Too much to eat: coronary disease, 1769-1969

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'O glotonye, on thee wel oghte us pleyne!
O, wiste a man how many maladies
Folwen of excess and of glotonyes,
He wolde been the moore mesurable
Of his diete, sitting at his table'

Chaucer, *The Pardoner's Tale*, circa 1390

In *The Pardoner's Tale* Chaucer makes it clear that our English ancestors were well aware of the price of self indulgence. Their intuitive insights into the consequences of overnutrition had to wait nearly 600 years before prospective studies confirmed in Western man its close relation to arterial disease, angina pectoris, myocardial infarction, diabetes mellitus and sudden death (Dawber, Moore & Mann, 1957; Dawber, Kannell & McNamara, 1964).

By coincidence the first major step forward, Heberden's recognition of angina pectoris, was announced in 1768, the year that James Cook set out on his first voyage to the Pacific. Heberden and Cook both had an ardent thirst for knowledge and an earnest desire to promote the welfare and happiness of mankind. Cook was probably the first exponent of preventive dietetics in the South Seas. Like most of the pioneers in public health he was a practical man. He saw the importance of Lind's work on scurvy and, by precept and example, overcame the resistance of the lower deck to the newest nutritional doctrine.

Heberden gave exemplary descriptions of angina and of sudden death but did not recognize the syndrome of infarction. His influence on later generations was strong. Infarction and angina continued to be confused until Herrick clearly defined the clinical features of sudden obstruction of the coronary arteries in 1912.

It is certain from the works of Latham (1876) that myocardial infarction did indeed occur in the nineteenth century. In lecture 26 he describes the

case of R.B., a 61-year-old male, who through immobilization from gout had become sedentary and fat. R.B. gave a typical clinical history of infarction and had at autopsy a ruptured interventricular septum. In lecture 37 we find the account given to Latham by Dr Bucknill of the final illness of Thomas Arnold who died in 1842 at the age of 47. Again it speaks clearly for infarction although the autopsy was unsatisfactory. These and two other cases cited in the same lecture were regarded by Latham as examples of angina pectoris with unusually rapid death. The familial nature of the disease is typified by the Arnold family. Thomas's father died of heart disease, as did his eldest son Matthew, the poet.

Dr Bucknill gave a contemporary view of the cause of angina in his conversation with his dying patient. 'He inquired if the disease was suddenly fatal. I answered that it was. "Was it a common disease?" I said not very common. "Where do you find it most?" "In large towns, I think". "Why?" "Perhaps from anxiety and eager competition amongst the higher, intemperance amongst the lower classes" '.

Coronary disease also occurred sporadically in Australia at this time. The first of my family to settle here reached Sydney in 1842 from Southwark. He built up a very successful architectural practice. He died suddenly at the age of 66 from a heart attack after 41 years in the colony.

During the present century the recorded death rate from heart disease has increased steadily in Australia. In 1967 cardiac disease before the age of sixty-five accounted for one-fifth of all male deaths. 70% of these were recorded as due to coronary disease. The economic loss to the nation in unearned income alone is at least 350 million dollars a year. While growing awareness and better diagnosis may account for some of the increase, these do not account for the continuing rise in post war years when diagnostic standards have been well established and doctors have been acutely aware of the problem (Reader & Wynn, 1966). Precisely when this disease

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assumed epidemic proportions will never be known. Myocardial infarction was not well recognized until after the publication of Levine's monograph in 1929. In the 1930s it was possible to be an eminent physician in Sydney without owning an electrocardiograph.

Disease is usually the resultant of an interaction between man and his environment. How has the balance been upset? Can the upward trend of premature mortality extending frequently now into males and even females in the fourth decade be stopped or reversed?

Coronary disease is a byproduct of affluence. For the majority of Australians life did not become easy until quite recently in our 200-year history. The squatters of the nineteenth-century found the challenge of the land, with its extremes of heat and cold, drought and flood and distance so great that only the very resourceful flourished. The cities were small, industry was on a very light scale, and those who lived urban lives engaged in trade and services.

In the first half of this century growth of population and wealth continued to be slow. Pleasures were simple and comparatively few could afford self indulgence. Since the Second World War a spectacular change has occurred. The power revolution and technological advances which have followed have brought to the masses in an almost classless society standards of living which only a few could afford a generation ago. *La dolce vita* is now within the reach of the average man. The use of leisure has become a critical problem. Pubs and clubs which provide food, drink and entertainment at reasonable prices attract a growing portion of the surplus in the pay packet. This chronic self indulgence has not been matched by an increase in physical activity. The reverse is most certainly true. At the same time competition amongst the more intelligent has increased and has generated the tension and anxiety which Dr Bucknill remarked on.

Because of the contrasts which they afford, the natives of New Guinea and other Pacific islands have been studied by medical scientists from Australia and New Zealand. In the villages of New Guinea obesity is virtually unknown, diastolic blood pressure does not rise with age, the diet is high in carbohydrate, low in animal protein and very low in fat; serum cholesterol lies between 120 and 140 mg/100 ml throughout life and coronary disease is absent (Whyte, 1958; de Wolfe & Whyte, 1958). Walking is the only form of locomotion and the benefits of education and competition are unknown. Work in the regimented pattern of the European hardly exists. Man does only what is necessary for survival and enjoyment.

New Guinea is now developing its own European-type society. The grass huts in the villages are being

abandoned for little urban boxes. The bodily changes that this metamorphosis engenders are being studied by Australian medical scientists and may teach us something of what it is in civilization which breeds arterial disease (Sinnott, Goldrick & Whyte, 1969).

Only some of the factors predisposing to coronary disease are measurable at present. Anxiety, tension, competitiveness and the personality associated with it have long been given some of the blame. Osler (1910) noted the prevalence of angina in the upper classes, the keen and ambitious, the indicator of whose engines is always at 'full speed ahead'. Yet he saw inconsistencies, for worry and work were chiefly the lot of the poor who were less afflicted.

In a personal experience of over 400 male survivors of myocardial infarction under the age of 60, only a few with obvious personality or tension problems have been low risk patients by Framingham standards. Many others also had these problems but showed in addition one or more organic abnormalities. Without measurable yardsticks of emotional states, work tension and fatigue it is difficult to be objective about the personality-anxiety hypothesis.

Western men and women exercise much less than they used to. Most people have an intuitive belief in the benefits of exercise. It fits in with the way they feel when fit and has moral overtones which accord with Hebrew-Christian ideas. Beginning with Morris's studies of bus drivers and conductors in London (Morris *et al.*, 1953) evidence for this belief has grown. Middle-aged men in Australia and New Zealand are now exhorted to jog or exercise daily. Yet this matter has been very incompletely explored. Training improves physical performance and has well-known effects, taken to be favourable, on heart rate, blood pressure and respiration. A number of authors have also found modest reductions in serum lipids after exercise programmes, but Hunter and his colleagues (1968) were unable to confirm this in Dunedin joggers covering 20 to 30 miles a week. There is considerable evidence that diet is a more important determinant of serum cholesterol than exercise.

Granted that it is beneficial, how much exercise is needed and how frequently must it be taken? It is most improbable that a proper clinical trial could ever be completed and what we decide to do will be largely guess-work illuminated perhaps by short-term studies. Experience in our clinic has been that in the presence of other risk factors, especially marked hypercholesterolaemia, vigorous regular exercise does not guarantee immunity from myocardial infarction.

Of the factors which are measurable blood pressure and serum cholesterol have been shown repeatedly to be the most important. In population studies both

are near normally distributed with a slight tendency to skew deviation towards the higher levels. In young and middle-aged subjects distribution curves for hypertension show some minor variation between different populations. It is unlikely that these differences account for the wide inter-racial differences in premature coronary mortality. Nor does hypertension appear to be the main precursor of premature myocardial infarction in our patients.

For serum cholesterol the findings are quite different. The mean varies from as low as 120 in some primitive populations to as high as 270 in a group of apparently healthy middle-aged executives and senior public servants in Sydney (unpublished data). As is well known, premature coronary mortality is unknown at the lowest levels and increases progressively as the mean for the population rises. Hypercholesterolaemia appears to be a necessary prerequisite for premature atheroma and thrombosis; it provides the essential background for other factors to operate. Some, fortunately the majority, stand it better than others and survive to a normal span. A time factor seems to be in operation in determining coronary disease for gross hypercholesterolaemia is particularly common among the younger coronary subjects. The relatively high levels of serum cholesterol in Western communities although normally distributed, can scarcely be regarded as biologically desirable.

This interpretation of endemic environmental hypercholesterolaemia accords with experience in the genetically determined disease, familial xanthomatosis (Type II hyperlipoproteinaemia of Fredrickson, Levy & Lees, 1967). The homozygotes show gross hypercholesterolaemia in the first year or two of life and seldom survive beyond 20. The heterozygotes usually show lesser degrees of abnormality, but by the age of 10 the abnormality is unequivocal. Some live a normal life-span but a high proportion die prematurely of vascular (usually coronary) disease in early or middle adult life. Such patients are seldom fat or hypertensive and show diabetes no more frequently than the general population. Their lipoprotein pattern, which shows increased low density lipoprotein in the S_f 0–20 class, appears identical with that of fat-sensitive Western man. The disease illustrates par excellence the operation of one strongly expressed risk factor. One hears no rumbles of dissent at the idea that this form of hypercholesterolaemia is dangerous and should be treated but some are unconvinced that the identical lipoprotein pattern induced by the environment merits any consideration at all!

Nevertheless there are clinical differences in genetic and acquired Type II disease which most likely reflect different chemical mechanisms. For example, the genetic disease is little affected by dietary fat

modification or clofibrate, while the acquired disease is usually responsive to both.

Hypercholesterolaemia in Australia is a function of diet. National food consumption figures agree with those from a survey of middle-aged males in our clinic that the average consumption of fat is 150 g per day, and this contributes 40% of calories (Woodhill, Palmer & Blacket, 1969). Although on average coronary subjects showed slightly higher fat consumption (43%) this is not sufficient to account for the higher levels of serum cholesterol which they showed. Clearly a relatively uniform national diet evokes differing quantitative responses. The commonest pattern both in coronary and apparently healthy subjects has been an increase in low density lipoproteins, hyperbetalipoproteinaemia or Type II hyperlipoproteinaemia.

Fig. 1 shows that this response is reversible. K.S. at the time of his infarction had a serum cholesterol of 440 mg/100 ml. With non-specific caloric restriction he lost weight and his serum cholesterol fell to 211 mg/100 ml. On a free diet sufficient to keep his weight steady his serum cholesterol rose to 350. After reduction of his fat intake serum cholesterol over the next 6 years was 217 mg/100 ml. Although most patients have behaved in the same way to weight reduction and fat modification some do not respond to such modest changes. They appear to have as much difficulty in handling fat as patients with xanthomatosis and some of their pedigrees are just as ominous.

The second and almost the only other pattern encountered has been hyperprebetalipoproteinaemia (Type IV of Fredrickson). The term carbohydrate-induced lipemia (Ahrens *et al.*, 1961) emphasizes its association with diabetes mellitus and intolerance of carbohydrate. In the fully developed syndrome the serum is milky due to increase in the triglyceride-rich, cholesterol-poor, very low density lipoprotein fraction. Nestel in this country has made a number of important contributions to our understanding of triglyceride metabolism in normal subjects and in patients with coronary heart disease (Nestel & Hirsch, 1965; Nestel, 1965, 1966a, b; 1967). A majority of the patients are fat and many have in addition elevated levels of low density beta lipoprotein. In a series of 103 male survivors of myocardial infarction under the age of 60, 37 or 34% showed abnormal elevation of triglycerides while 28% showed abnormalities of glucose tolerance (Palmer, Woodhill & Blacket, 1969). None of these patients were overt diabetics and a family history of diabetes was rare. Recognition of hypertriglyceridaemia is important in management, for fat reduction and its accompanying increase in carbohydrate intake may well accentuate the disorder.

Fig. 2 shows the mean response of weight,

FIG. 1. The effect of a strict modified fat diet (30% of calories) and polyunsaturate substitution in a young male survivor of a severe myocardial infarct. K.S., 40, male, glucose tolerance normal fasting serum triglycerides 56 mg%, serum uric acid 7.6 mg/100 ml.

FIG. 2. The effect of carbohydrate reduction and fat reduction in a group of thirty-one blood donors with milky serum. (From Mishkel & Woodhill, unpublished.)

cholesterol and triglycerides to dietary modification in a group of thirty-one apparently healthy blood donors with milky serum. They were overweight, consuming more food than they needed and had hyperglyceridaemia. Carbohydrate consumption was reduced from 420 to 170 g and fat from 165 to 115 g per day without polyunsaturate substitution. There was a prompt reduction of serum triglycerides and a lesser fall in serum cholesterol attributable to the fall in very low density lipoproteins. Serum cholesterol was now about the mean for the community. Although none of these subjects was typed by electrophoresis it can safely be assumed that most, if not all had Type IV disease (Mishkel & Woodhill, unpublished).

In Australia Type IV is frequently associated with alcohol to which these subjects are often extremely sensitive. Fig. 3 is an example. A drastic weight reduction programme brought a spectacular fall in triglycerides and cholesterol. Even so at ideal weight the tendency to hyperglyceridaemia persisted. Later estimations where the triglycerides were higher coincided with a series of parties and dining out on vacation in Sydney. Such patients frequently obtain further improvement with clofibrate or phenformin.

Obesity shortens life and has been a common precursor of coronary disease in our subjects. Nevertheless, epidemiological studies have shown little correlation between serum cholesterol and weight.

This too has been our experience. Whyte and his colleagues in Canberra have confirmed this and have also found that cholesterol production and total body cholesterol is proportional to the degree of obesity (Whyte *et al.*, 1969). They have found, as have others, a correlation between serum triglycerides and free fatty acid flux and obesity (Nestel & Whyte, 1968). By lipoprotein electrophoresis some, probably the majority, of obese subjects have Type II patterns while others have Type IV.

Fig. 4 shows a common effect of conventional weight reduction, brought about in this case by global restriction of food, especially carbohydrate. Cholesterol fell gradually but rose again when a steady new state was reached. Triglyceride was mildly elevated and fell promptly to 120 mg/100 ml in the first few weeks of negative calorie balance. In this patient angina and gout disappeared when he lost weight.

Fig. 5 from a similar subject with angina and gout and a low initial serum cholesterol shows the usual early fall with weight reduction and a rise when a new steady state was reached.

In our series of 107 post-coronary subjects mentioned above there was no correlation between loss of weight and fall in serum cholesterol on a strict modified fat diet. The changes in body weight were less than in the cases illustrated above.

There are obvious paradoxes about obesity which cannot be enlarged upon here. When considerable

FIG. 3. The response to weight reduction and alcohol restriction in a subject with severe carbohydrate-induced hyperlipemia. J.S.B., 42, male, glucose tolerance normal, tolbutamide response normal, E.P.G. Type IV.

FIG. 4. The treatment of angina pectoris by weight reduction; the effect on serum cholesterol. H.V.R., 65, male, glucose tolerance normal, insulin response high, serum uric acid 8.6 mg/100 ml (gout), serum triglycerides 209 mg/100 ml, E.P.G. Type II.

it undoubtedly predisposes to coronary disease but its principal effects may well be mediated through non-lipid pathways. Fat people have a higher than average cardiac output, tend to be hypertensive and

diabetic and through lack of exercise and cardiac challenge may lack the reserves to cope with coronary thrombosis.

Our experience agrees with the general theory that disorder of nutrition is one factor promoting a high coronary mortality in this country. Obesity, hyperbetalipoproteinaemia and hyperprebetalipoproteinaemia are all metabolic diseases dependent on a good food supply. Genetic predisposition has been shown to influence the latter two and may well play a part in obesity also. Further study of the interrelationships between input and output of energy in these states is difficult but essential.

It provides a useful perspective to enumerate broadly the main facts relating nutrition to coronary heart disease.

(1) Epidemiological studies of different populations show profound differences in the diets of high-mortality countries like Australia and low-mortality countries like New Guinea (primitive) or Japan (highly industrialized).

(2) International differences in serum lipoproteins and cholesterol parallel differences in mortality and diet. No country with low cholesterol levels experiences a high coronary mortality.

(3) By appropriate feeding, lipoprotein patterns characteristic of low mortality countries can be converted into those found in high mortality countries.

(4) Migrants from low mortality countries to high mortality countries in general adopt the habits of

FIG. 5. Angina pectoris and low serum cholesterol. Failure of serum cholesterol to change permanently with weight reduction. V.A., 51, male, glucose tolerance abnormal (no glycosuria), serum uric acid 10.0 mg/100 ml (gout), serum triglycerides normal.

their adopted land and experience its coronary mortality. When through conquest nations are partly starved mortality from coronary disease, thromboembolism and diabetes falls.

(5) The lipoprotein patterns found in high mortality countries are clearly attributable to the diet consumed. They can be modified in the direction of those found in low mortality countries by appropriate dietary modification.

(6) The most common dietetically induced abnormality in Western society is hyperbetalipoproteinaemia. When acquired endogenously by heredity or disease in extreme form this is a highly lethal disease.

(7) Prospective studies in high mortality countries show that subjects with the higher lipoprotein levels on average succumb sooner than the rest. The higher the level the earlier the morbidity and mortality.

In summary, the evidence is very strong that Chaucer's intuitions were correct. Many who suffer and succumb before their time are fat from plain gluttony. But others are not and gluttony is for them an unjustly harsh word. What they eat is right for quantity but the hyperlipoproteinaemia which comes from their high fat diet favours accelerated arterial ageing and thrombosis. Their genetically determined biochemical pathways are unable to tolerate what others can handle with impunity.

What of the future? The wealth of the Western nations has led to a way of life which favours arterial disease in an increasing number of the population. Few live by the sweat of their brow and bread is no longer the staff of life. Prosperity and modern farming have made it possible for every meal to be a banquet. Habituation to so-called protective foods, high in protein and high in fat has been encouraged by nutritionists and Governments and begins in the cradle. The evidence is that soon after the growth period has finished and this diet is continued, fatty infiltration of blood vessels begins. Asian countries, notably Japan, with comparable standards of living but with a different diet do not share this experience nor do they share our coronary mortality.

Most of us are hedonists at heart and the Spartan life was so remarkable and disagreeable in human experience that the word has become part of our language. The pleasures of the table are part of our reward for success. In Australia particularly where most come from humble British stock, some at the pleasure of the Crown, good eating is part of the tradition. Drinking too is part of the tradition and the automobile has become a status symbol. Yet coronary disease, stroke and peripheral vascular disease touch most families and the more thoughtful want to know why. Quite by chance the four subjects chosen to illustrate in this paper the different effects

of dysnutrition are all successful business men, two of them university graduates. All of them have become disciples of the new nutrition. They have learned that our present food and cooking habits are not the only pleasurable ones, that the table can be pleasant and not very different from what tradition has made it, though guided by a different philosophy. The word is spreading. Some are re-educating their children as well. Perhaps in the long term hyperlipoproteinaemia will be seen in the same light as hypertension, hyperglycaemia and hyperuricaemia which are all regarded as 'diseases' and treated vigorously. None of these is so clearly dependent on identifiable factors in the environment as hyperlipoproteinaemia. Correcting them by taking pills does not disturb unduly the habits of a lifetime and is acceptable to the majority. Whether attitudes to hyperlipoproteinaemia will change in the Western world sufficiently to influence coronary mortality only time will tell.

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