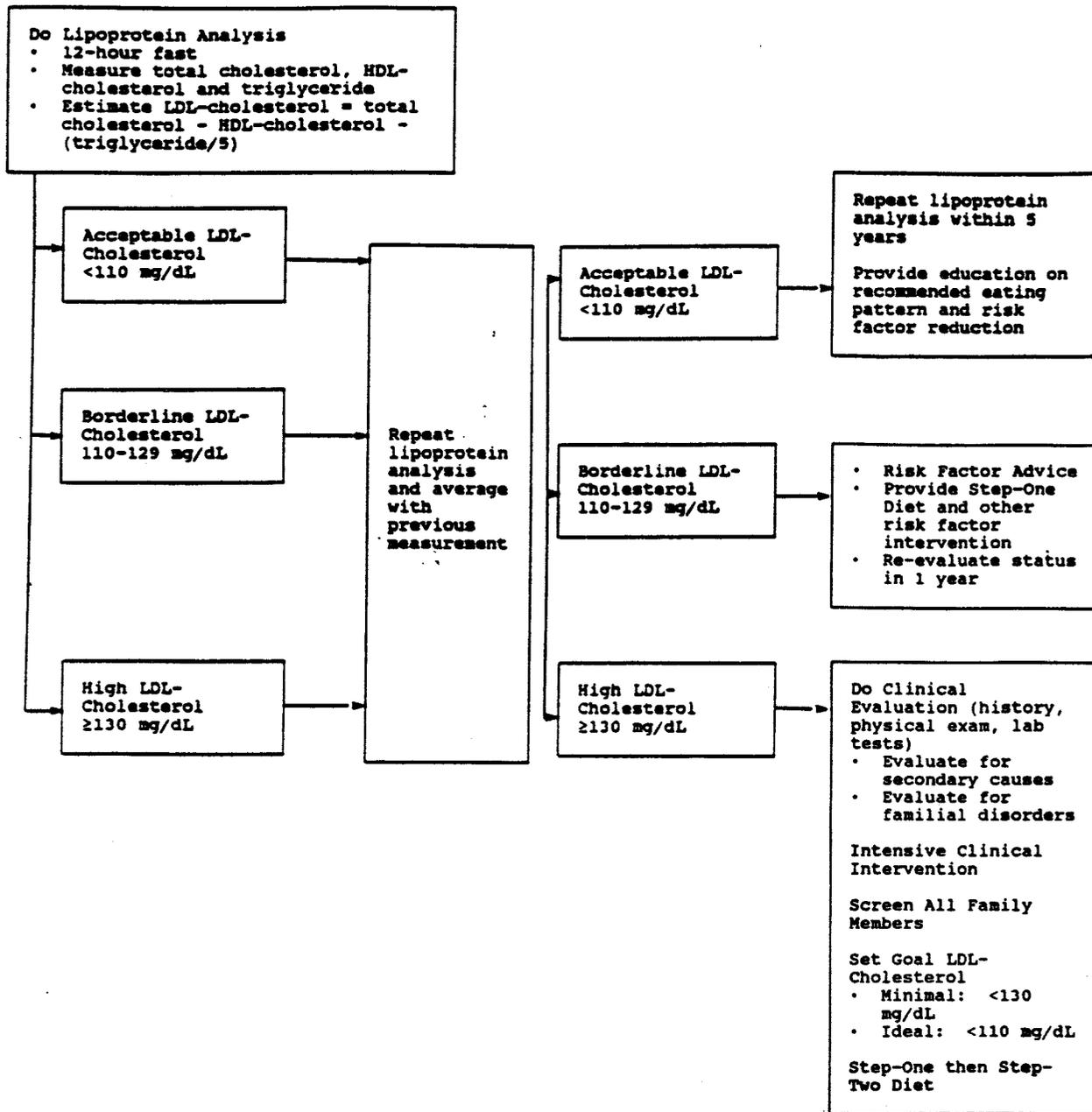
**8. Number of Children and Adolescents Affected by the Screening Recommendations, and Cost Estimates**

Using LRC data, the panel estimated the percentages of children and adolescents who would be affected by its recommendations and the costs entailed. Its analysis indicated that, using a combination of a positive parental history of premature cardiovascular disease and parental high cholesterol ( $\geq 240$  mg/dL) as the screening criteria, 25.1 percent of all children would be tested (Table 3-1).

Of these, 5.6 percent (average of 5.2 and 6.0 percent in the first and second decades, respectively) would have a positive family history of parental premature cardiovascular disease. A lipoprotein analysis would be obtained for these individuals. Because comparable data are not

Figure 3-2

Classification, Education, and Followup Based on LDL-Cholesterol



available for grandparental history of premature CVD, this 5.6 percent represents the minimum number that would receive a lipoprotein profile. The remaining 19.5 percent of all children and adolescents ( $25.1\% - 5.6\% = 19.5\%$ ) would have their total cholesterol measured because of high parental cholesterol.

Table 3-3, Part I, shows the estimated number of children who would require total cholesterol and LDL-cholesterol measurement according to the screening recommendations described. These recommendations would result in screening approximately 25 percent of all children over 2 years of age. This would initially involve about 14,650,000 children. Thereafter, about 1 million children would be screened annually.

Table 3-3, Part II, shows the estimated costs of implementing the screening recommendations. The estimated costs for obtaining total and LDL-cholesterol measurements would range from approximately \$173 million to \$346 million. These figures represent laboratory costs only; additional costs for office visits, nutrition counseling, and drug therapy would add to these estimates. Once screening has been conducted the first time on each child, the annual costs would be about 1/15 of the initial costs, a range of about \$12 million to \$23 million.\*

Several reviews (Berwick et al. 1981; Kinosian and Eisenberg 1988; Strong and Dennison 1988) discuss the benefits, costs, and risks of over- and under-diagnosis of children with elevated cholesterol and review possible screening approaches. These reviews note that community-wide interventions and targeted screening are likely to be more efficient than universal screening, but that no data are presently available on the effectiveness of such interventions on the prevention of CHD in later life. Further research concerning efficient ways to improve dietary behavior in

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\* Approximately 60 million U.S. children are now ages 2 to 18, and about 14,650,000 would be screened at start-up. An additional 1 million children would enter into screening each year.

Table 3-3

Estimated Number Requiring Screening and Cost Estimates

Part I: Estimated Number Requiring Screening  
(Total Number of U.S. Children Ages 2-18 years=60,148,000)

A. Estimated number with parental high cholesterol of $\geq 240$ who require a total blood cholesterol measurement.	11,278,860 (19.5% of 60,148,000)
1) Will have an initial total blood cholesterol measurement of 170-199 mg/dL and have a repeat measurement.	2,932,215*
2) Will retest at $\geq 170$ mg/dL and have a lipoprotein analysis.	1,466,107 (estimated 50% of A <sub>1</sub> )
3) Will have an initial total blood cholesterol measurement of $\geq 200$ mg/dL and require a lipoprotein analysis.	586,443 <sup>†</sup>
B. Estimated number with positive family history of premature cardiovascular disease who require a lipoprotein analysis.	3,368,288 (5.6% of 60,148,000)
C. Of those who had a lipoprotein analysis, estimated number who have LDL-cholesterol $\geq 130$ and need a second lipoprotein analysis.	1,217,997 <sup>††</sup>

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Note: Since approximately 60 million U.S. children are now ages 2 to 18, about 14,650,000 would be screened at start-up. An additional 1 million children would enter into screening annually.

\* Minimum estimate based on 25%  $\geq 170$  mg/dL (selected populations here may have higher proportions).

<sup>†</sup> Minimum estimate based on 5%  $\geq 200$  mg/dL.

<sup>††</sup> Based on LRC, 40.5% of universe of those with LDL  $\geq 130$  mg/dL will be detected at second visit. (Total N [60,148,000] x .405 x .05)

Sources: U.S. Census for population figures, Lipid Research Clinics Family Study data for percentage estimates of children to be screened.

**Table 3-3**

**Estimated Number Requiring Screening and Cost Estimates**

**Part II: Estimated Costs of Screening**

	<b>Range of Costs per Child</b>	<b>Total Range of Costs</b>	
<b>Total cholesterol measurements</b>			
A 11,728,860 (initial measurement)	\$5-\$10	\$58,644,300	- \$117,288,600
A <sub>1</sub> 2,932,215 (repeat measurement)		14,661,075	- 29,322,150
	Subtotal	<u>\$73,305,375</u>	- <u>\$146,610,750</u>
<b>Lipoprotein analyses</b>			
A <sub>2</sub> 1,466,107 (average of 2 total cholesterol measurements ≥170 mg/dL)	\$15-\$30	\$21,991,605	- \$43,983,210
A <sub>3</sub> 586,443 (total cholesterol ≥200 mg/dL)		8,796,645	- 17,593,290
B 3,368,288 (positive family history)		50,524,320	- 101,048,640
C 1,217,997 (repeat lipoprotein analysis)		18,269,955	- 36,539,910
	Subtotal	<u>\$99,582,525</u>	- <u>\$199,165,050</u>
	<b>START-UP COST*</b>	\$172,887,900	- \$345,775,800
<hr/>			
	<b>ANNUAL COST†</b>	\$11,525,860	- \$23,051,720

\* For 14,650,000 screened at start-up.

† For 1 million screened annually.

Sources: U.S. Census for population figures, Lipid Research Clinics Family Study data for percentage estimates of children to be screened.

high-risk individuals and in the population at large, and the efficiency of various screening approaches, is needed to provide better cost-benefit estimates for each approach.

## **C. CLINICAL EVALUATION**

### **1. Classification Based on LDL-Cholesterol Levels**

Clinical evaluation is intended to detect children and adolescents with high LDL-cholesterol levels ( $\geq 130$  mg/dL). Once a lipoprotein analysis has been obtained, it should be repeated to determine the average LDL-cholesterol level (Figure 3-2). Those with acceptable LDL-cholesterol levels ( $< 110$  mg/dL) are provided education on the recommended population eating pattern and risk factor reduction and are retested in 5 years (Figure 3-2). A child whose average LDL-cholesterol is borderline (110-129 mg/dL) receives risk factor advice (see below), a Step-One Diet and other risk factor intervention, and is re-evaluated in 1 year. A confirmed high LDL-cholesterol leads to a clinical evaluation and an intensive clinical intervention that includes evaluation for secondary and familial disorders, professional dietary counseling, and regular followup (Figure 3-2). Upon occasion, the child or adolescent may have an initial high LDL-cholesterol ( $\geq 130$  mg/dL) but a follow-up LDL of  $< 110$  mg/dL. Such discrepant analyses may be related to marked laboratory variability, or drastic alterations in dietary intake of saturated fat and cholesterol or weight reduction. The physician will need to exercise judgment as to whether a third baseline LDL value is indicated.

### **2. Secondary Hypercholesterolemia**

All children and adolescents with high LDL-cholesterol levels ( $\geq 130$  mg/dL) should be considered for possible secondary (and potentially reversible) causes of hypercholesterolemia as

outlined in Table 3-4. Some of the conditions present especially in children or adolescents are obesity, oral contraceptive use, and isotretinoin (Accutane®) or anabolic steroid therapy. Such conditions can be ruled out by taking a careful history, physical examination, and appropriate laboratory analyses. Physicians will need to consider whether blood glucose and tests of liver, kidney, and thyroid function should be obtained on each child with high LDL-cholesterol levels prior to considering treatment. Alkaline phosphatase is frequently "elevated" in children during growth and is not a good indicator of obstructive liver disease. If the hypercholesterolemia is secondary, the primary disease should be treated, if possible. If the child is taking a medication that may cause high LDL-cholesterol levels, the medication should be discontinued, if possible, and the LDL-cholesterol levels re-evaluated.

### **3. Primary Elevations of Blood Lipid and Lipoprotein Levels**

Following the clinical evaluation and the exclusion of secondary causes of hypercholesterolemia (Table 3-4), a child or adolescent is considered to have a primary elevation of blood lipid and lipoprotein levels. As part of the intensive clinical intervention, the physician can consider whether the primary abnormality is also familial by screening all family members, namely, parents and siblings (Figure 3-2). This approach has several advantages. First, it may provide useful information about the kind of familial disorder that the child or adolescent has; second, the siblings and parents of children or adolescents with primary disorders of lipid and lipoprotein levels, particularly LDL-cholesterol levels, have a two- to five-fold increased risk for a lipid abnormality; third, screening of all family members brings together the family and emphasizes the importance of the lipid abnormality and the need to have the entire family change their eating patterns; fourth, such information may also influence the intensity of the clinical intervention in regard to dietary and/or drug therapy.

Table 3-4

**Causes of Secondary Hypercholesterolemia**

**Exogenous**

Drugs - Corticosteroids, isotretinoin (Accutane<sup>R</sup>), thiazides, anticonvulsants, beta blockers,  
anabolic steroids, certain oral contraceptives

Alcohol

Obesity

**Endocrine and Metabolic**

Hypothyroidism

Diabetes mellitus

Lipodystrophy

Pregnancy

Idiopathic hypercalcemia

**Storage Diseases**

Glycogen storage diseases

Sphingolipidoses

**Obstructive Liver Diseases**

Biliary atresia

Biliary cirrhosis

**Chronic Renal Diseases**

Nephrotic syndrome

**Others**

Anorexia Nervosa

Progeria

Collagen disease

Klinefelter syndrome

#### 4. Familial Disorders of LDL-Cholesterol Metabolism

Elevated LDL-cholesterol levels are not usually secondary to other disorders or drugs. The two most common familial lipoprotein disorders expressed as elevated LDL-cholesterol levels that are currently recognized in children are familial hypercholesterolemia (FH) and familial combined hyperlipidemia (FCH). In addition, high or borderline levels of total and LDL-cholesterol often aggregate in families; such familial problems are most often due to polygenic influences, that is, the small effects of a number of different genes.

Determination of whether the hypercholesterolemia is monogenic, polygenic, or multifactorial, will help guide the assessment and management of the affected child and family. An important first step, in addition to taking a family history, is evaluation of blood cholesterol, triglyceride, LDL-cholesterol, and HDL-cholesterol levels in both parents and siblings, and in some instances, first degree relatives of parents.

A major thrust of the algorithm shown in Figure 3-2 is the detection of children with primary elevations of LDL-cholesterol ( $\geq 130$  mg/dL). Because the screening approach recommended for cholesterol measurements is focused on the identification of children and adolescents whose parents have a high blood cholesterol level ( $\geq 240$  mg/dL) or whose parents or grandparents have premature cardiovascular disease, the young patients found to have primary elevations in LDL-cholesterol will be more likely to have a familial disorder of LDL metabolism. Even so, the majority of these children will not have an LDL disorder that results from the expression of one of the known single gene (monogenic) disorders. For example, even in families with premature CHD (before 55 years of age), Goldstein and coworkers found that familial hypercholesterolemia (FH) was present in only 4 percent of such families while familial combined hyperlipidemia (FCH) accounted for about 10 percent (Goldstein et al 1973). Further, about 5

percent of children and adolescents (or 1 in 20) have an LDL-cholesterol above 130 mg/dL; thus, in a group of 500 children and adolescents, about 25 will have a high LDL-cholesterol. Since the prevalence of FH heterozygotes is about 1 in 500, about 1 in 25 children with an LDL-cholesterol above 130 mg/dL will be FH heterozygotes. Because of its delayed expression, the prevalence of FCH in children is not known with accuracy. However, in a population of children and adolescents especially selected in a fashion similar to that recommended here, Cortner and coworkers (Cortner et al. 1990) found that FCH was about three times as common as FH.

**a. Polygenic Hypercholesterolemia**

The majority of children with primary elevations in LDL-cholesterol will have polygenic hypercholesterolemia. Their parents and siblings will tend to have above average, or in some cases elevated, total and LDL-cholesterol levels. Thus, these levels often aggregate in families. Such familial problems, based on our current understanding, are most often due to polygenic influences, that is, the small effects of a number of different genes.

**b. Familial Hypercholesterolemia**

A number of clues may help the clinician decide whether a child or adolescent with a primary elevation of LDL-cholesterol has FH. An evaluation of the family members is particularly helpful in this regard. For example, one out of two of the parents, and one out of two of the siblings of an FH child will have elevated total and LDL-cholesterol levels, while the unaffected first-degree relatives will have completely normal levels. The triglyceride levels in such children are usually normal (below the age- and sex-specific 95th percentiles, see Table 1-5). In addition, the child or adolescent with FH will tend to have more extreme elevations of total and LDL-cholesterol, most often above 240 mg/dL and 160 mg/dL, respectively, with the

average levels being about 300 mg/dL and 240 mg/dL, respectively (Kwiterovich et al. 1974; Kwiterovich 1989). Finally, the presence of extensor tendon xanthomas in the affected parent of such children indicates the presence of FH until proven otherwise. In contrast, the child or adolescent who is an FH heterozygote will usually have a normal physical exam, since tendon xanthomas are rarely found before the age of 10 years, and only about 10 to 15 percent develop tendon xanthomas in the second decade, primarily in the Achilles tendons and extensor tendons of the hands. The clinical manifestations of CHD are very rare in FH heterozygous children, even in the second decade (Kwiterovich et al. 1974). However, the development of CHD in about half their parents, (by age 50 in the FH fathers and by age 60 in the FH mothers) (Goldstein and Brown 1989), provides a strong rationale for the early detection and treatment of children with FH.

FH is due to a decreased number of functioning LDL receptors (Goldstein and Brown 1989). However, the assessment of LDL receptor activity is not routinely available. The measurement of LDL receptor activity in lymphocytes (Cuthbert and Lipsky 1989), or the identification of one of a dozen or so mutations in the LDL receptor gene using techniques of recombinant DNA (Hobbs et al. 1987), remain the purview of a few specialized research laboratories. Thus, routine measurement of LDL receptor activity in children with primary elevations of LDL-cholesterol is not indicated nor available. The assessment of LDL receptor activity by specialized research centers, however, is indicated in a rare FH homozygous child (one in a million) who has inherited two mutant FH genes. Such children have cholesterol levels that average about 700 mg/dL, but many reach 1,000 mg/dL or higher (Sprecher et al. 1984). The profound elevation of LDL in these children is accompanied by clinical signs such as planar xanthomas which are present by the age of 5 years in the webbings of hands, and over the elbows and buttocks. Tendon xanthomas, corneal arcus, and clinically significant CHD are often present



by the age of 10 years (Sprecher et al. 1984); aortic stenosis due to atherosclerosis in the aortic valve is often present.

**c. Familial Combined Hyperlipidemia**

During the evaluation of a child or adolescent with a primary elevation of LDL-cholesterol (Figure 3-2), several useful clues may help the clinician determine whether the elevated LDL is a result of the genetic disorder, FCH. First, in the parents the elevated LDL-cholesterol may be accompanied by significant hypertriglyceridemia (type IIb lipoprotein pattern), or alternatively, the parent may have a normal or borderline LDL-cholesterol level with hypertriglyceridemia (type IV lipoprotein pattern). Some of the siblings or parents of such a child may have normal or borderline LDL-cholesterol levels with elevated LDL apoB levels (hyperapobetalipoproteinemia) (Kwiterovich 1988). Second, the triglyceride levels in such children are usually modestly elevated (an average of 120 mg/dL for boys and 130 mg/dL for girls) (Kwiterovich 1988). Third, the average levels of total and LDL-cholesterol are lower in children with FCH than in those with FH--220 mg/dL and 160 mg/dL, respectively (Kwiterovich 1988). Fourth, tendon xanthomas are not present in children or even adults with FCH. Finally, another characteristic of patients with FCH is that their lipid values may tend to fluctuate from clinic visit to clinic visit; for example, as the LDL level falls, the triglyceride level may increase, and vice versa.

**d. Defective Apo B100**

Another genetic cause of primary elevations of LDL-cholesterol has been identified more recently (Vega and Grundy 1986; Soria et al. 1989). In contrast to FH, where the defect is in the LDL receptor itself, the LDL from such affected patients has a defect in that portion of apolipoprotein B that is recognized by the LDL receptor. Thus, such LDL particles are not

removed as efficiently by the normal LDL receptors. This results in a moderate increase in LDL-cholesterol. The precise proportion of children with primary elevations of LDL-cholesterol that have this genetic defect in apolipoprotein B is not currently known. The defect may affect 1 in 500 of the general population. The precise diagnosis involves techniques of recombinant DNA, and this test is not routinely available to the clinician. The association of this mutation with premature CHD is currently under study.

## **5. Other Primary Disorders of Lipid and Lipoprotein Metabolism**

Since the risk assessment algorithm recommended by this panel (Figure 3-1) includes a lipoprotein analysis in children and adolescents with a positive family history of premature (before age 55 years) cardiovascular disease in a parent or grandparent, abnormal lipoprotein profiles other than elevated LDL-cholesterol (type II lipoprotein pattern) may be observed. Since these children will come from families with premature cardiovascular disease, it is likely that these abnormal lipoprotein profiles reflect the presence of some familial dysfunction in lipid and lipoprotein metabolism (Lauer et al. 1988a).

### **a. Hypertriglyceridemia with Acceptable LDL-Cholesterol Levels (Type IV Lipid Pattern)**

Again, the family screening of the siblings and parents is helpful to determine the familial nature of the elevated triglyceride level in the presence of a normal LDL-cholesterol level. For example, if one of the parents has an opposite lipoprotein profile, such as an elevated LDL-cholesterol with normal (type IIa) or elevated (type IIb) cholesterol, then such a child or adolescent may have FCH, despite the normal LDL-cholesterol level (a type IV lipoprotein pattern). On the other hand, the affected parent may be similar to the child or adolescent suggesting the presence of familial hypertriglyceridemia.

**b. Low HDL-Cholesterol with Normal Triglyceride and Normal LDL-Cholesterol Levels (Hypoalphalipoproteinemia)**

Finally, some children who have a lipoprotein analysis because of a positive family history of premature cardiovascular disease will have an isolated low level of HDL-cholesterol (<35 mg/dL) with a level of triglyceride that is less than the age- and sex-specific 95th percentile (Table 1-5) and an acceptable LDL-cholesterol (<110 mg/dL). Such isolated primary decreases in plasma HDL-cholesterol levels have been referred to as "hypoalphalipoproteinemia" (Schaefer 1984; Third et al. 1984). Families with individuals with familial hypoalphalipoproteinemia are at risk of developing premature CHD (Third et al. 1984). Again, one of the parents will most often have very low levels of HDL-cholesterol (Schaefer 1984; Third et al. 1984). However, it is not unusual in such families that some of the affected relatives will have some hypertriglyceridemia accompanying the low levels of HDL-cholesterol. If the triglyceride level is quite elevated (>150 mg/dL), then the HDL-cholesterol may be secondary to an elevated triglyceride, rather than the primary metabolic defect (Deckelbaum et al. 1984). The LDL-cholesterol levels will be normal in most affected family members. Abnormalities in the genes for the major lipoprotein of HDL apoA1 have been detected in some families with hypoalphalipoproteinemia (Schaefer 1984; Breslow 1989; Assman 1990), but this approach has not yet reached clinical utility.

Since these children or adolescents come from families with a history of premature cardiovascular disease (or in some cases with a parent with hypercholesterolemia), they should receive the same intensive clinical intervention as children with primary elevations of LDL-cholesterol.

**c. Extreme Elevations in Blood Triglycerides**

In some children and adolescents, the levels of triglycerides may be profoundly elevated. These conditions are quite rare and are unlikely to be detected using the screening algorithm proposed in this report. These conditions are mentioned only briefly here; for a more detailed exposition of these familial dyslipoproteinemias, the reader is referred to a recent review (Kwiterovich 1990). In one condition, there are profound increases in the triglyceride-rich chylomicrons, due to an inherited defect in lipoprotein lipase, an enzyme responsible for catabolism of triglyceride in triglyceride-rich lipoproteins. The genotype includes a double dose of a mutant allele for the lipoprotein lipase gene, and several defects have been described on the DNA level (Langlais et al. 1989). The phenotype is presented early in childhood with abdominal pain, lactescent plasma, and hepatosplenomegaly. LDL-cholesterol values are often low. Occasionally a combination of elevations of both chylomicrons and VLDL (type V lipoprotein pattern) occur in childhood (Kwiterovich 1977). Finally, a few children have approximately equal elevations in cholesterol and triglyceride, suggesting familial dysbetalipoproteinemia.

**6. Other Risk Factors**

Obtaining information on CHD risk factors other than elevated LDL-cholesterol is important because many of them carry an independent risk and are modifiable by changes in lifestyle and diet (Table 3-5). Reversal of these risk factors may also affect the levels of LDL-cholesterol and HDL-cholesterol. Because parents often provide a role model for habits developed by children, modification of other risk factors should be directed to the entire family.

Family history is frequently an expression of an interaction between genetic and environmental factors. As suggested in this report, when genetically linked cholesterol disorders

**Table 3-5**

**Other Risk Factors That May Contribute to Earlier Onset  
of Coronary Heart Disease (CHD)**

- **Family history of premature CHD, cerebrovascular or occlusive peripheral vascular disease (definite onset before the age of 55 years in a sibling, parent, or sibling of a parent)**
- **Cigarette smoking**
- **Elevated blood pressure**
- **Low HDL-cholesterol concentration (< 35 mg/dL)**
- **Severe obesity ( $\geq$ 95th percentile weight for height by National Center for Health Statistics growth charts)\***
- **Diabetes mellitus**
- **Physical inactivity**

\*This corresponds to  $\geq$ 30% overweight.

are determined, they may be modifiable by changes in personal and family behavior. While genetic problems currently cannot be altered, the expression of these risk factors may be modifiable through treatment.

Experimentation with cigarette smoking often begins in early adolescence. The primary prevention of smoking is a most important effort requiring the recognition of the effects of parental and adult smoking, peer pressure, and advertising upon young children (Perry et al. 1988). Cessation of cigarette smoking is an important goal in both adolescents and their families. Smoking is an independent risk factor for CHD, and is associated with childhood low HDL-cholesterol levels as well (Dwyer et al. 1987; Moscovitz et al. 1990).

Elevated blood pressure among children has been addressed by the Second Task Force on Blood Pressure Control in Children (Task Force on Blood Pressure Control in Children 1987). The reader is referred to this for the management of children with high blood pressure for their age.

A low HDL-cholesterol level is often present in children and adults with an inherited blood lipid problem. In adults, when a low HDL-cholesterol is combined with a high LDL-cholesterol level, the risk for CHD increases further. Low HDL-cholesterol sometimes can be modified favorably through regular aerobic exercise, cessation of cigarette smoking, and weight reduction to correct overweight.

Obesity in childhood and adolescence is a common health problem, and pronounced increases in its prevalence have occurred in the United States from the 1960s to the 1980s (Kolata 1986; Gortmaker et al. 1987). National health studies estimate that 27 percent of children ages 6-11 and 22 percent of adolescents ages 12-17 in the United States are obese (Gortmaker et al.

1987). Obese children are at increased risk of becoming obese adults with relative risks estimated at 1.0-2.3 (Johnston 1985).

Obese children are at greater risk for a number of health problems including diminished work capacity, insulin resistance, and hypertension (Smoak et al. 1987; Becque et al. 1988). They also experience difficulties in social and psychological adjustment (Dwyer 1973; Johnston 1985). Obesity in children is positively related to increased VLDL-cholesterol and LDL-cholesterol and inversely related to HDL-cholesterol (Freedman et al. 1985b) and is also associated with clustering of multiple CHD risk factors (Smoak et al. 1987).

Reducing obesity has been shown to improve risk factor levels in adults (Ahrens 1984; Brunzell 1984) and is reported to be a high priority of the majority of physicians caring for children, despite low levels of reported physician confidence in their counseling skills (Price et al. 1987 and 1989). Several approaches have been demonstrated to be successful in reducing obesity in children and adolescents and are reviewed elsewhere (Coates and Thoresen 1978; Johnston 1985). Obese children should be encouraged to maintain a constant weight as they grow until their weight is at a desirable level for their height. Obese adolescents who have reached adult height should be encouraged to achieve desirable weight through an appropriate balance of caloric restriction and regular aerobic exercise.

Adolescents with high alcohol intake also have an increased likelihood of having high triglyceride levels, high blood pressure, and obesity. Finally, children with diabetes are at high risk of developing complications of diabetes relatively early in life, including predilection to premature atherosclerosis.

In summary, the increasing prevalence of obesity, high prevalence of elevated serum cholesterol, low levels of physical activity, and changing nutritional habits of children in the United States highlight the need for identification of all CHD risk factors and attention to lifestyle by health professionals who care for children (Strong and Dennison 1988).

#### **D. APOLIPOPROTEIN SCREENING**

Currently apolipoproteins are not indicated for screening or clinical evaluation on a routine basis. This is due to lack of widely available, reliable, and standardized measurements for these fractions; inadequate epidemiological data on the population distribution of apolipoproteins; and a lack of studies on the effectiveness of treatment specifically to lower elevated apolipoprotein levels alone (Grundy and Vega 1990).

#### **E. REFERRAL TO A SPECIALIZED CENTER**

In children and adolescents with a family history of premature CHD, multiple risk factors, a total cholesterol level above the 95th percentile (approximately 200 mg/dL), or elevated cholesterol due to secondary causes, referral to a specialized lipid center is indicated when, in the judgment of the physician, adequate assessment and care will be enhanced by referral.

## IV. THE INDIVIDUALIZED APPROACH: TREATMENT

### A. DIET THERAPY

The general aim of diet therapy is to reduce elevated blood cholesterol levels while maintaining a nutritionally adequate eating pattern. The primary emphasis is on decreasing the level of saturated fatty acids, total fat, and cholesterol and on consuming only enough calories to achieve or maintain desirable body weight. Diet therapy is presented in two steps, the Step-One and Step-Two Diets, which are designed to reduce progressively intakes of saturated fatty acids and dietary cholesterol.

#### 1. Definition of Total and LDL-Cholesterol Initiation Levels for Diet Therapy

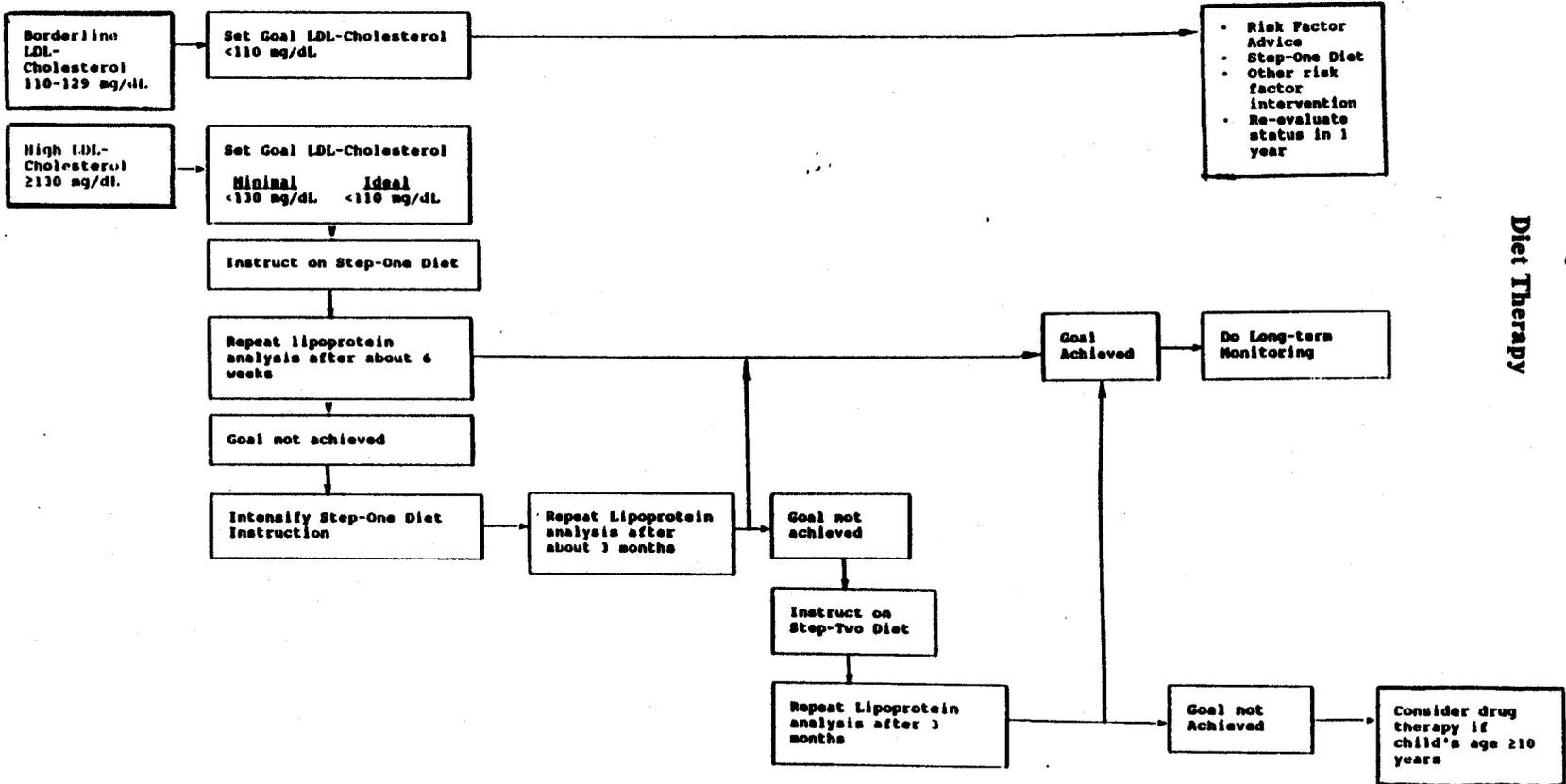
The panel's recommended initiation levels (cutpoints) for dietary intervention in children and adolescents with a family history of CVD or parental hypercholesterolemia are shown in Table 4-1. Children and adolescents with total cholesterol levels <170 mg/dL or LDL-cholesterol levels <110 mg/dL have acceptable levels. These young people should receive education on the recommended population eating pattern (see section II) and risk factor reduction.

Therapeutic dietary instruction is indicated in all children and adolescents with a total cholesterol level  $\geq 170$  mg/dL or an LDL-cholesterol  $\geq 110$  mg/dL. Those with borderline total blood cholesterol levels 170 to 199 mg/dL or borderline LDL-cholesterol levels 110 to 129 mg/dL (about the 75th to 95th percentile) require advice that consists of instruction on the Step-One Diet and other risk factors by a physician, registered dietitian or other qualified nutrition professional, or other appropriately trained health professional, with re-evaluation in 1 year (Figure 4-1).

Table 4-1

**Cutpoints of Total and LDL-Cholesterol for Dietary Intervention  
in Children and Adolescents With a Family History of Hypercholesterolemia  
or Premature Cardiovascular Disease**

<u>Category</u>	<u>Total Cholesterol</u>	<u>LDL-Cholesterol</u>	<u>Dietary Intervention</u>
Acceptable	<170 mg/dL	<110 mg/dL	Recommended population eating pattern
Borderline	170-199 mg/dL	110-129 mg/dL	Step-One Diet prescribed and other risk factor intervention
High	≥200 mg/dL	≥130 mg/dL	Step-One Diet prescribed, then Step-Two Diet if necessary



Diet Therapy

Figure 4-1

Children and adolescents with high total cholesterol  $\geq 200$  mg/dL or high LDL-cholesterol  $\geq 130$  mg/dL (95th percentile) are more likely to have one of the inherited disorders of LDL metabolism such as FH or FCH. Children and adolescents whose high total cholesterol ( $\geq 200$  mg/dL) is due to an elevated LDL-cholesterol ( $\geq 130$  mg/dL) require intensive clinical intervention, including detailed assessment of current eating patterns and instruction on a Step-One Diet by a physician, registered dietitian, other qualified nutrition professional, or another appropriately trained health professional. If, after at least 3 months of good adherence to the Step-One Diet, LDL-cholesterol values are still high (LDL-cholesterol  $\geq 130$  mg/dL), the Step-Two Diet is required (Figure 4-1).

## **2. Goals**

The goal of diet therapy in these children and adolescents is to lower LDL- and total cholesterol levels. Minimal goals are to lower cholesterol levels below the initiation levels. For example, for a child whose level is in the high category--LDL-cholesterol  $\geq 130$  mg/dL (corresponding to total cholesterol  $\geq 200$  mg/dL)--the minimal goal is to lower it to below these levels. Ideally, the LDL-cholesterol level should be lowered to  $< 110$  mg/dL (corresponding to total cholesterol  $< 170$  mg/dL) (Figure 4-1).

An important goal for lowering blood cholesterol in obese children is to achieve and maintain desirable weight.

## **3. Monitoring and Followup**

A child or adolescent on the Step-One or Step-Two Diet should be followed to check lipid and lipoprotein levels and to assess adherence to the diet. Physicians may adopt monitoring

schedules that meet the needs of individual families; an example of a followup schedule used in some lipid research clinics is outlined in Figure 4-1 and described on page 4-15.

#### 4. Step-One and Step-Two Diets: Overview

The primary emphasis of diets for children of all ages is on adequacy of calories and nutrients--carbohydrate, protein, fat, vitamins, and minerals--to promote growth and development and allow for physical activity. Both the Step-One and Step-Two Diets (Table 4-2) are nutritionally adequate for children and adolescents.

The Step-One Diet calls for an average intake of saturated fatty acids less than 10 percent of total calories, of total fat an average of no more than 30 percent of calories, and of cholesterol less than 300 mg per day. These are the same nutrient intakes recommended for the general population in Section II. What makes the diet therapeutic is prescription in a medical setting together with the monitoring and followup offered by health professionals. The Step-One Diet reduces the major and obvious sources of saturated fatty acids and cholesterol in the diet.

If, after at least 3 months on the Step-One Diet, the minimal goals of therapy are not achieved, the child or adolescent should usually progress to the Step-Two Diet (Figure 4-1). This diet calls for further reduction of saturated fatty acids to less than 7 percent of total calories and of dietary cholesterol to less than 200 mg/day. Adoption of the Step-Two Diet requires careful planning to ensure adequacy of nutrients, vitamins, and minerals; a registered dietitian or other qualified nutrition professional should be consulted at this stage, if this has not been done before.

**Table 4-2****Characteristics of Step-One and Step-Two Diets for Lowering Blood Cholesterol**

<b>Nutrient</b>	<b>Recommended Intake</b>	
	<b>Step-One Diet</b>	<b>Step-Two Diet</b>
<b>Total Fat</b>	Average of no more than 30% of total calories	Same
<b>Saturated Fatty Acids</b>	Less than 10% of total calories	Less than 7% of total calories
<b>Polyunsaturated Fatty Acids</b>	Up to 10% of total calories	Same
<b>Monounsaturated Fatty Acids</b>	Remaining total fat calories	Same
<b>Cholesterol</b>	Less than 300 mg/day	Less than 200 mg/day
<b>Carbohydrates</b>	About 55% of total calories	Same
<b>Protein</b>	About 15-20% of total calories	Same
<b>Calories</b>	To promote normal growth and development and to reach or maintain desirable body weight	Same

## **5. Step-One and Step-Two Diets: Food Choices**

Foods to choose in implementing the Step-One and Step-Two Diets are discussed below; see also Table 4-3. Examples of the two diets with number of servings from each major food group are shown in Appendix C, Tables C-1 and C-2. (Also see Appendix C for detailed nutrient information on selected foods and sample menus to help in implementing diet therapy.) Note that these tables present examples only; different choices may be made to accommodate individual preferences and needs.

### **a. Meat, Poultry, and Fish**

Major sources of high-quality protein, which is vital during periods of growth, are meat, poultry, and fish. Meat is a good source of iron, zinc, and vitamin B12. Meat and poultry are also major contributors of SFA, total fat, and dietary cholesterol. The Step-One Diet differs from the Step-Two Diet primarily in the type or preparation method, rather than the amounts of meat, poultry, and fish. In the Step-Two Diet, only the very leanest kinds are included.

Beef, pork, and lamb should be lean and well trimmed before being cooked to prevent part of the fat from migrating into the lean tissue during cooking. Ground meat should be lean and drained well after cooking. Meat can be ground at home, or a butcher can grind very lean, well-trimmed cuts of meat such as those that come from the round. Ground turkey, which can be seasoned and used like ground beef, is very lean if it does not contain turkey skin and fat. Processed meats, such as Vienna sausage, frankfurters, and bologna, are often high in SFA, but several brands of processed sliced meats (cold cuts) are lower in fat.

Table 4-3 (Page 1 of 5)

Foods To Choose and Decrease for  
the Step-One\* and Step-Two Diets

Food Group	Choose	Decrease
<b>Meat, Poultry, and Fish</b>		
	Beef, pork, lamb--lean cuts well-trimmed before cooking	Beef, pork, lamb--regular ground beef, fatty cuts, spare ribs, organ meats, sausage, regular luncheon meats, wieners, bacon
	Poultry without skin	Poultry with skin, fried chicken
	Fish, shellfish	Fried fish, fried shellfish
	Processed meat--prepared from lean meat, e.g. turkey ham, tuna wieners	Regular luncheon meat, e.g. bologna, salami, sausage, wieners
<b>Egg</b>		
	Egg whites (2 whites equal 1 whole egg in recipes), cholesterol-free egg substitute	Egg yolks (if more than 4 per week on Step-One or if more than 2 per week on Step-Two); includes egg used in cooking
<b>Dairy Products</b>		
	Milk--skim or 1% fat (fluid, powdered, evaporated), buttermilk	Whole milk (fluid, evaporated, condensed), 2% low-fat milk, imitation milk
	Yogurt--nonfat or low-fat yogurt or yogurt beverages	Whole milk yogurt, whole milk yogurt beverages

\* The Step-One Diet has the same nutrient recommendations as the eating pattern recommended for the general population.

Table 4-3 (Page 2 of 5)

Foods To Choose and Decrease for  
the Step-One\* and Step-Two Diets

Food Group	Choose	Decrease
<b>Dairy Products (cont.)</b>		
	Cheese--low-fat natural or processed cheese (part-skim mozzarella, ricotta) with no more than 6g fat per oz on Step-One, or 2g fat per oz on Step-Two	Regular cheeses (American, blue, brie, cheddar, colby, edam, monterey, whole-milk mozzarella, parmesan, swiss), cream cheese, Neufchâtel cheese
	Cottage cheese--low-fat, nonfat, or dry curd (0 to 2% fat)	Cottage cheese (4% fat)
	Frozen dairy dessert-- ice milk, frozen yogurt (low-fat or nonfat)	Ice cream
		Cream, half & half, whipping cream, non- dairy creamer, whipped topping, sour cream
<b>Fats and Oils</b>		
	Unsaturated oils-- safflower, sunflower, corn, soybean, cotton- seed, canola, olive, peanut	Coconut oil, palm kernel oil, palm oil
	Margarine--made from unsaturated oils listed above, light or diet margarine	Butter, lard, shortening, bacon fat
	Salad dressings-- made with unsaturated oils listed above, low-fat or oil-free	Dressings made with egg yolk, cheese, sour cream, whole milk

Table 4-3 (Page 3 of 5)

Foods To Choose and Decrease for  
the Step-One\* and Step-Two Diets

Food Group	Choose	Decrease
<b>Fats and Oils (cont.)</b>		
	Seeds and Nuts-- peanut butter, other nut butters	Coconut
	Cocoa powder	Chocolate
<b>Breads and Cereals</b>		
	Breads--whole grain bread, hamburger and hot dog bun, corn tortilla	Bread in which eggs are a major ingredient, croissants
	Cereals--oat, wheat, corn multigrain	Granola made with coconut
	Pasta	Egg noodles and pasta containing egg yolk
	Rice	
	Dry Beans and Peas	
	Crackers, low-fat--animal- type, graham, saltine- type	High-fat crackers
	Homemade baked goods using unsaturated oil, skim or 1% milk, and egg substitute--quick breads, biscuits, cornbread muffins, bran muffins, pancakes, waffles	Commercial baked pastries, muffins, biscuits

Table 4-3 (Page 4 of 5)

Foods To Choose and Decrease for  
the Step-One\* and Step-Two Diets

Food Group	Choose	Decrease
<b>Breads and Cereals (cont.)</b>	Soup--chicken or beef noodle, minestrone, tomato, vegetarian, potato	Soup containing whole milk, cream, meat fat, poultry fat, or poultry skin
<b>Vegetables</b>	Fresh, frozen, or canned	Vegetables prepared with butter, cheese, or cream sauce
<b>Fruits</b>	Fruit--fresh, frozen, canned, or dried	Fried fruit or fruit served with butter or cream sauce
	Fruit juice--fresh, frozen, or canned	
<b>Sweets and Modified Fat Desserts</b>	Beverages--fruit-flavored drinks, lemonade, fruit punch	
	Sweets--sugar, syrup, honey, jam, preserves, candy made without fat (candy corn, gum-drops, hard candy), fruit- flavored gelatin	Candy made with chocolate, coconut oil, palm kernel oil, palm oil
	Frozen desserts-- sherbet, sorbet, fruit ice, popsicles	Ice cream and frozen treats made with ice cream

Table 4-3 (Page 5 of 5)

Foods To Choose and Decrease for  
the Step-One\* and Step-Two Diets

Food Group	Choose	Decrease
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Sweets and Modified Fat Desserts (cont.)

Cookies, cake, pie,  
pudding--prepared with  
egg whites, egg substi-  
tute, skim milk or 1%  
milk, and unsaturated  
oil or margarine; ginger-  
snaps; fig bar cookies;  
angelfood cake

Commercial baked pies,  
cakes, doughnuts, high-fat  
cookies, cream pies

The skin should be removed from poultry before cooking to decrease saturated fatty acids; chicken and turkey without skin are generally low in SFA and total fat. Fish is low in SFA and can be eaten frequently. Certain types of shellfish, (e.g. shrimp and crayfish) which are high in cholesterol but very low in SFA and total fat, may be eaten occasionally.

Organ meats, such as liver, brains, heart, kidney, and sweetbreads, are high in cholesterol. However, liver, heart, and kidney are rich sources of iron and zinc and can be eaten about once a month.

**b. Eggs**

Eggs are a good source of high-quality protein, iron, and other minerals and vitamins, but because an average egg yolk also contains 213 mg of cholesterol, egg yolks should be eaten only in moderation in the Step-One Diet. To achieve the Step-Two recommendation of less than 200 mg of cholesterol per day, egg yolks should be eaten less frequently than in the Step-One Diet.

Egg whites, which contain protein but no cholesterol, can be eaten as often as desired. Two egg whites may be substituted for one whole egg in most recipes. Egg substitutes are made primarily of egg white and may be used to replace eggs, totally or partially, in dishes such as scrambled eggs, omelets, and baked items.

**c. Dairy Products**

Dairy products are primary and important sources of protein, calcium, and phosphorus; whole-milk products also contain SFA and fat. Low-fat cheese (no more than 6 grams fat per ounce) and low-fat and nonfat milk and yogurt provide as much or more calcium and protein as

whole milk dairy products with little or no SFA (see Appendix C, Table C-5). In moving to the Step-Two Diet, a further reduction in saturated fatty acids may be accomplished by selecting milk and yogurt containing 1 percent fat or less and low-fat cheese with no more than 2 grams of fat per ounce.

**d. Fats and Oils**

Both the Step-One and Step-Two Diets include unsaturated fats and oils, which do not elevate cholesterol levels. All fats and oils, whether saturated or unsaturated, provide an equal number of calories, i.e., 9 per gram while carbohydrate and protein have only 4 calories per gram.

Good sources of unsaturated fatty acids include safflower, sunflower, corn, cottonseed, soybean, olive, canola, and peanut oils. Because margarine is low in saturated fatty acids and cholesterol, it should be used in place of butter. Margarines with labels that list one of the unsaturated oils as the first ingredient should be used. Vegetable oil shortening, made by partially hydrogenating oil, is higher in saturated fatty acids than most margarines. Mayonnaise and salad dressings (regular and reduced fat) are usually made with unsaturated oils.

In food preparation, unsaturated vegetable oil or margarine should be used instead of lard, beef fat, and poultry fat. The vegetable fats known as tropical oils--coconut, palm kernel, and palm oils--are high in saturated fatty acids and should be avoided. These saturated vegetable fats are often used in nondairy products (whipped toppings, sour cream substitutes, coffee creamers), bakery goods (cookies, cakes, pie crust, crackers), processed foods (TV dinners), and popcorn oils (microwave popcorn).

On the Step-Two Diet, using tub margarines and oils that are very low in SFA's, in addition to choosing only very low fat or skim dairy products and the leanest meats, helps to reduce dietary intake of SFA's to 7 percent of calories. In order to maintain total fat at 30 percent of calories while reducing SFA's, increased amounts of foods high in unsaturated fatty acids should be used. Thus, the Step-Two Diet requires more servings of unsaturated margarines and oils than the Step-One Diet.

**e. Breads and Cereals**

The breads and cereals group includes breads, cereals, pasta, rice, starchy vegetables, and dry beans and peas. These foods are high in complex carbohydrate, and most are low in fat. They are good sources of protein, B vitamins, iron (if fortified), and fiber (if whole-grain). They can be increased in the Step-One and Step-Two Diets to replace foods high in saturated fatty acids.

Pasta, rice, and dried peas and beans can be eaten frequently and, in combination with limited amounts of lean meat, poultry, and fish, provide complete protein without excessive amounts of SFA or calories. Some examples of combination dishes include very lean ground beef with spaghetti sauce served over pasta, chili with beans, chicken and rice casserole, and fish soup served over rice.

**f. Vegetables and Fruits**

Vegetables and fruits are major sources of vitamins, particularly vitamins A and C, and minerals. They also provide fiber. Eating a variety of fruits and both raw and cooked vegetables is suggested. The number of servings of vegetables and fruits is usually increased to replace the calories previously provided by higher fat foods.

**g. Sweets and Modified-Fat Desserts**

Moderate amounts of sweets and modified-fat desserts (low in saturated fatty acids) may be used as part of a well-balanced eating pattern that includes a variety of food.

Many commercial desserts are made with fats high in saturated fatty acids, such as animal fat, butter, or cream. When desserts are made at home, the amount and type of fat and amount of egg yolk can be controlled. Cookies, cakes, and pie crusts can be made using unsaturated oil or margarine, egg whites or egg substitutes, and skim milk. If candy is chosen, it should be of the kind that has very little or no fat (e.g., hard candy, gum drops, candy corn). Candies that are high in SFA, such as chocolate varieties, should be limited.

**6. Safety of Nutritional Changes**

The Step-One and Step-Two Diets are safe and consistent with normal growth and development. They are moderately low in saturated fatty acids, total fat, and dietary cholesterol but are not low-calorie diets. Thus they are sufficient to maintain growth. Recent reports of several cases of growth retardation in young children following inappropriately low-fat diets was due to inadequate consumption of calories (Pugliese et al. 1987; Lifshitz and Moses 1989). Children and adolescents with high blood cholesterol levels require careful nutrition evaluation, assessment of growth and development, and adequate followup.

There has been concern about the amount of trace minerals (particularly iron, zinc, and calcium) provided by diets low in saturated fatty acids, total fat, and dietary cholesterol (Mauer 1988). The mineral intake resulting from the Step-One and Step-Two Diets generally meets the RDA's (NRC 1989b). Some flexibility in toddlers' diets is called for to enable them to meet the

RDA's for iron, zinc, and calcium; such flexibility is appropriate because toddlers are in a transition period in which they gradually assume the family eating pattern. Examples of diets designed to conform to the nutrient intakes of the Step-One and Step-Two Diets (Appendix C, Tables C-1 and C-2) provide more of these minerals than is typically consumed by this age group.

The Step-One and Step-Two Diets recommend consumption of up to, but not exceeding, 10 percent of calories as polyunsaturated fatty acids, because they aim to decrease SFA, using unsaturated fatty acids for the remaining dietary fat. No human population consumes a diet very high in polyunsaturated fatty acids. High amounts of dietary polyunsaturated fatty acids may lower HDL-cholesterol levels (NRC 1989). In adults, excess polyunsaturated fatty acids may promote gallstone formation (Sturdevant et al. 1973). Animal studies indicate that very high intakes may contribute to tumor formation as well (NRC 1982).

Long-term experience with children and adolescents on the Step-Two Diet is lacking, and more research from controlled clinical trials is needed. One such study, the Dietary Intervention Study in Children, is currently under way.

#### **7. Other Hygienic and Dietary Means To Lower Blood Cholesterol**

Other hygienic and dietary means to lower blood cholesterol have been tried in adults as adjuncts to diet therapy. One method used in research studies is to increase amounts of water-soluble fiber in the diet. While fiber supplements are not recommended, foods high in fiber are a suitable component of a cholesterol-lowering eating pattern and increased fiber intake has been shown to effect modest reductions of total and LDL-cholesterol in adults. However, the effect of fiber has not been studied in children. Developing the habit of regular aerobic exercise may

improve the lipoprotein pattern and help prevent obesity. Control of modifiable risk factors in parents and older siblings is also important, because of their ability to set examples as role models.

## **8. Implementing Diet Therapy: The Team Approach**

The individualized approach to lowering blood cholesterol levels in children and adolescents calls for the participation of a multidisciplinary team of health professionals, including physicians, nurses and nurse practitioners, registered dietitians and other qualified nutrition professionals, health educators, and, when drug therapy is prescribed, pharmacists.

Physicians can provide effective leadership in the assessment and treatment of risk factors for CHD in children and adolescents. Studies in risk factor behavior have demonstrated that patients perceive advice from their physicians as important (Schucker et al. 1987). Physicians also are responsible for monitoring and reinforcement in followup. When referring to an expert in dietary counseling or lipid management, the physician should reinforce the value of such an approach in order to enhance its effectiveness.

Physicians can organize systems in practice to improve delivery of preventive care. The use of reminder systems for patient care visits and routine periodic testing can enhance health maintenance evaluations (Cohen et al. 1982; Cheney and Ramsdell 1987). Chart records can utilize flowsheets or other reminder systems, as in other aspects of well-child care. Designating office personnel other than the physician to monitor completion of screening tasks may improve adherence to preventive recommendations (Kottke et al. 1987).

Physicians can refer patients to other health professionals for dietary assessment, education and counseling, and monitoring. When referring to office or community resources, physicians can

provide a clear message to patients and families that elevated blood cholesterol requires dietary change and emphasize the importance of participating in the educational process.

The multidisciplinary team of health professionals, which plays an important role in implementing the individualized approach to diet therapy, includes physicians, nurses and nurse practitioners, registered dietitians and other qualified nutrition professionals, and health educators. They may work together to identify, assess, counsel, and monitor each patient.

**a. Identifying High-Risk Children and Adolescents**

The health professional team can help identify families and children who may be at high risk for elevated cholesterol. For example, health professionals working in hospitals may help to identify affected children of victims of premature CVD; health professionals working with schools may detect children and adolescents who are at risk for increased blood cholesterol levels and elevated blood pressure due to obesity; and public health and occupational health professionals may identify high-risk families and refer them to appropriate sources of health care.

**b. Dietary Assessment**

Dietary assessment, ideally carried out by a registered dietitian or other qualified nutrition professional, begins with a review of current eating practices, including where meals and snacks are eaten (at home or away from home), how they are prepared, and when they are eaten. Information about family lifestyle is helpful in evaluating the frequency of meals away from home and use of commercially prepared foods. Often, it is helpful to request that the child and/or parent and other care providers record the child's food intake for a week.

Accurate assessment of a child's typical food intake is challenging. Children may have difficulty recalling food eaten and lack knowledge of food ingredients and preparation. Parents may be unaware of all the foods their child eats away from home. A compromise between a practical method and one that provides adequate detail may be necessary. The 24-hour recall has not been extensively used with pediatric age groups. Eck et al. (1989) conducted food recalls on children 4 to 9.5 years by interviewing the child and both parents together. This "consensus recall" provided more accurate information than interviewing individuals separately. The counselor may request that food records be kept by parents and/or care providers (day-care workers, baby-sitters), who have been instructed in measuring, weighing, and recording food eaten. Older children and adolescents can be instructed in keeping their own food records.

When available, a computerized nutrient analysis program is a helpful tool for dietary assessment, although manual methods may be employed effectively as well. The foods recalled or written on a food record are entered and the resulting analysis provides immediate detailed information about dietary intake. The computerized nutrient analysis program should have complete data on all foods, especially those containing fatty acids and dietary cholesterol. The analysis of the total diet can be used to show parents how to incorporate low-fat foods at home to compensate for high-fat foods, such as hot dogs or cheeseburgers, eaten away from home. Computerized nutrient analysis can also be used to show how popular foods, such as pizza and hamburgers, can be worked into the eating pattern. An eating pattern containing low-fat foods is usually more acceptable when some favorite higher-fat foods are also included. Professional nutrition journals can be of help in identifying computerized nutrient analysis programs.

**c. Education and Counseling: Role of the Family and Adherence Issues**

The child or adolescent diagnosed with elevated blood cholesterol often has established some high-fat eating patterns, and a change is necessary to meet the goals of healthful eating. Making these changes entails altering a number of food choices. The best support for the child with high blood cholesterol is a home environment in which everyone above approximately 2 years of age follows the recommended population eating pattern, that is, eats foods low in saturated fatty acids, total fat, and dietary cholesterol, and in which the child is encouraged but not pressured to eat the suggested foods.

Making life-long changes in eating patterns should proceed at a reasonable pace, starting with easy-to-accomplish changes in significant dietary sources of saturated fatty acids followed by more difficult tasks (Franklin et al. 1988). Substituting low-fat foods rather than eliminating foods provides a positive focus. Health professionals can work with the family to establish both short- and long-term goals, plan strategies for change, identify ways of facilitating the dietary changes, evaluate everyday eating in relation to the goals, and strengthen commitment and persistence in reaching goals (Rabb and Tillotson 1985). Simple, organized patient education approaches using non-physician personnel have been demonstrated to be practical and effective (Blair et al. 1988). A counseling method that works well for some families involves establishing contracts with children that specify changes in eating behavior. Goal attainment can be measured during clinic visits or telephone contacts. Goals should be revised as necessary.

In general, the most effective counseling promotes an emotionally healthy attitude toward eating. The following points can be discussed with parents (Satter 1987):

- **Maintain a positive relationship with your child regarding food selections and eating patterns.**
- **Structure consistent meals and snacks.**
- **Plan ways of coping with situations in which it is difficult to follow the suggested eating pattern.**
- **Don't encourage unnecessary eating; cut down on food cues or reminders to eat.**
- **Provide foods low in fat, saturated fatty acids, and dietary cholesterol. Healthy snacks will help prevent hunger and decrease feelings of dietary restriction.**
- **Think of your child or adolescent as a person first and as an individual with high blood cholesterol second.**
- **Use your own good judgment when setting eating limits, and involve your child or adolescent in setting these limits.**
- **Acknowledge that "slips" will occur, and encourage a quick return to low-fat eating.**

Helping the family discover ways of removing barriers to change is likely to result in greater success with the eating plan. Parents and older children should be asked how effective they believe making the requested changes will be, how valuable they believe the outcomes or pay-off to be, and how difficult they expect the changes will be for them (Bandura 1977). Poor adherence may be related to family issues other than meals. For example, schedule changes, vacations, illness, and parental discord can have a great effect on a child's eating behaviors. The perceptive health professional will assess and discuss these issues as needed.

Educational materials for children need to be age-appropriate and should use concrete terms and examples for suggested food choices. High- and low-fat foods can be identified in

some way meaningful for the child. The importance of eating healthful foods and exercising can best be explained to young children in relation to their feeling good, being strong, getting enough fuel to all parts of the body, and growing bigger and taller. Food models can be used for teaching about portions of food, in addition to information on nutrients. As the child matures, more comprehensive materials can be used to present additional information.

Much of the food older children eat is consumed away from home. Detailed suggestions for preferred choices at school, from vending machines, and from fast-food sources are included in section II, Tables 2-2, 2-3, 2-4, 2-5, and 2-6. Weight-conscious adolescents should be encouraged to avoid fad diets, select foods from all of the food groups, choose from a wide variety of low-fat foods, and increase physical activity.

**d. Monitoring and Followup**

Monitoring and followup is an important component in implementation of the Step-One and Step-Two Diets. An example of a schedule for monitoring and followup is provided by the practice followed in some lipid research clinics (Figure 4-1), where lipids and lipoprotein levels are rechecked approximately 6 weeks after starting the cholesterol-lowering diet. A careful assessment of dietary compliance is conducted, including analysis of several days of food records kept by the child's parents and/or other care providers. A computerized nutrient analysis program can be utilized, if available. Team members may improve adherence, if necessary, through telephone followup and other methods. Another visit is required several months after initiation of therapy to complete the evaluation of the diet's effect. The child who has met the goals of diet therapy should then enter long-term monitoring and be re-evaluated twice a year in order to monitor adherence. Those who have not met their goals should receive intensified instruction on the Step-One Diet and be re-evaluated after about 3 months. Those children and adolescents who

are adhering to the Step-One Diet and still have not met their goals should receive Step-Two Diet instruction with its further reduction of saturated fatty acids and cholesterol. They should be seen and evaluated again in 3 months. After 3 months on the Step-Two Diet, some children and adolescents with extremely high LDL-cholesterol levels will need to be considered for drug therapy (Figure 4-1).

Physicians should exercise their judgment in using or adapting this sample schedule to their own patients' needs.

## **B. DRUG THERAPY**

### **1. When To Consider Drug Therapy**

The panel recommends that drug therapy be considered in children ages 10 years and older if, after an adequate trial of diet therapy (6 months to 1 year), LDL-cholesterol remains above the levels cited below. Whenever drug therapy is prescribed, diet therapy should be continued in order to make the treatment regimen as effective as possible (Cobb et al. 1991).

- Consider drug therapy if LDL-cholesterol remains  $\geq 190$  mg/dL.
  
- Consider drug therapy if LDL-cholesterol remains  $\geq 160$  mg/dL and
  - There is a positive family history of premature cardiovascular disease (before 55 years of age), or
  - Two or more other cardiovascular disease risk factors are present in the child or adolescent after vigorous attempts have been made to control these risk factors (see Table 3-5).

These guidelines, though arbitrary, are based on published data indicating that cutpoints that minimize misclassification between children and adolescents with FH and those without FH are LDL-cholesterol of about 164 mg/dL and total cholesterol of about 235 mg/dL (Kwiterovich et al. 1974). These values, which approximate the 99th percentiles for children and adolescents, can be rounded to 160 mg/dL and 230 mg/dL for LDL- and total cholesterol, respectively (NHLBI 1980). Children and adolescents with these levels are the most likely to become adults with an LDL-cholesterol  $\geq 200$  mg/dL, and to have an inherited basis for their high LDL-cholesterol level. It is recommended that drug therapy be considered if necessary in children ages 10 and older because the early lesions of atherosclerosis begin to occur at about age 10. However in certain cases, when children have extremely high cholesterol levels, physicians may decide to initiate drug therapy at a younger age.

Another factor that influences the institution of drug therapy is a positive family history of premature cardiovascular disease, particularly if it occurs in a parent, grandparent, or an affected parent's sibling during the third or fourth decades of life. Some of these children and adolescents will also have low levels of HDL-cholesterol ( $< 35$  mg/dL), high blood pressure, and obesity, indicating further potential risk of future cardiovascular disease.

Only a small proportion of children and adolescents should be considered for drug therapy because of side effects, expense, and the lack of definitive, prospective data on the effect of such treatment on CHD.

## **2. Goals of Drug Therapy**

The minimal goal of drug therapy is to achieve a level of LDL-cholesterol  $< 130$  mg/dL. Ideally, the level should be brought lower, if possible, to near an LDL-cholesterol  $< 110$  mg/dL.

### 3. Monitoring and Followup

A child or adolescent should be seen 6 weeks after starting a medication and every 3 months thereafter to determine the effects of drug therapy and continued diet therapy on LDL-cholesterol levels. The effect of drug therapy on blood triglyceride level and HDL-cholesterol levels should also be monitored. Height and weight should be obtained at each visit and a growth chart kept by the health provider. Other clinical chemistry tests appropriate to the prescribed drug should be obtained at the 6-week and 3-month visits and yearly thereafter. Once the goal cholesterol level has been reached, the child or adolescent should be seen every 6 months to a year.

### 4. Choice of Drugs

Drugs that are currently used for treatment of hypercholesterolemia and high LDL-cholesterol levels in children and adolescents are the bile acid sequestrants cholestyramine (Questran® and Cholybar®) and colestipol (Colestid®). Niacin (nicotinic acid, vitamin B<sub>3</sub>), HMG CoA reductase inhibitors, probucol, gemfibrozil, D-thyroxine, paraminosalicylic acid (PAs), and clofibrate are not recommended as routine drugs for use in children and adolescents.

At present only bile acid sequestrants (cholestyramine, colestipol) have proven efficacy, relative freedom from side effects, and apparent safety when used in children and adolescents (West et al. 1980; Kwiterovich 1986). Nicotinic acid has been used without serious short-term effects in children with homozygous FH and in a limited number of children with heterozygous FH (Levy et al. 1972; Khachadurian and Uthman 1973; Stein 1989). Long-term safety of other lipid lowering agents such as lovastatin and probucol are not yet established in adults. Therefore, it is prudent at present not to recommend that drugs other than bile acid sequestrants be administered to children or adolescents. An exception to this rule may be considered for a child

or adolescent who does not have an adequate response to diet plus bile acid sequestrants. In this case, the patient can be referred to a lipid specialist for consideration of nicotinic acid therapy.

## **5. Dosages, Side Effects, Combinations of Drugs**

### **a. Bile Acid Sequestrants**

Cholestyramine and colestipol are anion exchange resins and act by binding bile acids in the intestinal lumen. Because they are not absorbed by the intestine, they lack systemic toxicity and thus are potentially safe in children. Both decrease the reabsorption of bile acids and their return to liver. This interruption of the enterohepatic circulation of bile acids promotes increased synthesis of new bile acids from cholesterol. LDL receptor activity in the liver then increases in response to decreased cholesterol in liver cells and this in turn increases removal of LDL from plasma and lowers LDL-cholesterol levels.

Cholestyramine and colestipol are both powders that are mixed with water or juice just before ingestion or, if more convenient, the previous evening. Cholestyramine has recently become available as flavored candy bars. In terms of cholesterol lowering, 5g of colestipol is equivalent to 4g of cholestyramine. The choice of one drug over the other depends on individual taste preference and gastrointestinal side effects; occasionally one is free of side effects for a given individual, while the other is not. If caloric intake is an issue, the number of calories per dose in different preparations of cholestyramine is: Questran Light® (1.6), Questran® (19) and Cholybar® (60).

The dose of the resin to be used is not related to the body weight of the child but to the levels of total and LDL-cholesterol after an adequate trial of diet therapy (Farah et al. 1979)

(Table 4-4). Thus, a child should be started on the lowest dose of the resin possible, then increased one dose at a time to achieve the goal of lowering total and LDL-cholesterol levels. The medication should be taken immediately before or after or during a meal, when the largest amounts of bile acids are present in the intestine. Breakfast and dinner are usually preferred to lunch, which children generally eat at school. To achieve the maximum lowering of LDL-cholesterol, the patient must continue to follow the therapeutic diet in conjunction with the sequestrant.

The most common side effects with bile acid sequestrant therapy are gastrointestinal. They include constipation, nausea, bloating, epigastric fullness, and flatulence. In growing children, it is important to consider potential adverse effects that may accompany sequestrant-associated malabsorption of neutral fats, fat soluble vitamins, and folic acid. Thus, in addition to close monitoring of height and weight achievement, appropriate analyses should be performed to ensure that specific vitamin deficiencies are prevented. Transient increases in transaminases and alkaline phosphatase can occur but are not common and probably do not signify hepatotoxicity. Mild increases in plasma triglyceride concentrations occur in some patients treated with resins. Occasionally, the sequestrants may increase the plasma triglyceride levels markedly (above 250 mg/dL), and treatment with a second drug (niacin) may be indicated. Bile acid sequestrants can also interfere with absorption of other anionic drugs given at the same time, and therefore, other drugs should be taken 4 hours after or 1 hour before ingestion of sequestrants. Drugs that may not be well absorbed in the presence of sequestrants include digoxin, thyroxine, thiazides, and others.

Table 4-4

**Initial Dosage Schedule for Treatment of Familial Hypercholesterolemic Children and Adolescents with a Bile Acid Sequestrant\***

Daily Doses of bile acid sequestrant <sup>†</sup>	Total cholesterol (TC) and low density lipoprotein cholesterol (LDL-C) levels (mg/dL) after diet	
	<u>TC</u>	<u>LDL-C</u>
1	<245	<195
2	245-300	195-235
3	301-345	236-280
4	>345	

\* These are generally recommended doses and may require adjustment based on the patient's response.

† One dose is the equivalent of a 9g packet of cholestyramine (containing 4g cholestyramine and 5g filler), one bar of cholestyramine, or 5g of colestipol.

Source: Farah et al. 1977

**b. Nicotinic Acid**

Nicotinic acid, a water soluble B vitamin, has been known as an effective cholesterol lowering agent for many years in adults (Coronary Drug Project Research Group 1975; Canner et al. 1986). Nicotinic acid acts by decreasing VLDL synthesis in liver, with subsequent lowered production of both VLDL and LDL. This drug improves the entire lipoprotein profile, producing lower levels of total, VLDL-, and LDL-cholesterol, and triglycerides, but higher levels of HDL-cholesterol. The lipid lowering effects are not shared by nicotinamide, which should not be substituted for nicotinic acid. The usefulness of this drug has been limited by the relatively high frequency of side effects. Experience with its use in growing children is limited, and it must be used cautiously in this age group.

In general, nicotinic acid should be prescribed only after referral to a lipid specialist and if cholesterol lowering therapy by diet and bile acid sequestrants has not reached its specific therapeutic goals. In children, nicotinic acid should generally be used in combination with bile acid sequestrants. Occasionally, it may be used as a sole therapeutic agent in situations where bile acid sequestrants are not tolerated because of side effects. Recently, nicotinic acid has been advocated for self-treatment of hyperlipidemia by the lay press, and because it can be obtained in health-food stores as a vitamin, many people have started taking relatively large doses without the care of a physician. Nicotinic acid used in higher doses ( $\geq 100$  mg/day) is a potentially toxic drug, and it should be taken only under the supervision of a physician. This is especially true for children and adolescents; nicotinic acid should be used in this age group only in special circumstances.

When nicotinic acid is prescribed, blood uric acid, glucose levels, and liver function tests should be monitored at each visit (especially when increasing dosages) because of the common