Papers and Originals

Present Position Concerning Prevention of Heart Disease*

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Recent advances in diagnostic skill and in the medical and surgical treatment of established cardiac lesions have overshadowed the preventive approach to heart disease. The very large and increasing size of the total problem of vascular disease urges on us the need for active planning of its prevention. Prevention of further progression in those who already have developed heart disease is being achieved to a limited extent, but this must not be allowed to obscure the ultimate goal of primary prevention. The elaboration of certain specific primary preventive measures is already possible, and others should soon follow, despite the serious lack of knowledge of the mode of causation of most major forms of heart disease. The purpose of this article is to draw attention to the present possibilities of preventing heart disease in the several forms in which it occurs in Britain. Its compilation was stimulated by our attendance at a W.H.O. meeting on this subject held in Bucharest in March 1965, and attended by representatives from 25 European countries (W.H.O., 1965).

Ischaemic Heart Disease

While ischaemic heart disease is almost a daily clinical experience for most doctors, not all are aware of the magnitude of the problem. In 1962 diseases of the coronary arteries and arteriosclerotic heart disease, together with so-called myocardial degeneration, were responsible for approximately half of all deaths in Britain. They accounted in men for 80% of deaths from circulatory diseases in England and Wales and a slightly higher proportion in Scotland, and in women for 60% of deaths from circulatory diseases in England and Wales and nearly 70% in Scotland. The mortality from ischaemic heart disease is greater in Scotland compared with England and Wales, and in 1961 the male mortality rate was the highest in the world and in excess even of the United States (415/100,000 population in Scotland compared with 376/100,000 in United States) (W.H.O., 1964).

Diseases of the coronary arteries are responsible for approximately 30% of all deaths among middle-aged men and have been a steadily increasing cause of mortality for a number of years. This increase appears to be involving those under 45 years of age at a faster rate than older sections of the population (Table I). Improved diagnosis is unlikely to have contributed much to the increase, as diagnostic methods have not changed greatly between 1952 and 1962, and this table, which represents age-specific death rates, indicates that there are other explanations than that of an ageing population to account for this increase. Even if one subscribes to the view (Campbell, 1963) that the chief reason for the rise in prevalence of ischaemic heart disease is the greater number of middle-aged people in the community resulting from the decline in mortality due to infectious disease in children and young adults, the fact remains that ischaemic heart disease is a formidable medical and economic problem requiring urgent attention.

TABLE I.—*Death Rates per* 100,000 *Living in England and Wales from Diseases of the Coronary Arteries and Arteriosclerotic Heart Disease* (420*) (*Registrar-General's Figures*)

Age Group	1952		1957		1962		Percentage Change 1952–62	
	M	F	M	F	M	F	M	F
30–34 years	5·8	0·9	7·4	1·1	8·6	1·4	+50	+55†
35–39 „	18·0	2·0	21·7	2·4	34·0	4·7	+89	+135†
40–44 „	41·8	6·4	55·7	7·1	73·7	9·8	+76	+59
45–54 years	150	27	178	28	213	36	+42	+33
55–64 „	453	130	527	143	639	172	+41	+32
65–74 „	1,010	1,451	1,155	1,520	1,395	1,613	+38	+12

* This number and those in Tables II and III indicate the *International Classification of Diseases* numbers.
† Derived from small numbers.

Although more years of working life are lost from ischaemic heart disease than any other disease (Morris, 1964), it is difficult to obtain an accurate picture of the true incidence of ischaemic heart disease. Information gained from certain selected family practices suggests that about 2% of men between 45 and 64 years and 1% of women of the same age consult their doctors each year because of clinical features of ischaemic heart disease. Morbidity figures are largely based on hospital records. This is a very selected group of the population. The Framingham experience in the United States indicates that more than half of those who die from acute myocardial infarction do so within one hour, and only just over half of those with an initial attack of acute infarction are admitted to hospital (Kannel *et al.*, 1963). This high frequency of sudden death emphasizes more clearly than anything else the importance of *preventing* the development of ischaemic heart disease.

Prevention of the Syndrome

Atherosclerosis of the coronary arteries begins in childhood or early adolescence, is present in all adults in this country, and progresses steadily with advancing age. In rather more than one-third of the population this leads to the clinical syndromes of ischaemic heart disease—angina, "coronary insufficiency," myocardial infarction, congestive heart failure, and sudden death. Whether or not coronary atherosclerosis will lead to ischaemic heart disease is determined by a compound of influences, including the degree and site of arterial disease, the occurrence and extent of thrombotic occlusion of the arterial lumen, the adequacy of the coronary anastomotic circulation, myocardial demands, and the anatomical distribution of the coronary arteries.

Prevention of the clinical syndrome of ischaemic heart disease depends on the effectiveness with which these causal factors can

* This paper contains our opinions only, and should not necessarily be interpreted as reflecting the views of other participants at the W.H.O. Conference on the Prevention and Control of Heart Disease held in Bucharest in March 1965.

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be controlled. Clearly, nothing can be done about the anatomical distribution of the coronary arteries, though it is interesting to question whether certain families among whom ischaemic heart disease is common inherit a disadvantageous form of coronary artery distribution. Similarly, permanent reduction of myocardial demands below a certain threshold is impossible and undesirable. This leaves the problem of preventing coronary atherosclerosis and thrombosis and of improving coronary anastomosis. These three have to be thought of as one, since the degree of development of each is dependent on or closely related to the others. As we do not understand the reasons why atherosclerosis develops in childhood or early in adolescence, it is unlikely that effective *primary* prevention will be possible for many years. Thus, inevitably when considering prevention of ischaemic heart disease, it must be accepted that at best this is *secondary* prevention. It is secondary in the sense that arterial damage may already be advanced, but primary in that no clinical features have developed and severe myocardial damage has not occurred. This discussion is not concerned with what might be called *tertiary* prevention—that is, the prevention of further coronary incidents after the initial presentation of one of the clinical syndromes of ischaemic heart disease. The focus is on what can be done to prevent apparently healthy individuals from developing any of the syndromes of ischaemic heart disease.

Risk Factors

Coronary atherosclerosis is universal in developed communities. Ischaemic heart disease fortunately is not, though it has been estimated (Morris, 1964) that, of 1,000 male doctors 40 years or under, 200 will develop ischaemic heart disease before the age of 65. Thus the identification of those in the population who are most at risk is important for effective prevention. This can and is being done. Many surveys (for example, Morris *et al.*, 1953 ; Hammond and Horn, 1958 ; Morris and Crawford, 1958 ; Oliver and Boyd, 1959 ; Breslow and Buell, 1960 ; Kagan *et al.*, 1962 ; Higgins *et al.*, 1963 ; Paul *et al.*, 1963 ; Sznajderman and Oliver, 1963 ; Doll and Hill, 1964 ; Doyle *et al.*, 1964 ; Stamler, 1964) have shown that apparently healthy individuals with the following characteristics or habits, which are listed below without any attempt to apportion priorities, have a greater incidence of ischaemic heart disease:

- Hyperlipidaemic states
- Hypertension
- Cigarette-smoking
- Physical inactivity
- Premature cessation of ovarian activity.

Less well documented but potentially important influences include:

- Diabetes
- Psychogenic stress and the reaction of the individual to it
- A rapid gain in weight
- Hyperuricaemia
- A thrombotic tendency.

While it is helpful from the point of view of prevention to list these known risk factors separately, ischaemic heart disease is more likely to result from an interplay of multiple related factors than from a single cause. Therefore a strong case can be made out for the elimination of as many as possible. Some factors are, of course, more amenable to control than others. For example, nothing can yet be done to prevent diabetes or hyperuricaemia. Similarly, psychogenic influences cannot be readily controlled. Individuals react to a given situation in many ways—for one it is a source of enjoyment, for another a challenge, for another it is overwhelming and a source of depression, for some it is a cause of anxiety, and for others the situation simply does not exist at all. The prevention of the effects of psychogenic stimuli on the development of ischaemic heart disease is therefore impracticable and must at least wait until they and the individual reactions to them can be measured and defined. Other risk factors are more readily controlled.

Hyperlipidaemia

Hypercholesterolaemia, which is mostly genetically determined (Schaefer *et al.*, 1958 ; Epstein, 1964), is one of the most important and well-documented risk factors (Kagan *et al.*, 1962 ; Kannel *et al.*, 1964). It is most commonly found in young men who develop ischaemic heart disease (Oliver and Boyd, 1953 ; Biörck *et al.*, 1957 ; Lawry *et al.*, 1957) and is probably present in approximately 20% of the population. Raised serum triglycerides are probably at least as important as high cholesterol levels (Albrink and Man, 1959 ; Carlson, 1960 ; Albrink, 1962). The position with regard to trials designed to lower elevated serum cholesterol levels still remains unsettled (Oliver, 1962), mostly because these trials have been undertaken in survivors of myocardial infarction and therefore in patients with advanced atherosclerosis, in whom other factors may well assume greater prognostic significance than elevation of serum cholesterol.

Several prolonged studies of diets low in saturated fat with or without a high unsaturated fat content have been conducted in such patients. Although some of these have shown a decrease in mortality (Morrison, 1955 ; Lyon *et al.*, 1956), the most carefully controlled investigations have not (Report of Research Committee on Low Fat Diet, 1965 ; Rose *et al.*, 1965). At present the results are insufficiently definite to permit firm advice with regard to any specific change in the dietary habits of a nation. Similarly, the long-term effects of oestrogens have been studied in three centres with negative or at best equivocal results (Oliver and Boyd, 1961 ; Marmorston *et al.*, 1962 ; Stamler *et al.*, 1963). To date, these various studies suggest that reduction of elevated cholesterol levels in *patients* does not influence prognosis. In this respect it has recently been shown that no correlation exists between serum lipid levels and five-year survival rates after first infarction (Little *et al.*, 1965). No controlled long-term studies have yet been completed to determine the effect of lowering elevated triglyceride levels. This is also true for hyperuricaemia. Recent advances in drugs—for example, clofibrate (Atromid-S)—and in dietetics now make it possible in the majority of patients to shift the serum lipids from high to low levels ; large-scale long-term studies of the effects of reduction of raised serum lipids are urgently required in those who are asymptomatic. The organization of such a scheme is practicable (Baker *et al.*, 1963), and one such study, the "anti-coronary club" in New York, has shown encouraging initial results (Christakis *et al.*, 1965).

Other Factors

Less can be said about *hypertension* in relation to the development of ischaemic heart disease, since it cannot be completely controlled even with the newest drugs. Furthermore, satisfactory control of high blood-pressure has not yet been shown to lead to any decrease in morbidity or mortality from myocardial infarction, in contrast to its beneficial effect on cerebral haemorrhage, renal failure, and heart failure (Hood *et al.*, 1963 ; Aurell and Hood, 1964).

Cigarette-smoking can, in theory, be completely controlled. In several studies it has been well documented that mortality rates from ischaemic heart disease are lower among ex-smokers than in those continuing to smoke (Hammond and Horn, 1958 ; Doyle *et al.*, 1964 ; Doll and Hill, 1964). *Physical slothfulness,* while potentially remediable, is difficult to combat except

through a national campaign to educate the public to its dangers.

Ovariectomy or irradiation of the ovaries is sometimes avoidable. Although many gynaecologists and radiotherapists seek to preserve the ovaries, the fact that the latter are endocrine glands with vital functions other than the production of the ova is still ignored. When induced or spontaneous cessation of ovarian activity has occurred prematurely (Sznajderman and Oliver, 1963), prolonged hormonal replacement is indicated.

A *thrombotic tendency,* though considered last in this discussion of risk factors in relation to ischaemic heart disease, may be as important as any of those already outlined or more important. Platelet thrombi form and fibrin is deposited *pari passu* with the accumulation of lipid in early arterial lesions, and thus contribute continuously to their progression and to the obstructive elements of advanced lesions. There are at present two difficulties in preventing such a thrombotic tendency. One is that no reliable test or group of tests has yet been developed which will make it possible to determine those of the apparently healthy population with this tendency; further work may show that tests of platelet stickiness will prove valuable in this respect. The other is that there is no satisfactory way of combating a tendency to arterial thrombosis. Anticoagulants produce only marginal benefit in the management of frank and massive arterial thrombosis, and, in view of this and the practical difficulties of their usage, there can be no question of advocating anticoagulants for prevention of ischaemic heart disease. Nor has fibrinolytic therapy any part yet to play in prevention.

Preventive Approaches

Thus there are two preventive approaches to ischaemic heart disease which should now be pursued actively and concurrently. One is the education of the public to stop cigarette-smoking altogether, to avoid obesity, and, for many people, to take more exercise. This advice could be got across in many ways—by general practitioners and medical officers of health, and through newspapers, radio, and television—and it may need a vigorous national campaign to be successful. Of course, a major shortcoming of giving such advice on a national basis is that not everyone will react to cigarette-smoking or physical inactivity by developing ischaemic heart disease. This outcome will be determined by the extent and nature of the three underlying pathological processes previously mentioned—coronary atherosclerosis, the development of intravascular thrombosis, and coronary anastomosis. The other approach is the correction of hyperlipidaemia in those who are asymptomatic. This requires rigidly designed controlled trials, and at present these are best conducted in major academic centres, or by one of the national research foundations.

Hypertensive Heart Disease

Hypertension manifests itself through its cardiac and vascular complications. Although responsible for fewer deaths than ischaemic heart disease, the prevalence of symptomless hypertension, much of which is probably undetected, is unknown. The national heart survey carried out in the U.S.A. in 1961–2 showed that hypertensive heart disease was the commonest form of heart disease in the apparently healthy population, occurring in 8% of males and 11% of females. There are few figures which enable accurate assessment of the prevalence of different forms of hypertension in the population, and such studies that have been done have different criteria for the pathological values of blood-pressure and different methods of measurement. In the majority the cause of the hypertension is unknown, though the diagnosis of essential hypertension can never be made with certainty until other causes of elevated blood-pressure have been excluded. The use of antihypertensive drugs has altered the prognosis of severe hypertension, and the mortality from hypertensive heart disease decreased in Britain between 1952 and 1962, particularly in the last five years. This is illustrated in Table II, though too much attention should not be paid to this data, since its quality and reliability are less good than that of other cardiovascular diseases. Most of the reduction in mortality is due to reduction of deaths from strokes and uraemia (Leishman, 1963). When moderate or severe hypertension is detected before there is evidence of heart disease, effective drug therapy can delay the development of left ventricular hypertrophy and of congestive failure (Hodge *et al.,* 1961; Hood *et al.,* 1963). There is a case then for the early detection of hypertension, and the annual or biennial clinical " check-up " has, in this respect, much to commend it.

TABLE II.—*Death Rate per* 100,000 *Living in England and Wales from Hypertension* (440–447), *Excluding Vascular Diseases of the Central Nervous System* (*Registrar-General's Figures*)

Age Group (Years)	1952		1957		1962		Percentage Change 1952–7		Percentage Change 1957–62	
	M	F	M	F	M	F	M	F	M	F
45–54	19·6	13·1	17·7	10·0	14·8	8·2	−10	−24	−16	−18
55–64	77·8	49·3	68·4	42·9	51·4	30·6	−12	−13	−25	−29
65–74	220·9	168·0	216·9	162·7	145·7	122·8	−2	−3	−33	−25

Effective prevention of hypertensive heart disease may also be practicable in the minority of the hypertensive population whose increase in blood-pressure is related to specific lesions or diseases capable of alleviation. Of the causes of such secondary hypertension urinary infection is probably the most controllable. Bacteriuria and hypertension are commonly associated, and many women have asymptomatic bacteriuria. Adequate measures to detect this and institution of the appropriate chemotherapy are positive steps which can be taken to attempt to prevent the deveolpment of chronic pyelonephritis. Screening of all the adult population is impracticable but it should not be impossible to culture at least once a year the urine of all women in the child-bearing age, particularly those who are parous. There is no evidence yet that hypertension can be prevented in those with moderately advanced pyelonephritis, so it is all the more important that routine screening for bacteriuria should be established widely and applied particularly to the young. If every general practitioner in the country were to arrange regularly for mid-stream urine specimens to be cultured the prevalence of hypertension could probably be reduced.

Other causes of secondary hypertension include polycystic disease, adrenal hyperfunction, phaeochromocytoma, and coarctation of the aorta. The prevention of the consequences of haemolytic streptococcal infection, such as glomerular nephritis, is considered in the section on rheumatic heart disease. Polycystic disease, adrenal hyperfunction, and phaeochromocytoma require hospital investigation for their substantiation, but coarctation of the aorta, though rare, is readily detectable. Routine palpation of the femoral arterial pulse, and comparison of its timing and velocity with the radial pulse when the arm is placed at the side of the body, is simple and quick. It should be a standard examination in all patients with hypertension.

Women who develop hypertension during pregnancy should be followed more closely in the hope of detecting early those who will remain hypertensive and others whose blood-pressure becomes abnormally elevated with increasing age.

Cor Pulmonale

There is widespread recognition of the importance of chronic cor pulmonale among the major causes of heart failure and death, yet there is almost no statistical evidence concerning the size of the problem. Comparative mortality statistics in

different countries are not available, because cor pulmonale is not identified as such in the *International Classification of Diseases* where death certificates are classified by the underlying chest conditions. Few hospital studies have been undertaken to ascertain the frequency with which heart failure is secondary to chronic pulmonary disease. In the major hospitals of the Sheffield Region cor pulmonale contributed 18 to 40% of the total cases of heart failure (Stuart-Harris *et al.*, 1959). Similar proportions are known to be experienced in certain European cities such as Prague and Belgrade, but more information is required on the size of this problem.

The W.H.O. (1961) report defined chronic cor pulmonale as "hypertrophy of the right ventricle resulting from diseases affecting the function and/or the structure of the lung, except when these pulmonary alterations are the result of diseases that primarily affect the left side of the heart or of congenital heart disease." In life cor pulmonale is difficult to diagnose before the onset of heart failure, since at an early stage the diagnostic criteria for the existence of right ventricular hypertrophy are largely electrocardiographic and may be unfulfilled. Yet knowledge concerning the incidence of the various forms of chest disease known to lead to cor pulmonale is growing, and it has been found that, in spite of the total length of the list, relatively few causes contribute most of the cases.

In Great Britain and Europe as a whole chronic bronchitis with or without emphysema, asthma, bronchiectasis, or generalized fibrosis such as pneumoconiosis are the major precursors of cor pulmonale. These states are all accompanied by excessive production of sputum occurring chronically and in acute exacerbations either alone or more commonly with reversible or irreversible obstruction of the airways (M.R.C. Committee's Report on the Aetiology of Chronic Bronchitis, 1965). They lead to fluctuating pulmonary hypertension, which is accompanied by disturbance of the arterial blood-gas tensions due to alteration of the ratio of alveolar ventilation and perfusion of the pulmonary capillaries. Abnormal pulmonary function and a generalized form of lung disease thus coexist with heart disease. Thromboembolic disease of the pulmonary vasculature and certain fibrotic conditions producing arterial occlusion cause another variety of cor pulmonale but form a relatively small proportion of the total.

Bronchial infection, heavy cigarette-smoking, exposure to atmospheric pollution, and the environment in industrial communities appear to provide the basis for chronic overproduction of bronchial mucus and lead to obstruction of the air passages (Stuart-Harris, 1965). Limitation of cigarette-smoking, promotion of clean air, and control of bronchial infection in those who have already acquired symptoms afford the best chance of hindering the further evolution of chest disease and thus the prevention of cardiac involvement. The ascertainment of those particularly likely to develop heart disease is readily possible by using simple tests of ventilatory function. Measurement of the forced expiratory volume and vital capacity by a spirometer or of the peak expiratory flow with the Wright peak flowmeter readily enables obstruction to ventilation or restriction of ventilation to be recognized. These tests were described in full in the M.R.C. Committee's Report on the Definition and Classification of Chronic Bronchitis (1965).

Persons already affected by bronchial obstruction are known to their family doctors because of their dyspnoea and liability to exacerbations of symptoms in winter-time. A far stricter surveillance of such patients with chest disease is desirable, and efforts to improve the pulmonary function by the use of antispasmodic drug therapy should be concentrated particularly on those who are only mildly disabled. An intensive effort with inhalants or oral preparations of isoprenaline, theophylline, and their derivatives, or aminophylline is more likely to be rewarding in those whose chest disease may still be reversible than concentration upon crippled patients whose airway obstruction is often irreversible. Bronchial infection should be treated simultaneously because this often contributes to obstruction. The value of prolonged prophylactic antibiotics is chiefly found in a shortening of the duration rather than in a reduction of the number of exacerbations of bronchitis during the winter-time. A similar reduction in duration can be effected by immediate antibiotic treatment at the outset of a cold or in anticipation of an exacerbation of bronchitis induced by "smog." Immunization, for instance, with influenza vaccine has not been proved to be of value statistically, largely because exacerbations caused by influenza form only a fraction of the total episodes due to respiratory virus infections. In so much as influenza can lead either to severe bronchitis in or even to death of patients with chest disease, it is worth while using vaccine prophylactically in winters when an influenza epidemic appears likely.

Rheumatic Heart Disease

Rheumatic heart disease accounts for about 8% of all deaths from cardiovascular diseases in women, though for less than 1% of male deaths. It is also a significant source of morbidity, particularly in the younger age groups. The overall mortality from rheumatic heart disease has fallen during recent years, but not to the extent that might have been expected in view of the striking decrease in rheumatic fever. Notification of acute rheumatism in children under the age of 15 fell by 38% between the years 1955–6 and 1961–2, and mortality was reduced by two-thirds between 1929–32 and 1946–9 in children between the ages of 5 and 14, suggesting that the incidence of rheumatic fever had been falling steeply in the years before notification was introduced.

Twenty years ago it was easy to show students patients with acute rheumatic fever or chorea, but now the former are uncommon and the latter almost non-existent. This decrease in rheumatic fever started many years before the antibiotic era, but whether it was due mainly to diminished spread of streptococcal infections or to improved individual resistance as a result of better socio-economic conditions is uncertain. Mortality from rheumatic heart disease, on the other hand, shows a much smaller decrease, and the pattern indicates that there has been least reduction in the 45–64 age groups (Table III). The relative higher incidence in the older age groups could be due to survivors from the years when rheumatic fever was more common and from the effects in younger patients of improved treatment of intercurrent infections and of heart failure, and, to some extent, of successful cardiac surgery. There are no reliable morbidity figures to indicate changes in the incidence of rheumatic heart disease, but there is no doubt that it continues to be a common problem for most cardiologists.

TABLE III.—*Death Rates per* 100,000 *Living in England and Wales from Rheumatic Heart Disease* (410–416) (*Registrar-General's Figures*)

Age Group	1952		1957		1962		Percentage Change 1952–62	
	M	F	M	F	M	F	M	F
15–24 years	3·3	3·8	2·5	2·5	1·3	1·2	−61	−69
25–44 „	10·7	15·2	8·9	13·2	6·6	8·8	−40	−42
45–64 „	28·0	37·3	24·9	37·3	21·2	33·2	−24	−11

Infection of the upper respiratory tract with beta-haemolytic streptococci of Lancefield Group A is an invariable precedent of an initial or recurrent attack of rheumatic fever (Report of Rheumatic Fever Committee, Royal College of Physicians, London, 1957). Rheumatic fever follows streptococcal epidemics in closed communities such as schools in up to 10% of those exposed, though Rammelkamp *et al.* (1952) put the figure in the region of 3% and Bywaters (1965) considered that only about one out of 300 streptococcal sore throats leads on to rheumatic fever. Whereas the relationship between acute streptococcal infections and rheumatic fever is established, the

relationship of streptococcal infection with the subsequent development of rheumatic heart disease is not. It is not certain how often rheumatic heart disease is preceded by overt rheumatic features, and Wood (1956) estimated that for every 100 recognized cases of juvenile rheumatism with or without carditis there must be 30 additional unrecognized cases of pure rheumatic carditis.

Although the incidence of rheumatic fever has declined, there has probably been less decline in the incidence of streptococcal infections in the community. An interesting question, therefore, is whether the beta-haemolytic streptococcus is continuing to produce chronic valvular heart disease, and perhaps also chronic glomerular nephritis, without the preceding classical acute features customarily associated with these diseases. This question is all the more interesting when it is realized that only a minority of acute streptococcal infections present as a sore throat and fever, and about 40% are asymptomatic (Feinstein *et al.*, 1964). The recognition of acute streptococcal infections is important, therefore, and throat swabs should be taken more regularly from children with minor upper respiratory infections.

The management and follow-up of recognizable acute streptococcal infections also require consideration. Many children develop a sore throat, even frank tonsillitis, every winter, and about half of these are associated with the haemolytic streptococcus (51% according to the M.R.C. Report on Acute Respiratory Virus Infections, 1965). Often antibiotics are given orally for a few days, the child recovers and is sent back to school. It has already been clearly recommended in the report of the Rheumatic Fever Committee of the Royal College of Physicians (1957) and in the report of the American Heart Association Committee on Prevention of Rheumatic Fever (1965) that adequate doses of penicillin (preferably starting with one injection of benzathine penicillin G) should be given for a full ten days for effective treatment of acute streptococcal infections, yet this advice is often not followed. Sulphonamides are not bactericidal and should no longer be used.

Few attempts have been made to follow the late effects of acute streptococcal infections, and a sore throat is usually regarded as an end in itself. There is a case then for the long-term study of the incidence of rheumatic heart disease in children with sore throats, and such a study might well be undertaken through the school medical service or family practitioners. It would need to be on a very large scale, but if it showed a higher incidence of rheumatic heart disease in children who had severe or multiple throat infections, then the adequacy of current treatment should be reconsidered.

All children and adolescents who have a history of rheumatic fever should be given penicillin prophylactically until late adolescence or early adult life. Oral penicillin or oral sulphonamides are effective when given as continuous prophylaxis, although 1.2 million units of benzathine penicillin G every four weeks intramuscularly is preferred by some (Wood *et al.*, 1964). Perhaps a case can also be made out for similar prophylaxis in children who have a persistently raised antistreptolysin O titre after a sore throat (Taranta *et al.*, 1964). The cost of adequate prophylaxis with penicillin after sore throats or rheumatic fever is small in relation to the cost of hospitalization for rheumatic fever and valvular heart disease.

A joint U.K./U.S.A. report of a 10-year follow-up study of the relative value of steroids and aspirin in the treatment of acute rheumatism has indicated that there is no evidence that either treatment is superior (M.R.C. and A.H.A. Cooperative Clinical Trial of A.C.T.H., Cortisone, and Aspirin, 1965).

Congenital Heart Disease

Congenital heart disease is an important primary and secondary cause of death among the newborn and children during the first year of life. It is estimated to occur in about 0.5% of births, and is the commonest form of heart disease under the age of 20. While congenital heart disease occurs more in some families than in others, heredity alone has not been shown to be the decisive factor in most of the malformations. Campbell (1965) has recently reviewed this problem and takes the view that genetic factors probably only assume significance under certain environmental conditions; and major chromosome abnormalities do not exist in patients with congenital heart disease (Anders *et al.*, 1965). Clinical and experimental observations have led to the recognition of certain environmental factors which may have a teratogenic effect on the foetus. These include maternal rubella and possibly other virus diseases of the mother during early pregnancy, radiation, drugs, and perhaps dietary deficiencies. In the majority of cases, however, it is not possible to incriminate any particular environmental cause.

The differentiation of the heart into its final form takes place during the first two months of gestation, and every effort should be made to avoid infections in early pregnancy. In Finland the incidence of acute infections is high in January and February, and the incidence of malformation of the heart is correspondingly higher in children born eight months later in September and October (Landtman, 1965). Maternal infections may harm the foetus either directly by infection of the embryo, as in the case of rubella, or by a toxic effect. The role of viruses in the aetiology of congenital malformations has been fully reviewed by Blattner and Heys (1961), and the problem of rubella has recently received detailed consideration by Lundström (1962). Since maternal viraemia may persist for several weeks after clinical evidence of the disease has disappeared (Fish, 1965), conception should be avoided and contraception practised for one or two months after rubella or contact with it. Mothers who have contact in the early months of pregnancy with rubella should be given gamma-globulin provided that the exposure has occurred 10 days or less prior to the inoculation, and, so far as it can be ensured, that such gamma-globulin contains good titres of neutralizing antibodies for the rubella virus. Active immunization offers the best protection against rubella, and the deliberate exposure of young girls to rubella before the reproductive age merits emphasis. The isolation recently (Alford *et al.*, 1964; Rudolph *et al.*, 1965) of the rubella virus from human embryos and from children with congenital heart disease born to mothers who had rubella during pregnancy has shown how at least one infection can lead to congenital heart disease. The role of influenza as a cause of foetal deformities is still unsettled (Doll *et al.*, 1960; Leck, 1963).

Hypoxia at confinement is a particular and potentially avoidable foetal hazard which is sometimes associated with persistent patency of the ductus arteriosus. Pulmonary hypertension and patent ductus are more common in babies born at high altitude.

The thalidomide disaster has brought home to everyone the danger of teratogenic effects of drugs given to pregnant women, and it is possible that drugs given to the father may also have a teratogenic effect. It is certainly the case that drugs are prescribed too liberally to pregnant women for the nausea and vomiting and emotional disturbances which often occur in early pregnancy, and the availability of certain drugs without prescription represents a special problem. Since no drugs can be regarded as completely safe for administration in early pregnancy, there should always be a good reason for their use.

Further investigation is urgently needed into possible aetiological influences during the nine months of gestation. A carefully controlled study of infective and chemical factors which might cause congenital heart disease is already under way in Liverpool (*Lancet*, 1965), where an elaborate system of notification has been established.

Organization

The organization of the National Health Service is designed to bring diagnostic and therapeutic services to those who require them. For cardiovascular diseases these services include advanced technical, radiological, and surgical skill. These facilities are provided in regional cardiovascular centres, and patients reach them through general practice, schools, industrial centres, insurance examinations, and so on. Preventive services applicable to chronic disease have lagged behind the treatment service, largely because of ignorance concerning the causes of disease against which action might be taken. The example of the type of organization required to fight a chronic disease such as tuberculosis is hardly valid for disorders where multiple aetiological factors appear to be concerned. Now that some causative factors can be discerned in the case of rheumatic heart disease and cor pulmonale and that risk factors have been identified for ischaemic heart disease, hypertension, and congenital heart disease, detection of heart disease at the earliest moment becomes important.

The establishment of an organization which would provide facilities for regular physical examinations should be considered at least as a pilot experiment. Many middle-aged men and women would undoubtedly benefit from an annual opportunity for reassurance or the early diagnosis of a potentially serious disease. Support for this view can be derived from the enthusiasm and interest which welcomed the "health-check" campaigns in Rotherham and in Glasgow recently. It is greatly to be hoped that public health authorities will join forces with clinicians and that health centres, truly devoted to prevention rather than to treatment, can be developed. Such a project would appeal also to those family doctors who wish to enlarge their experience and to initiate new developments.

Conclusions

Most doctors practise medicine by diagnosis and treatment. Some study aetiology and pathogenesis. Few work on the prevention of disease, partly because effective prevention of chronic disease requires formidable organization, partly because clinical medicine is more popular, and partly because in the past doctors were seldom taught preventive medicine during their training. Lack of certainty about causation might be put forward as another reason, but complete characterization of the aetiology of disease is not always necessary before prevention becomes effective. There are also obvious difficulties in identifying vulnerable groups. Nevertheless, much could now be done towards the prevention of ischaemic heart disease, cor pulmonale, and perhaps rheumatic heart disease. Closer collaboration between clinicians, epidemiologists, and public health workers is particularly needed.

It is clear from this outline of some of the possibilities of preventing heart diseases that further progress will depend on the establishment of preventive programmes and clinics. Some programmes, such as the reduction of cigarette-smoking and control of atmospheric pollution, require to be conducted on a national basis. Others, such as the detection and treatment of hyperlipidaemia, or the control of asymptomatic bacteriuria in relation to hypertension, require further elaboration before their value can be assessed. The medical schools and the staff of major teaching and district hospitals can help by providing facilities and encouraging pilot surveys. The expense of the organization and of the execution of these measures is small when compared with the potential yield in terms of human welfare, the saving of man-power, and the reduction in costs of the medical services.

The prevention of heart disease is a challenge which requires the vigour and enthusiasm of active medical administration and an enlightened approach by the medical profession. This review outlines current knowledge and attempts to define some of the ways in which the prevention of heart disease could be promoted on a much wider scale than at present.

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