

# Infant-Feeding Practices and Blood Cholesterol Levels

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THE RELATIONSHIP of lipid metabolism, serum cholesterol levels and atherosclerosis is still unresolved. The clinical importance of quantitative and qualitative changes in dietary fat intake also remains unresolved. However, it has been shown that unsaturated fats added to the diet in sufficient proportions will lower serum cholesterol levels in adults.<sup>1</sup> Many well-qualified observers believe that serum cholesterol levels serve as an important index of atherogenicity.

Holman's investigations<sup>2</sup> and those of other researchers over the world have indicated that atherogenesis is usually present during and after the third year of life. If this is true, and if serum cholesterol levels are important barometers of the degree of susceptibility to atherosclerotic changes, then lipid metabolism in infancy and childhood deserves intensive study. The present work was undertaken to determine serum lipid levels and the effect of various dietary changes on them in infants.

## MATERIAL AND METHODS

At birth the serum cholesterol level of an infant averages 75 mg. per 100 ml. This level rises rapidly in an American child fed a formula of cow's milk. The major elevation in serum cholesterol levels takes place during the first few months of life.

During a serial study of serum cholesterol levels from birth, it was noted that in infants who had been fed a preparation of soy milk because of an allergic state the expected

elevation of serum cholesterol did not occur. The soy milk preparation is high in essential fatty acids. The trend in these infants was similar to that described, in reports from Italy, where infants are usually breast-fed and early childhood diets contain large amounts of vegetable fats.

Corn oil contains 53 gm. of linoleic acid, 12 gm. of saturated fatty acids, 28 gm. of oleic acid and 1.5 gm. of sitosterol per 100 gm. Therefore 50 gm. of corn oil were added to the evaporated milk formula in a homogenous mixture obtained with a food blender. This formula was alternated with one of plain evaporated milk. Serum cholesterol levels were determined at weekly intervals from blood drawn from the femoral vein. The study was continued until an infant was discharged from the hospital because of parental or guardian demand.

## RESULTS

The results demonstrated in these experiments with infants parallel those of similar investigations in adults. There was a depressant effect of corn oil, with its large amounts of essential fatty acids, on serum cholesterol levels.<sup>3</sup> Breast milk also contains a high percentage of essential fatty acid (53 per cent unsaturated fatty acids, 47 per cent saturated fatty acids) and should, therefore, depress serum cholesterol levels. Breast milk also differs from evaporated milk in protein and total fat content (1.2 per cent protein in breast milk and 2.2 per cent protein in evaporated milk diluted 1:2). It might be expected that in infants fed breast milk the lipid findings would be similar. This has not been found true.

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This study was continued during the year following the experiment described. Serum cholesterol levels were determined monthly from birth, in infants fed an evaporated milk formula. Similarly, cholesterol levels were determined in infants fed a prepared milk formula\* containing 55.9 per cent of total fatty acids as unsaturated fats. (Cow's milk fat is 43 per cent unsaturated.)

Fifty-three normal infants fed an evaporated milk formula and twenty-seven normal infants fed a prepared milk formula have been observed for periods up to four months. The serum cholesterol levels differ in these two groups. The average cholesterol levels for the infants fed the evaporated milk formula were: after two weeks, 98 mg. per 100 ml.; after four weeks, 128 mg. per 100 ml.; after eight weeks, 162 mg. per 100 ml.; after twelve weeks, 187 mg. per 100 ml. The latter level appears, from our data, to persist for a number of years through childhood. The infants fed prepared milk had lower serum cholesterol levels: after two weeks, 84 mg. per 100 ml.; after four weeks, 98 mg. per 100 ml.; after eight weeks, 123 mg. per 100 ml.; after twelve weeks, 128 mg. per 100 ml. At sixteen and twenty weeks, serum cholesterol levels of both groups began to approximate each other. During this period cereal, whole milk, meat and dairy products were added. Those infants receiving no supplement to the formula except fruit did not experience a rise in serum cholesterol levels.

#### COMMENTS

Limited data on breast-fed infants do not appear to be in agreement with that found in the foreign literature. Serum cholesterol levels in these infants are considerably higher than would be expected from a milk relatively high in unsaturated fat. Maternal diets have been shown to qualitatively alter the fatty acid content of breast milk. American mothers have high caloric and high saturated fat intake. The difference in maternal diets may explain the discrepancy between our

findings and those reported in the foreign literature. Serum cholesterol levels must be studied in breast-fed infants of mothers receiving varying fat diets.

The atherogenetic process may be reversible during the formative years. Therefore, if nutrition affects atherogenesis, it must be a constant influence over the life span of the individual. It is possible that many nutritional aspects of infancy and childhood play prominent roles in the physiology and pathology of adulthood, not only by virtue of habits learned but also by metabolic alterations which are maintained.

Present day efforts are concerned with reversing the atherosclerotic changes encountered in adulthood and averting malignant sequelae. Preventative medicine would be better served however, if alterations in the etiologic factors concerned with atherosclerosis were attempted during the formative years when significant remissions are more easily accomplished. If dietary changes are to be made, these changes would be most useful if begun during early life.

In this experiment with infants and in others in adults, supplemental feeding of essential fatty acid presents a serious problem of the added calories. Fifty grams of corn oil increases the total daily caloric intake of these infants considerably. It is difficult to construct a program to lower serum cholesterol without creating or aggravating the problem of obesity. Infants fed this additional formula gain weight more rapidly. The prepared milk formula used in the present experiment eliminates this caloric excess.

If a preventative program in infancy were to be undertaken, it should be considered that encouraging the development of larger babies and probably larger adults by added calories could adversely affect our antidegeneration program by placing a greater burden on unadapted organs and biochemical mechanisms. Caloric excess can be avoided by substitution of essential fatty acid for saturated fats present in milk.

A high intake of essential fatty acid may lower serum cholesterol levels in infants. This does not make the link between lipidemia

\* S.M.A., supplied by Wyeth Laboratories, Inc., Philadelphia, Pennsylvania.

and atherosclerosis clearer. Until a method more objective than biochemical is available for measurement of atherosclerosis in man, epidemiologic studies will continue to give us inconclusive and conflicting answers to this important problem.

#### REFERENCES

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#### DISCUSSION

DR. W. STANLEY HARTROFT (*St. Louis, Missouri*): How much corn oil did you give the adults?

DR. POMERANZE: We gave them 6 ounces a couple of times a day—very large doses. These were cooperative patients and we found a significant lowering of serum cholesterol levels.

DR. HARTROFT: That is nearly 1,500 or 2,000 calories.

DR. POMERANZE: Yes. Whether or not they took all of it, I do not know. Again, what the significance of all of this is, I have no way of knowing. However, I would suggest that if we are going to attack this problem from a dietary point of view, infancy is the time to attempt it.

DR. R. ALFIN-SLATER (*Los Angeles, California*): Serum cholesterol levels always worry me when they are unaccompanied by any other determination. Did you perform any fecal sterile analysis on the babies at all?

DR. POMERANZE: No.

DR. ALFIN-SLATER: What happens to the cholesterol that is removed from the blood?

DR. POMERANZE: I have no idea.

DR. ALFIN-SLATER: Do you not think it would be helpful to make such an analysis?

DR. POMERANZE: It surely would.

DR. W. E. CORNATZER (*Grand Forks, North Dakota*): Professor Joseph Anderson from the Physiological Hygiene Laboratory of the University of Minnesota, recently described a study made there on 180 medical students. Two different laboratories performed the cholesterol determinations in this group who took the corn oil daily for four weeks in the form of a milkshake. There was a slight gain in weight in many of the students and a drop in the blood cholesterol levels.

DR. POMERANZE: I am not offering our findings as conclusive. I am not convinced of the importance of cholesterol levels as a barometer of atherosclerosis, but I think that it is as good a biochemical instrument as

we have for the type of work going on at this time.

DR. ALFIN-SLATER: Are there any figures available on cholesterol levels in babies fed breast milk as compared with those fed a formula?

DR. POMERANZE: I have gone through the available literature and there are figures from Italy and from one other country where the babies were breast-fed; and in those babies the cholesterol levels were kept fairly low. They paralleled our figures with the soy-bean preparation.

#### SUMMARY OF SYMPOSIUM

DR. C. ARTOM (*Winston-Salem, North Carolina*): Dr. Hartroft, would you sum up the facts and point out the areas for further investigation?

DR. HARTROFT: I think this meeting has served a useful purpose in bringing together not only current data from recently performed experiments but also some of the earlier work which we tried to collate with newer knowledge. Dr. Artom and Dr. Cornatzer pointed out in a broad way the two possible sites of the mechanism and action of choline. It may act both in the tissues and in lipid transport.

It is over a quarter of a century since the lipotropic factors were discovered and named in 1932 by Best and his co-workers. In that first paper the possibilities of where and how choline acts were pointed out. We are still debating these same possibilities twenty-five years later, albeit with new information, but still without definitive answers. This area is one urgently requiring further investigation.

Dr. Lucas, speaking on the transport of cholesterol, added new data that are very exciting, clearly showing the effect of choline on the serum cholesterol in the presence of exogenous cholesterol.

There are certainly some obvious questions raised here. Where does the cholesterol come from when it is increased in the serum in this manner? Where does it go when the choline is removed and the serum cholesterol level decreases? One explanation could be intestinal absorption but I gather this explanation had been eliminated.

DR. C. C. LUCAS (*Toronto, Canada*): I think it is ruled out, of course, where there is no cholesterol being fed; but when cholesterol is fed I do not know how else to explain what we see, other than the effect of absorption, but there may be some more subtle thing.

DR. HARTROFT: You have not analyzed the fecal excretion of cholesterol?

DR. LUCAS: No.

DR. HARTROFT: Dr. Chow has emphasized an important factor—the background composition of the diet in regard to calories and absorption of food and vitamin content are important in interpreting any results in clinical investigation as well as with animals.

Dr. Berkowitz' technic on radioactive iodine absorption and radioactive fat absorption is interesting. There is a little reservation as to how widely this method should be applied in patients until more observations have been made.



Dr. Moon in California and others have now shown that lipid plaques may be present in newborn infants, indicating that the disease can begin *in utero*. There is growing evidence that a number of the so-called "degenerative" diseases that manifest their symptoms in old age may have had beginnings much earlier in life.

DR. LOUIS FREEDMAN (*New York, New York*): Per-

haps the data from the laboratory and clinical and animal experimentation are not so controversial as is the interpretation. Similar data are interpreted in different ways, depending on whether it is applied to animals actually used or to man. Perhaps more careful use of statistical evaluation of the data is needed and more appreciation that data on animals may have some application to man if properly interpreted.

