Discussion

A divisional system of clinical organization operates in Bangour Hospital as recommended in the Brotherston¹ and Cogwheel² reports. One of the special features of this organization³ is a division of community medicine which comprises hospital medical administrators, two medical officers of health, and eight general practitioners elected by all the practitioners in the area. This division provides a particularly effective platform from which to launch ventures like the general-practitioner unit and also to integrate closely the hospital and community medical effort.

Another special feature of the area is the Livingston integrated health services experimental project⁴ in which each doctor is a general practitioner/specialist with a list limited to 1,500 and a five-session appointment as a medical assistant in Bangour Hospital.

It is noteworthy that Livingston doctors used the unit considerably more than other doctors in the area. The eight Livingston doctors out of 24 doctors who used the unit admitted 130 (46.5%) of the 284 cases. It can be assumed that this is a result partly of the practitioner's specialist training and partly because he is in the hospital frequently and regularly. There may also be other motivations, such as proximity of the practice to the hospital, but whatever the reasons this type of appointment clearly results in greater use of the unit by these practitioners and consequently reduces the demands on consultant services.

When the proposal to establish the unit was under consideration some of the hospital staff opposed the idea on the grounds that the unit would quickly become "another long-stay unit," that it would make demands on the back-up

facilities to the detriment of the rest of the hospital, and that practitioners would not provide full care for their patients but that hospital staff would be left to deal with emergencies and other problems. None of these forebodings in fact emerged.

Patients were all regularly and conscientiously visited—64% were visited five times or more by their doctor while in the unit. The unit has been incorporated in the hospital's postgraduate teaching programme and practitioners have presented cases in teaching ward rounds. There is great potential for further development of this aspect of the unit's activity.

The nursing staff have found work in the unit stimulating and rewarding and have not found difficulties in working with a large number of doctors and their patients.

This study shows the practicability and desirability of such a unit in a district general hospital.

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Contemporary Themes

Cardiovascular Disease in the Tropics*—IV, Coronary Heart Disease

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For the purpose of this presentation I would like to outline briefly the "nutritional-metabolic" theory of atherogenesis,⁵⁷ which has received considerable support from the epidemiological studies of Ancel Keys and his collaborators.⁵⁸ I will then examine how certain situations in the tropical environment appear to challenge this major hypothesis and will discuss other contributions which the tropical situation makes to the world-wide problem of coronary heart disease.

Nutritional-Metabolic Theory

A very personal view of the nutritional-metabolic theory is shown in Fig. 1. There are two major indices of a community's

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susceptibility to coronary heart disease. (1) Epidemiological studies have clearly and repeatedly shown that populations with a high mortality from coronary heart disease have relatively high

FIG. 1—Illustration of the nutritional-metabolic concept of community susceptibility and incidence of coronary heart disease.

blood cholesterol levels, and, conversely, where mortality from coronary heart disease is low the blood cholesterol level tends to be low. High cholesterol levels and high rates of coronary heart disease occur almost exclusively where the usual diet is high in total fat, saturated fat, and cholesterol. (2) In the vast majority of cases of coronary heart disease the underlying disease process is severe atherosclerosis, and at necropsy the amount of coronary atherosclerosis present is an index of community susceptibility to coronary heart disease.

Both of these indices of *susceptibility* can be regarded as prerequisites to coronary heart disease, but an *essential* factor may not necessarily be a *sufficient* cause in itself. It is well established that where the disease is endemic certain characteristics are present in the population or in their environment which can considerably affect its *incidence*. These include hypertension, cigarette smoking, and diabetes as well as physical inactivity, obesity, raised uric acid level, emotional stress, and soft drinking water. The presence of these risk factors and of possible protective factors can produce significantly different incidences of coronary heart disease in communities with the same degree of basic susceptibility.

Coronary heart disease is very uncommon in most tropical and subtropical countries except among those sections of the community who are affluent and following the way of life common to most economically advanced countries. Those few cases which have been reported have almost always been in elderly subjects often with associated hypertension.⁵⁹ Racial, ethnic, climatic, and geographical factors appear to be completely irrelevant to the incidence of coronary heart disease, except insofar as they condition or determine social class and economic status. It is the experience of the vast majority of clinicians and pathologists working in the tropics that even the obese, sedentary, severely hypertensive, longstanding diabetic does not (except with the rarest of exceptions) develop coronary heart disease, even in soft-water areas. In terms of the hypothesis it seems that unless the prerequisites for atherosclerotic disease are present the presence of risk factors either singly or in various combinations will rarely if ever produce coronary heart disease.

Coronary Heart Disease in Ceylon

From Ceylon there have been several reports of coronary heart disease which apparently conflict with the hypothesis we have discussed. It has been frequently stated that there is a striking contrast of a high incidence of coronary heart disease associated with a low fat diet and a comparatively low level of blood cholesterol. Coronary heart disease is regarded as equally common in lower and upper income groups, and it is held that it is very unlikely that dietary fat plays a part in this disease in Ceylon.⁶⁰⁻⁶²

There is no information that relates to the true incidence or prevalence of atherosclerosis or coronary heart disease in Ceylon but it is abundantly clear that myocardial infarction is a common cause for admission to hospital and a common cause of death in those few who come to necropsy.⁶³⁻⁶⁴ Moreover, myocardial infarction in Ceylon occurs on a background of atherosclerosis and coronary artery thrombosis.⁶⁵ The mean cholesterol levels in subjects with coronary heart disease in two hospital studies was 234 and 245 mg/100 ml with a very wide range of values—106 to 384 mg/100 ml.⁶¹⁻⁶² The mean level in the patients with coronary heart disease was higher than the mean level in hospital patients with other cardiac diseases and was higher than the mean level in hospital patients without heart disease—about 180 mg/100 ml. As elsewhere in the world, however, hypertension, diabetes, and a family history of coronary heart disease were frequent in the Ceylonese subjects.⁶²

The crucial question relates to diet. It is stated that the total fat intake in coronary heart disease patients is about 55 g/day (27% of total calories), compared with about 155 g/day in the U.K. (44% of total calories).⁶¹ However, a key feature in the Ceylonese diet is that almost 80% of the fat intake is in the form

FIG. 2—Serum cholesterol levels in Rarotongan and Atiu-Mitiaro Polynesian islanders (Hunter⁶⁷).

of coconut or coconut oil, which although a vegetable oil is highly saturated; lauric acid accounts for 45% of the fatty acid content of the coconut oil. Recent studies have emphasized that the cholesterol-raising effect of saturated fatty acids is practically restricted to those fatty acids with 12 to 16 carbon atoms. The chief dietary "enemies" are thus lauric (12C), myristic (14C), and palmitic (16C) acids.⁶⁶

There is additional evidence from the Cook Islands regarding the effect of coconut oil on blood cholesterol levels.⁶⁷ Rarotongan, who had come under considerable European influence, were compared with Atiu and Mitiaro Islanders, who were "living the simple, more traditional Polynesian life as planter-fishermen." The blood cholesterol levels in males and females were significantly higher in the Atiu-Mitiaro islanders, and within this group the females had higher levels than the males. On the other hand, the Rarotongans were more overweight and had higher systolic and diastolic blood pressures and a higher frequency of hypertension (see Fig. 2).

Examination of the dietary patterns showed that the Atiu-Mitiaro islanders had lower total caloric, lower protein, and lower carbohydrate intakes but about the same total fat intake as the Rarotongans. However, the Atiu-Mitiaro islanders derived 89% of their total fat intake from coconut, compared with Rarotongans, who derived only 7% from coconut and 86% from animal sources (pork, dripping, butter, and tinned corned beef). There is no hospital admission or necropsy data regarding coronary heart disease in these Polynesians, but clearly this is another poor community in which blood cholesterol levels indicate that the population might be susceptible to atherosclerosis and possibly at risk for coronary heart disease.

The observations in Ceylon and Polynesia do not, to my mind, seriously challenge the nutritional-metabolic hypothesis: they serve to expand the concept and to emphasize certain limitations. The blood cholesterol level is but a crude indicator of susceptibility to atherosclerosis, and in the ultimate analysis we will certainly be concerned with specific fatty acids in the blood and tissues as determinants of the atherosclerotic process. These specific fatty acids may not only play the major part in effecting a rise in blood cholesterol levels but may have additional effects on other mechanisms possibly involved in the coronary heart disease story, such as fibrinolytic activity and platelet or leucocyte adhesiveness. Ceylon and similar situations provide most remarkable natural experiments from which the coronary-stricken countries of the world could derive considerable benefit.

Nomads of East Africa

In Africa there are several isolated groups of particular interest to those concerned with coronary heart disease: the nomadic peoples of Somalia, Kenya, and Tanzania, whose diet consists mainly of milk, meat, and blood. They are lean, active people

in whom blood pressure does not rise with age and in whom there is apparently no clinical or electrocardiographic evidence of coronary heart disease. The nutritional-metabolic hypothesis is challenged by this direct question: "If saturated fat and cholesterol in the diet cause hypercholesterolaemia and atherosclerosis, why are the pastoral Masai and Samburu of East Africa free of these things despite a high milk and meat intake?"⁶⁸ It is indeed true that despite their traditional diet most of these nomadic groups have low blood cholesterol levels which do not rise with increasing age.⁶⁸⁻⁷⁰

The assumption made by many workers is that the Masai and similar nomadic groups consume a diet high in calories and rich in animal fat and cholesterol during their entire lifetime. In a population who are generally very lean and who engage in moderate physical activity, there must be reasonable doubt about the validity of this assumption. It seems far more likely that they live on no more than a subsistence level of intake despite intermittent very large intakes of milk and meat.

There are no available data in any study of nomadic peoples which express in quantitative terms the food intake of a group over a long period of time, but we do know that seasonal variations in the availability of food is marked and famine and famine relief are unfortunately familiar features of their life patterns. It takes a long-continued intake of a diet high in saturated fats to maintain high blood cholesterol levels; we know little if anything about the effects on cholesterol metabolism of an irregular high-fat diet interspersed with periods of deprivation. From studies on the camel-herding Rendille nomads of northern Kenya we know that a way of life very similar to that of the Masai and Samburu can be associated with blood cholesterol levels similar to those seen in affluent societies.⁷¹ We also know that these high blood cholesterol levels are not an essential feature of camel-herding societies as opposed to cattle-herding societies, for just across the Kenya border a study in Somali nomads has revealed low blood cholesterol levels which do not rise with age (see Fig. 3).⁷²⁻⁷³

FIG. 3—Serum cholesterol levels in Samburu and Rendille nomads in Kenya (Shaper and Jones⁷¹) and in Somali nomads (Lapicciarella *et al.*⁷²).

Those workers who do not accept that irregularity of food supply may account for the low blood cholesterol levels of the nomads have postulated that "freedom from emotional stress or abundance of physical exercise may be present as overriding protective mechanisms despite a long-continued diet of milk and meat."⁶⁸ The capacity of habitual physical activity to prevent hypercholesterolaemia is at best limited, and psychological stresses are certainly not essential for the development of hypercholesterolaemia, nor does the absence of stress prevent a rise in blood cholesterol on the appropriate diet.

More recently there has been a new development in the story of the Masai and their freedom from coronary heart disease. Sophisticated studies have been made of the absorption, synthesis, and excretion of cholesterol in young Masai at an agricultural school.⁷⁴⁻⁷⁶ In contrast to white Americans who have a limited maximal absorption capacity of 300 mg cholesterol, the

Masai could absorb more than 650 mg cholesterol. Compared with the 25% suppression of synthesis found in white Americans, the Masai could suppress 50% of their endogenous cholesterol synthesis. It was concluded that this efficient feed-back mechanism protects the Masai from the development of dietary-induced hypercholesterolaemia. Furthermore, this characteristic is regarded as reflecting a long-term biological adaptation; a genetically transmissible trait unique to the Masai.

Before accepting this hypothesis of genetic uniqueness we should be convinced that the white American group, habituated to a regular high-fat, high-cholesterol intake and with a large cholesterol pool, is indeed biologically normal in its response to further loading with cholesterol. Either the Masai are unique or, alternatively, *they* are normal—that is, possessed of a physiological mechanism which is associated with and conducive to good health.

Until there are reliable data on the long-term habitual diets of these nomadic peoples and until we have more evidence regarding what is biologically normal in our own cholesterol metabolism, the exceptional status of these fascinating nomadic groups must remain in doubt.

Blood Coagulation

In our search for the causes and mechanisms of atherosclerosis and coronary heart disease, the tropical situations provide a further opportunity for study. In many tropical countries where coronary heart disease is rare there are groups of people who have a high incidence of the disease, such as the white population of South Africa and the Asian population of East Africa. These coronary-prone groups can readily be identified in the sea of non-susceptibles, and it seems reasonable to expect that they should differ clearly from the non-susceptibles in those factors which are of *fundamental* importance in the causation and production of coronary heart disease. This has been shown to be true for blood cholesterol levels and it may possibly obtain in other factors, such as those concerning blood coagulation.

Comparative studies in white and African subjects in South Africa have produced no clear evidence to suggest that the African's freedom from coronary heart disease is due to a lesser coagulability of his blood,⁷⁴ nor have subsequent studies in other tropical groups. On the other hand, fibrinolytic activity, the enzymatic ability to break down fibrin or thrombus, was much greater in the African subjects,⁷⁴⁻⁷⁷ and rapid fibrinolytic activity has also been described in natives of New Guinea compared with white Australians.⁷⁸⁻⁷⁹

Studies in East Africa have compared coronary-prone middle-aged Asian men and non-susceptible middle-aged Africans, and fibrinolytic activity was found to be significantly greater in the African subjects.⁸⁰ In the Asians but not in the Africans an abnormal glucose tolerance test was associated with an even weaker fibrinolytic activity than in non-diabetics. In the Asians but not in the Africans there was a significant relation of fibrinolytic activity with both skinfold thickness and serum cholesterol level but not with the serum triglycerides. All these observations also hold true for European middle-aged men living in East Africa.

In looking at the results of studies in blood coagulation and fibrinolysis it is essential to differentiate between the results in young subjects and those carried out on middle-aged men. In Uganda we found that in young Africans and young Asian men fibrinolytic activity was brisk and was the same in both groups. In middle-aged Africans the fibrinolytic activity remains as brisk as that seen in young men of either racial group. Only in the middle-aged Asian and European men is there a striking decrease in fibrinolytic activity.

In any study involving different racial groups there must always be the possibility of genetic differences. In Kenya a study has been made on the acute effects of feeding fat to African and Asian university students⁸¹ and the results compared with those obtained in an earlier study of European subjects in Glasgow.⁸² The control level of fibrinolytic activity was

greater in the young African and Asian subjects in Nairobi than in the Europeans in Glasgow. A high fat meal, which produced a raised triglyceride level in all three racial groups, had no effect on fibrinolytic activity in the African or Asian students but it depressed fibrinolytic activity in the Europeans. The conclusion is drawn that there are genetic differences between the three racial groups in respect to their fibrinolytic enzyme systems and that this may determine the differing racial incidences of atherosclerosis. As the Asian group in Kenya suffer considerably from coronary heart disease, the conclusions seem a little unusual.

A brief comment on platelet adhesiveness. In our studies on middle-aged European, Asian, and African men in Uganda using both the Payling Wright and Hellem methods we found no difference at all in platelet adhesiveness between these three groups.⁸⁰ If it is reasonable to assume that factors relating to causation or mechanisms of coronary heart disease should differ clearly in coronary-prone and non-susceptible groups then platelet adhesiveness seems to be a factor of doubtful primary importance.

From these studies in the tropics there appears to be reasonable evidence that fibrinolytic activity, like blood cholesterol and blood pressure levels, need not necessarily change with increasing age. The reduction in fibrinolytic activity seen with increasing age in coronary-prone groups is probably related to factors known to predispose to coronary heart disease, such as hyperlipidaemia, diabetes, cigarette smoking, obesity, and physical inactivity. Reduced fibrinolytic activity may provide a mechanism for the enhancement of atherosclerosis and thrombus formation in the presence or absence of complicated atherosclerosis.

Conclusion

In conclusion I would like to restate the message of these lectures. I have been concerned to show that information derived from environmental situations very different from our own may give a perspective to the problems of our own community, a perspective which we could not possibly obtain from studies confined to our own environment.

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