MEDICAL PRACTICE

*Occasional Review***Prospects for prevention**

RICHARD DOLL

All will agree that the health of the nation may be improved in many ways, not only by the activities of our profession as we strive to prevent and treat disease, but also by the social and economic changes that result in better nutrition, smaller families, less overcrowding, and better education. I doubt, however, if anyone has a clear idea of the relative returns to be expected from investment in each of these fields, and it cannot be easy for those who are seeking to improve health on the national scale to know how to allocate available funds. Understandably, therefore, allocation tends to be made on the basis of the existing pattern, modified by a judicious response to competing pressures.

In recent years these pressures have shifted, and it is now commonly argued that the burden of disease and the cost of services could both be reduced by redistributing funds in favour of prevention¹; while some add that such action would have the additional attraction of reducing the dependence of society on the medical profession.²⁻³ This shift in public opinion is due to many factors. One is the very success of curative medicine, which has been so great that cures are taken for granted and clinical medicine is now blamed for its remaining failures. Another is the increasing scope, complexity, and, particularly, cost of the services that aim to cure, which has been so great that four Secretaries of State were led to write, in 1976, that "curative medicine may be increasingly subject to the law of diminishing returns."⁴ Opinion has been changed, too, by the experience of iatrogenic illness that has sometimes accompanied the use of effective drugs and of the environmental hazards that have sometimes resulted from industrial growth and the introduction of new and potentially noxious materials. Most

importantly, however, the spread of information is making more and more people aware that many common diseases are capable of being prevented by means that have not yet been fully implemented.

The Royal College of Physicians (London), for its part, has done much to stimulate interest in prevention, by its advocacy of seat belts and its reports on smoking, atmospheric pollution, fluoridation, dietary fibre, and the prevention of coronary thrombosis.⁵⁻¹¹ I doubt, however, if it would welcome proposals for any major redistribution of funds away from clinical medicine. For our daily work makes us aware not only of the pressures on existing services but also of the improvements that regularly flow from increased provision of services and from the introduction of new therapeutic procedures. It seemed, therefore, that it might be timely to review the current perspectives for improving health in Britain and what we can hope to achieve by means of prevention.

Potential for improvement in health

When the World Health Organisation was established, we were encouraged to think in terms of positive health and to measure it on a scale that culminated in "complete physical, mental, and social well being." Positive health remains, however, elusive to quantification, and we still have to measure the impact of our work by the extent to which we succeed in preventing, curing, and relieving disease—including in this term injuries and medical disabilities of all sorts. Even this is a daunting project, and there is no simple way in which all measures of morbidity can be combined. One index of the total burden, which was made by combining hospital inpatient days, outpatient referrals, general practitioner consultations, days of sickness benefit, and loss of life expectancy led Black and Pole¹² to conclude that mental illness and handicap and respiratory disease led the field, each contributing over 13% to the total burden. It is difficult, however, as they pointed out, to know what weight to give a consultation with a general practitioner

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Gibson Laboratories, Radcliffe Infirmary, Oxford OX2 6HE

SIR RICHARD DOLL, FRS, warden of Green College and honorary director of the Imperial Cancer Research Fund's Cancer Epidemiology and Clinical Trials Unit

in comparison with the loss of a year's life and, in the practice of prevention, we have to consider each category separately. If, in this review, I emphasise mortality, it is for two reasons. Firstly, it is unequivocal and of overriding importance to the individual and, secondly, the medical and social changes required to reduce it nearly always reduce the corresponding morbidity as well. Mortality will not, however, assess changes in such outstanding causes of disability as arthritis and mental illness, and these demand individual and separate attention.

I shall begin, therefore, by reviewing briefly the changes in total mortality that have occurred in the past 100 years and the potential for improvement that remains. The changes are illustrated in figure 1. This shows the numbers that would be expected to die at different ages if a cohort of 10 000 men experienced the sex and age specific mortality rates that were observed in England and Wales 100 years ago—that is, just before a progressive decline in mortality set in—and the corresponding numbers that would be expected if they experienced the mortality rates recorded in the latest years for which life tables have been published (1977-9). Between these dates, the proportion of deaths in infancy, childhood, and early adult life were greatly reduced, with the result that the greatest number of deaths would now be expected to occur between 75 and 79 years of age. Figure 2 shows a similar change for women, save that the modal age of death is now over 80.

This dramatic improvement has led many people to inquire whether mankind might, under ideal conditions, live for much longer periods. In fact, however (to oversimplify), we seem to have an inbuilt biological clock that ensures that only very few will survive for more than 100 years. Despite a fourfold increase in men and a ninefold increase in women, the proportions of those who can expect to become centenarians, even among the men and women who have survived to 65, are still only one in 1000 and five in 1000 respectively. That Old Parr lived to be 152 is unlikely for many reasons, including Harvey's observation that: "His power of memory had failed considerably so that he had no clear remembrance of his own actions as a young man, of the public events, famous kings and leaders, wars and civil disturbances in his early youth. . . . He remembered only his

FIG 1—Numbers of men dying at different ages if 10 000 were subject from birth to the mortality rates current in 1871-80 (○—○) and in 1977-9 (●—●).

FIG 2—Numbers of women dying at different ages if 10 000 were subject from birth to the mortality rates current in 1871-80 (○—○) and in 1977-9 (●—●).

actions of most recent years."¹³ This is, indeed, a remarkable inversion of the normal order of memory loss in the aged. Nor can credence be given to the popular idea¹⁴ that villagers in the mountains of southern Ecuador or the Caucasus have attained similar ages. In both countries exaggeration has been fuelled by local pride at the national and international interest in the reported phenomenon. In Ecuador, construction of family trees from church and civil records¹⁵ (P J Cook, unpublished observations) showed progressive exaggeration of age among the elderly and repeatedly showed that claimed centenarians were actually under 100. The oldest age to be confirmed was 105, but one of 112 could not be excluded. In the Caucasus, where church records have been destroyed, demographic data strongly suggest that the situation is similar.¹⁶

But even if there is no realistic prospect of extending the biblical span of life from three score years and ten to five score and ten, we can reasonably aim to extend it to 85 or 90, with few people dying of disease before the age of 70. This hope of prolonging the normal expectation of life is encouraged both by our increasing knowledge of the avoidability of each of the major medical causes of mortality under 70 years of age and by the fact that the rate of change in mortality measured over the past 10 years compares favourably with that in the past except in young adult life (table I) and for the *anni mirabiles* that followed the introduction of sulphonamides and antibiotics. Progress, therefore, continues to be made, and there is no reason to suppose that it will suddenly cease. It seems, however, that more than half of all life lost under 85 years of age is now due to death between 55 and 74 years and only 11% to death in infancy and childhood (table II); while more than half, at all ages combined, is due to neoplasms and ischaemic heart disease (table III). Clearly, therefore, any major advance now requires an attack on these main killing diseases in middle age.

Apart from these we must pay special attention to those causes of death and disability that, contrary to the general trend, present increasing risks. These are fortunately few, and the extent of the deterioration they have produced is in no way comparable with that produced by the epidemics of lung cancer and myocardial infarction that began before the second world war. Table IV lists those causes that seem to reflect real changes of importance in the incidence of disease and may be related to

TABLE I—Trends in mortality rates, 1841 to 1980

Period	Infant mortality	% Change in 10 years* Death rate at ages (years)			
		5-9	20-34	45-64	75-84
1841-5 to 1871-5	+1	-7	-1	+3	+1
1871-5 to 1901-5	-3	-18	-18	-4	-4
1901-5 to 1931-5	-23	-16	-14	-12	-2
1931-5 to 1951-5	-33	-50	-33	-12	-6
1951-5 to 1971-5	-16	-16	-18	-5	-9
1969-70 to 1979-80	-33	-24	-7	-9	-7

*Mean change over two or three decades.

TABLE II—Life lost under 85 years of age at different ages

Age at death (years)	% Of life lost
<1	8.3
1-14	2.9
15-34	7.3
35-54	17.4
55-74	52.1
75-84	12.1
<85	100.0

TABLE III—Life lost under 85 years of age from different causes

Cause of death	% Of life lost
Neoplasms	26.7
Ischaemic heart disease	24.7
Accidents, poisoning, etc	8.2
Cerebrovascular disease	7.9
Other vascular disease	6.4
Pneumonia	4.7
All other	21.6
All causes	100.0

TABLE IV—Causes of increased mortality 1968-78

Cause of death	Sex	Age group (years)	% Increase*	No of deaths 1978	Cause of increase
Cancer of oesophagus	M	≥20	12	2084	Alcohol
Cancer of lung	F	≥50	48	7244	Cigarettes
Cancer of pleura	M	≥20	43	216	Asbestos
Cancer of breast	F	≥20	11	11914	?
Cancer of cervix uteri	F	20-39	59	175	Multiplicity of sexual partners
Melanoma of skin	M and F	≥20	37	763	?
Alcoholism	M and F	20-64	141	148	Alcohol
Drug dependence	M and F	15-39	263	99	Addictive drugs
Cirrhosis of liver	M and F	20-64	54	1150	Alcohol
Motor cycle accidents	M and F	15-49	58†	1029	Motorcycles

*Percentage increase in rate standardised for age.
†1974-8 only.

social changes in the past 50 years. In most cases the reasons are obvious: the increasing use of alcohol, addictive drugs, and motor cycles by both sexes and of cigarettes by women; increased industrial exposure to asbestos, particularly by men; and a greater number of sexual partners. It is not clear, however, whether the increase in mortality from cancer of the breast can be wholly explained by changes in the pattern of fertility, nor whether the large increase in mortality from melanoma of the skin, which has affected white populations throughout the world, can be attributed wholly to increasing acute exposure of the untanned skin to ultraviolet light.

Problems in the practice of prevention

Progress will continue to be made by improvements in treatment and, when the present economic crisis recedes, by the

provision of more services; but the opportunities for improving health by the prevention of disease are at least as great and possibly even greater. They are, however, seldom easy to realise. Firstly, the value of any preventive measure may be extremely difficult to prove without the cooperation of many thousands of people, if not hundreds of thousands, all of whom may need to be convinced that the measure is worth while before they are prepared to test it and then, when they are, the proper conduct of the critical test may be considered unethical. Secondly, the measures that have to be taken may have far reaching social effects that enter into the balance of costs and benefits. Thirdly, the measures may be expensive, and it may be uncertain whether greater benefit might not be obtained by spending the money on clinical care. Fourthly, the perception of costs and benefits depends not only on "objective" quantification but on a whole variety of subjective assessments.

This last aspect is often neglected, but it greatly complicates the evaluation of any new programme of intervention.¹⁷ Factors that affect perception include the length of time before effects are produced and the concentration of effects in space and time. An explosion that injures 50 people, for example, is generally considered worse than a series of accidents that injure the same number individually on different occasions. Harm of a new sort or of an unfamiliar origin is considered worse than harm that is familiar. Risks that are endured by choice are of less concern than those that are suffered involuntarily, and risks produced by an enterprise that affects people other than those who benefit from it are less acceptable than similar risks that affect only the potential beneficiaries. And overriding all these considerations is the fact that an individual who suffers harm from a preventive measure is immediately identifiable, while the person whose disability is avoided or whose life is saved may be distressingly anonymous. This is true also of clinical medicine, when potentially dangerous treatments have to be prescribed; but it is much more worrying in the practice of prevention, however favourable the balance of the odds, when an individual who has not felt ill enough to consult a doctor is offered protection against a disease that he is not certain to get at the cost of a small but definite risk of developing another. It should not be surprising, therefore, that, when all these factors are taken into account, the public sometimes resists the application of a measure that would reduce the toll of disease by a large amount, while pressing for action that may be very costly and would produce little or even, in some cases, no benefit at all.

In practice, all that we, as a profession, can do is to draw up the medical balance sheet as accurately as possible, make our recommendations, and help to educate the public to understand the reasons for them. We must recognise, however, that any decision to take action will depend largely on the way the risks and benefits are perceived.

Scope for prevention

The opportunities that now seem feasible are listed under seven broad headings in table V. Most are well known, and I shall not repeat the evidence on which they are based; nor can I refer to them all. In particular, I shall omit consideration of the socioeconomic factors that contribute to morbidity and mortality in the poorer sections of the community, not because they are unimportant but because they were examined in great detail in the Black report on inequalities in health,^{18 19} and it

TABLE V—Opportunities for prevention

Socioeconomic improvements	Control of infection
Modification of personal habits:	Control of pollution
Smoking	Population screening:
Use of alcohol and addictive drugs	Antenatal
Diet	Postnatal
Physical exertion	Prophylactic medication
Protection against trauma	

would be impossible to add anything worth while to such a review in a few sentences. All 37 recommendations in that report deserve attention. Some concern the collection of information and the direction of research; some relate to subjects that I shall refer to under other heads—that is, smoking, alcohol, and screening for hypertension and fetal defects: and some entail major expenditure on the provision of services and benefits. So far as the last are concerned, the medical members of the study team thought that the amount required for “education and preventive measures specifically directed towards the socially deprived” was too great to be obtained by diverting money from the acute services without doing the latter serious harm,²⁰ and in this I unhesitatingly concur.

MODIFICATION OF LIFE STYLE

Of the other listed heads, the one that offers the greatest opportunities is the modification of personal habits, particularly smoking and (more speculatively) diet.

Smoking

The avoidance of smoking would alone reduce the mortality from all cancers by about a third (including avoidance of not only the large majority of cancers of the mouth, throat, and lung, but also a substantial proportion of the deaths attributed to cancers of the bladder, kidney, and pancreas). It would almost eliminate chronic obstructive lung disease and the complications of peripheral vascular disease, would reduce the age specific mortality from aortic aneurysm by at least three quarters and the mortality from myocardial infarction by about a quarter, and would probably lead to a small reduction in perinatal mortality in the poorer socioeconomic groups. Whether it is possible to mitigate the worst effects of smoking by using tobacco other than in cigarettes remains to be proved. Lifelong pipe and cigar smokers have mortality rates that are close to those in non-smokers: but many people seem unable to switch from cigarettes to pipes or cigars without carrying over the habit of inhaling that is learnt from smoking cigarettes, and it is not known whether such a switch, under these conditions, has any appreciable effect on the risk of disease. It seems, however, that modern cigarettes that deliver less tar and nicotine than their predecessors are also less likely to produce some diseases. Otherwise it would be impossible to account for the trend in mortality from cancer of the lung, which has been declining in young men for 20 years and in young women for five,²¹ despite the relatively small change in the national consumption of cigarettes and an actual increase in the number smoked by women. In this respect it is important to note that the differences in the risk of lung cancer produced by different types of cigarette will be seriously underestimated unless we compare people with lifelong exposure to each type—just as we had to wait until sufficient time had elapsed after the introduction of cigarette smoking for elderly people to have been smoking since youth before the maximum effects of smoking were observed. When these proper comparisons are made, the reductions already observed of about 50% are extremely encouraging (table VI).

Unfortunately, there has been no corresponding reduction in the mortality from myocardial infarction, and the question arises whether the chemical that increases the risk of infarction could be carbon monoxide or some other constituent of smoke that has been less altered. It has long been assumed, without any good evidence whatever, that the responsible agent was nicotine, and one priority for research should be to find out which component of smoke is, in fact, the responsible agent.

The recommendations for prevention in the college's last report on smoking,¹⁰ which have been popularised so effectively by Action on Smoking and Health (ASH), emphasise the need for more intensive education, the phasing out of tobacco

promotion, the restriction of smoking in public places, and increased taxation, particularly on high tar cigarettes. Nothing has happened since their publication to invalidate these recommendations: but the case for restricting smoking in public places has been strengthened by the accumulation of evidence that inhaling other people's smoke may increase the risk of respiratory infection in children and cause a few cases of lung cancer in adults.²²⁻²⁴

TABLE VI—Male mortality from lung cancer in England and Wales: recent trends in early middle age

Age (years)	Annual death rate per 1 000 000 men	
	Born circa 1910* Observed 1940-60	Born 1930-50† Observed 1980
30-34	40	13
35-39	98	45
40-44	253	134
45-49	597	378

*High tar intake throughout smoking history.

†High tar intake only in first decade or so of smoking history only in men aged 45-49.

Note: For comparability, all rates are for “all respiratory cancer, excluding larynx”; data for 1940-60 are estimated from Doll and Peto,¹⁶ appendix E.

Diet

How far disease may be avoided by relatively simple modifications of the twentieth century diet is still a matter for debate. Fortunately there is less controversy about the sort of modification that is likely to be desirable. Whether the object is to avoid cancer, coronary heart disease, hypertension, diabetes, diverticulitis, duodenal ulcer, or constipation, there is broad agreement among research workers that the type of diet that is least likely to cause disease is one that provides a high proportion of calories in whole grain cereals, vegetables, and fruit; provides most of its animal protein in fish and poultry; limits the intake of fats, and, if oils are to be used gives preference to liquid vegetable oils; includes very few dairy products, eggs, and little refined sugar; and is sufficiently restricted in amount not to cause obesity.

The extent of the effect of such a diet on the risk of cancer is not reliably known. In so far as it avoided obesity it should reduce the risk of cancers of, at least, the endometrium and gall bladder; but these are not common diseases. The high proportion of cereal fibre and the low proportion of fat might reduce the risk of cancer of the large bowel and perhaps also of the breast, and the high content of vegetables and fruit might provide antipromoting agents or inhibit carcinogenesis in other ways. Further research is, however, needed to establish the reality of most of these presumed effects.

Avoidance of obesity should also reduce the risk of hypertension and diabetes, and I see no reason to doubt the conclusion of many specialist committees, including (early in 1982) an expert committee of the World Health Organisation²⁵ that a reduction in the mean concentration of serum cholesterol for the entire adult population to less than 200 mg/dl (5.17 mmol) would lead to a substantial reduction in morbidity and mortality from myocardial infarction. Nor do I doubt that it should be possible to achieve this by reducing the amount of saturated fats and cholesterol in the diet, particularly if the amount of cereal fibre is increased at the same time.²⁶⁻²⁷ It is difficult to know how much weight to give to the declining trend in mortality from coronary heart disease in the United States compared with Britain, as the data for Rochester, Minnesota, which are probably the most reliable, show that some of the decline in the rates there could have been due to reduced fatality, produced presumably by more aggressive treatment.²⁸ I am, however, impressed by the results of controlled trials of various methods of reducing blood cholesterol concentration. Taken separately, each of these studies (including even the recent multiple risk

factor intervention trial²⁹) have observed too few infarcts to be statistically reliable; but an overview of the available evidence from all of the randomised trials of cholesterol lowering treatments clearly indicates a reduction in morbidity from myocardial infarction that corresponds with the reduction predicted from follow up studies of men and women with known concentrations of blood cholesterol, irrespective of whether the reduction in cholesterol was achieved by diet or drugs.^{30 31}

It is not for doctors to advise people to live their lives as invalids in order to die healthy, and if the modifications proposed seriously detract from the pleasures of life the penalty of disease, appreciable though it is, may be considered light. Fortunately, however, the type of diet that is recommended could enhance the pleasure of eating, rather than the reverse.

Alcohol

The harmful effects of alcohol are much more extensive than the production of disease in the drinker himself, as they include injuries inflicted under its influence intentionally or otherwise on others; but even ignoring these secondary effects of intoxication, the current trends in mortality directly due to alcohol induced disease must cause serious concern. These trends have accompanied an increase in average consumption of nearly 100% a head since 1950, which threatens to herald a new epidemic of alcoholism such as those that afflicted Britain at an interval of 120 years—1750 and 1870. The medical problem of prevention is complicated by the fact that there is now strong, if not quite conclusive, evidence that a daily quota of one or two pints of beer or a few glasses of wine reduces the risk of death from cardiovascular disease, perhaps by raising the serum concentrations of high density lipoproteins.^{32 33} Policy based on purely health considerations should, therefore, aim to reduce heavy drinking and encourage light. Unfortunately this is difficult to achieve. The only certain way to reduce heavy drinking is to reduce the average amount drunk by the whole population.^{34 35} This may be brought about most simply by increasing cost relative to available income³⁵⁻³⁷ but we should not despair of other methods and should give the maximum support to the idea of setting up a body comparable to Action on Smoking and Health to press for "action against alcohol," as has already been proposed by the conference of college presidents.

Physical activity

Another characteristic of modern life that distinguishes it from the past, even more starkly than the modern diet, is the low level of physical activity. This, it seems, contributes to obesity and high levels of blood pressure, blood lipids, and insulin activity, and consequently to atherosclerosis, since they may all be reduced by a programme of vigorous walking.³⁸ Physical activity, too, increases serum high density lipoproteins, so that it is not difficult to account for the many epidemiological observations relating a sedentary life to an increased risk of myocardial infarction. Whether ritual jogging is an appropriate antidote is, perhaps, less clear. I prefer to support Bannister's plea³⁹ for a national policy that associates good health with positive enjoyment, by providing an increased network of sporting facilities of all sorts and for all sections of the community, and Muir Gray's plea (personal communication) for more showers at the place of work.

OTHER METHODS

Of the other opportunities for prevention, few seem capable of making any major impact on the burden of disease in Britain within the next few years. Much of our past improvement was,

however, due to the cumulative effect of many small advances and the same is likely to be true in the future.

PROTECTION AGAINST TRAUMA

No type of prevention illustrates protection against trauma better than the steady accretion of regulations to prevent trauma. By this means, the toll of deaths on the roads has been held to around 6000 a year for the past 50 years, the rate per million population being actually lower now than it was in the 1930s, despite the enormous increase in traffic. Further regulations are now required to diminish the prevalence of alcoholic driving, to allow, in particular, for random tests in dangerous conditions, and to diminish the risk of motorcycling, which is 18 times greater per mile ridden than that of driving a car or 250 times the risk of travelling by train.⁴⁰ The number of motorcycles on the road has grown in parallel with the increased cost of petrol and public transport, and the trend will be difficult to reverse. Prohibition would be socially unacceptable; but it might help to provide better opportunities for training, to require motorcyclists to keep their headlights on at all times and wear better protective and reflective clothing, and to strengthen the current system for testing ability to ride.

Other regulations to prevent trauma, which cover an immensely wide range of activities from the operation of industrial machines to the construction of buildings to prevent loss of life from fire, provide a striking illustration of the failure of society to pay any serious attention to the relative costs and benefits of its actions. Alterations to high rise buildings after the collapse of Ronan Point are estimated to have cost between £2m and £20m per life saved* while new fire regulations increased the cost of the Liverpool teaching hospital by £11m⁴² and sought to impose an expenditure of £4m (1975 figures) on the University of Oxford for alterations to departments that had never seen the loss of a single life. Even a cardiac transplant programme would provide a better return for the money.

CONTROL OF INFECTION

Of the more specifically medical methods of intervention, those that have had the most success in the past have aimed at the control of infection, either by preventing the spread of the agent or by immunising against it. I should like to think that a more determined attack could eliminate tuberculosis; but this is unrealistic under conditions in which intercontinental travel is easy and many foci of heavy infection exist abroad. BCG vaccination at birth of children born to high risk groups together with routine radiological examination applied selectively to new immigrants and to residents returning after a long sojourn in areas of high incidence should help; but it is difficult to suggest anything else that could be added to the intensive treatment of infectious patients and the current programme of searching for and investigating the contacts of new cases.

Greater opportunities are, I suspect, likely to present themselves from the use of special vaccines for high risk groups, such as vaccines against influenza and pneumonia in old age, and from the development of new vaccines against viral and parasitic diseases. Active immunisation against hepatitis B virus is already a possibility for high risk subjects and may soon be available for use on a world wide scale. Its main use in Britain would be to prevent hepatitis, but in the tropics it should also help to prevent many of the common hepatomas. No one, I think, now believes that a single vaccine could prevent all types of cancer, but several viruses do seem to contribute to the process by which some specific types of cancer are produced. Some of these might be prevented by immunisation, including several cancers

*The original estimate was £20m⁴¹ but uncertainty about the method of calculating the cost of complying with the new building regulations leaves open the possibility of a much lower figure (A V Cohen, personal communication).

that depend on infection with the Epstein-Barr virus and, perhaps most importantly in Britain, cancer of the cervix uteri, a disease that is clearly venereal in origin⁴³ even though the identity of the infective agent is still open to doubt.

More immediately important, on a world scale, is the development of a vaccine against malaria. This it seems is now a real possibility, since the slow development of immunity under natural conditions is now thought to be the result of adaptation of the parasite rather than a human weakness, and it seems feasible to produce, by synthesis or recombinant DNA techniques, large enough amounts of antigen from sporozoites or merozoites for vaccines to be evaluated.⁴⁴ Prevention of the spread of malaria is not, however, altogether irrelevant in Britain as the number of cases recorded in England and Wales increased progressively with the increase in air travel from 101 in 1970 to over 2000 in 1979.⁴⁵

CONTROL OF POLLUTION

Contrary to public opinion, there is, I believe, little that can now be done to prevent disease by applying more rigid rules for controlling pollution other than those that already operate. The virtual elimination of coal smoke from town air since the disastrous "smog" of 1952 has been followed by a dramatic fall in the mortality from chronic obstructive lung disease,²¹ and there is no evidence that current levels of pollution have any measurable effect on the incidence and progress of the disease. Whether the concentration of sulphur dioxide, which has been reduced much less than the concentration of smoke, does any damage to vegetation and to river life when deposited as acid rain is another matter; but there is no good medical evidence to justify the enormous expense that would be required to reduce materially the current emission of sulphur by industry.

Pollution can have more subtle effects. The polycyclic hydrocarbons that are inevitably produced by the combustion of fossil fuel, whether for heating or transport, must be presumed to cause some cases of lung cancer, no matter how low their concentration; and so must radioactivity (which, it is not always realised, is released into the environment in roughly equal amounts for a given output of power by the combustion of coal and the use of nuclear energy). Estimates of the effects of various such pollutants require numerous assumptions that may have to be modified in the course of time; but on present evidence it seems unlikely that the total effect of all types of pollution, other than in the workplace, can cause more than 1% of all fatal cancers,⁴⁶ and I know of no practicable means by which this proportion could be much reduced without major penalties in cost or social disruption.

Effects on mental development, such as lead pollution has been suspected of causing, are even more difficult to assess. That large amounts of lead can do serious damage is obvious; but whether prolonged exposure to smaller amounts that do not produce toxic symptoms can lead to personality changes and diminish intellectual development is not. I am not convinced that the amount in air has been enough to damage children's brains, though the amount dissolved in soft water passing through lead pipes may have been. I can understand, however, the public concern and the political need to respond to it without waiting for more convincing scientific evidence.

The controversy about the effects of lead and the way it has been conducted are not unique. Many similar issues inevitably arise in an industrial society in which the standard of health is so high that marginal effects become of medical importance. They are, moreover, meat and drink to the press, radio, and television, which have to compete for public interest in a free society, and we must expect such campaigns to increase in number and intensity. We have not as yet evolved efficient methods for taking decisions in these circumstances, and new ways need to be found for providing government with authoritative scientific opinion that can be seen to be independent of the interests affected, as well as to discourage the presentation

of television programmes such as those we have recently seen on organ transplants and the hazards of asbestos and cotton, which were comparable in their inaccuracy and irresponsibility with some of the statements of the American tobacco industry. In these public controversies the claims and counterclaims that are made recall the reporting of aeroplane losses during the war. These were distorted so regularly by each side that an accurate estimate of the true losses could be obtained by simple calculation of the geometric mean.

The development of scientific certainty of harm is a gradual process and there are no rules for deciding when, in the development of such evidence, action becomes advisable. Judgments will properly differ and the possible advantages of imposing "prudent" restrictions without waiting years for strict proof are obvious. But, in view of the large number of possible hazards that could be restricted, the advantages of waiting for good evidence may be not merely economic, for vigorous actions against dozens of unproved and certainly small hazards may divert social and political attention from truly effective action against the few things that are reliably known to be of substantial importance.

POPULATION SCREENING

Of the measures referred to so far, few require the intervention of doctors, apart from their role in education and in the research on which the discovery of the means of prevention depends. One that does is screening for signs of incipient disease that can be treated to stop further development: sometimes called secondary prevention.

Antenatal screening

Such screening has long been routine in obstetrics, and success in persuading a higher proportion of women to attend for examination early in pregnancy is probably one of the main factors responsible for the recent fall in perinatal mortality. With a rate that was down to 11.8 per 1000 births* in 1981 (and under nine per 1000 in some areas), further improvements can be only slight, and large controlled trials will be needed before new and expensive methods of monitoring may be justified. Routine monitoring of the fetal heart rate has not survived the test of controlled trials, in either pregnancy or labour.⁴⁸⁻⁴⁹ Nor is there any evidence to suggest that the measurement of urinary oestriol in high risk patients⁵⁰ can help to avoid the risk of fetal death (though it can certainly predict it) despite its frequent citation as an example of a cheap method of prevention.⁴¹ Techniques that are more promising include the measurement of serum uric acid when the blood pressure rises,⁵¹ the formal recording of fetal movements by the mother, with investigation if they are reported to be reduced,⁵² and screening for bacteriuria and urinary infection with mycoplasma and chlamydia, two organisms that particularly infect women in the poorer economic groups⁵³ and all of which lead to an increased risk of premature birth.

In societies where termination is acceptable, screening to detect abnormalities in the fetus promises to prevent many years of personal misery and to secure social savings by avoiding the birth of children who are seriously deformed or doomed to die early in life from slow deterioration. Amniocentesis to detect Down's syndrome or open spina bifida is now common; but a whole range of new opportunities is opened up by the ability to examine amniotic cells for enzyme defects, to sample fetal blood, and even to analyse globin genes (to detect thalassaemia) in small amounts of amniotic DNA. Amniocentesis, fetoscopy, or placental aspiration cannot be performed in all pregnancies; but high risk groups, in which they are justified, may be defined

*This reduction is due, to some extent, to the postponement of death to later ages, but not entirely, as the infant mortality rate is also decreasing.⁴⁷

in various ways, sometimes simply by history, family history, or maternal age, sometimes by estimating the amount of α -feto-protein in maternal serum, and sometimes, when the condition is common enough, by screening the entire population to detect heterozygotic parents. The approach is relatively new, and we are only now beginning to sense its full potential.⁵⁴

Postnatal screening

Screening after birth, in contrast, is a much more dubious proposition. Its value has been reviewed in great detail for the provincial departments of health of Canada by a committee which concluded that there was at least fair evidence to justify screening for, and intervening to prevent, some 31 conditions or groups of conditions in the general population and a further 20 in defined high risk groups.⁵⁵ On this basis, it advised "that the annual checkup, as practised almost ritualistically in North America, be abandoned" and substituted by a series of selective examinations at different ages. Most of these concerned infants and young children or high risk groups, such as men occupationally exposed to polycyclic hydrocarbons and people with a family history of diabetes or frank vascular impairment, who already are—or should be—examined routinely. The few remaining conditions that, it is suggested, should be sought for periodically in the adult population are: hypertension (blood pressure not less than quinquennially from age 16); breast cancer (annual mammography ages 50 to 59); cervical cancer (cervical smear from sexually active women every three to five years); large bowel cancer (occult blood in faeces annually from age 45); and progressive incapacity with aging (general assessment biennially from age 65, annually from 75). It is, however, not yet clear that the benefit to be obtained by carrying out these procedures at such frequent intervals, nor from any amount of mammographic screening for cancer of the breast, nor from testing the faeces for occult blood to pick up early cases of cancer of the large bowel, would justify the economic and psychological costs. I do not, however, doubt the value of periodic cervical screening in sexually active women, and no one, save perhaps Illich⁵⁶ doubts the desirability of making occasional contact with elderly people who have not sought it of their own volition nor of recording the blood pressure every five to 10 years after the age of 40. Whether levels of diastolic pressure less than 105 mm Hg require intervention should be decided by the results of the Medical Research Council's current trial,⁵⁷ but there can be no doubt of the value of discovering and treating people with higher levels, irrespective of the presence of symptoms.

PROPHYLACTIC MEDICATION

The last of the main heads that provide scope for prevention is the use of prophylactic medication, which has been practised so successfully to prevent diseases due to a deficiency of iodine or vitamins. Why it has not yet been extended to prevent dental caries, by the simple expedient of adding fluoride to water supplies, is a mystery that should provide a good topic for historical inquiry in the future. Meanwhile, people continue to suffer unnecessary pain and inconvenience from dental decay, repair, and replacement. Why, too, the medical profession has been so slow to adopt anticoagulant medications that have been shown unequivocally to prevent postoperative venous thrombosis and antiplatelet agents that prevent the recurrence of myocardial infarction is difficult to understand.

Prophylactic medication may, however, have many other useful applications, including, perhaps, if reliable evidence can be obtained, dietary supplements to prevent neural tube defects in the fetus or to act as anticarcinogenic agents in the adult, oestrogens to prevent osteoporosis and fractures in postmenopausal women, and aspirin to reduce the risk of myocardial infarction and stroke, either for everyone over (say) 50 or selectively after transient ischaemic attacks. All these are now

being or are about to be tested in controlled trials, not only to determine efficacy but also to determine the risk of side effects (which may be real enough in the case of aspirin to inhibit its use in 5-10% of people).

I should have liked to be able to report the results obtained from study of the prophylactic value of aspirin, in which over 5000 British doctors have helped by volunteering to be randomly allocated to take 500 mg a day or to abstain so far as possible from taking any aspirin at all. Fortunately, however, the death rates among them have been so low, partly because only 13% has been smoking cigarettes, that the study has had to be extended beyond the period initially intended. Now, however, 25 000 American doctors have come to our aid and agreed to be randomised to take or not to take a slightly lower dose under double blind conditions (C Hennekens, personal communication), and a clear result should become available within a few years.

MENTAL ILLNESS

I have not said anything about the prevention of mental illness, except for those gross or potential defects detectable in the developing fetus. This is not because other types are unimportant, nor because they are necessarily impossible to prevent. A programme for intervention is, however, unlikely to be effective unless the illnesses can be defined and attributed to single factors or groups of factors that act synergistically and are amenable to intervention. None of the main categories of mental illness, except for the organic psychoses due to infection, drugs, etc, as yet satisfies these criteria (although they may be satisfied by such rare conditions as psychosocial dwarfism⁵⁸) and it will, I suspect, be many years before we can design a programme for the prevention of mental illness, at either the individual or the social level, that will be more cost effective than a programme that provides for the treatment and support of affected individuals.

Conclusions

In presenting this review I have confined myself to matters that are the specific responsibility of the medical profession to investigate, if not to act on. I cannot conclude it, however, without referring to three matters that must concern doctors in common with all other educated members of the public, but which, if neglected, could more than counteract all the preventive measures to which I have referred. These are malnutrition due to maldistribution of food supplies and the pressure of an increasing world population, social disruption that is probable if the current heedless waste of world resources continues, and the threat of nuclear war. No one who is concerned with prevention can be indifferent to these new social hazards.⁵⁹

If, however, we leave them aside the practical steps that can be taken to prevent disease mostly require changes in personal behaviour and the factors that influence it. The type of action that is most likely to be effective can be taken only by central government or one of its agents. Government cannot, however, be expected to act, nor should it in a democratic society, until the ground has been prepared and the public is likely to approve its actions. When it is, government can influence behaviour both by regulation and by modifying the balance of incentives. No disincentive is as powerful as cost, and no single measure would contribute more to the prevention of disease than increased taxation to reverse the trends of the past 30 years that have made tobacco and alcohol progressively cheaper in terms of the labour required to buy them. More difficult to achieve, but in the long run perhaps even more important, is the use of tax and subsidy to encourage the consumption of a healthy diet.

But if government cannot be expected to lead in matters that affect the conduct of our daily lives it can in regard to the administration of the Health Service, and the Department of

Health and Social Security has more to do than to issue booklets that "suggest how the prevention of disease and the promotion of health can be advanced."⁴ Without specific requirement, the district authorities, which have the unenviable task of robbing Peter to pay Paul, will inevitably give a higher priority to the clinical needs of today than to the prospects for prevention in the future. They should therefore be asked to submit detailed programmes for preventive services, with specified minimum budgets. Such programmes should be wide enough to include health education and the encouragement of sport, as well as family planning and the obvious medical measures of immunisation and screening. Many of these services are best provided by general practitioners and health visitors, but district health authorities may have to provide skilled help, along the lines suggested by Muir Gray (personal communication) if these services are to reach everyone who needs them.

Physicians, for their part, together with scientists in other fields, have a prime responsibility to intensify research into the causes of disease and to show beyond reasonable doubt that the proposed methods of prevention do in fact work. Secondly, we have to advise both the general public and the authorities what needs to be done. Many of the problems with which we are faced cross specialties and ought to be considered by a body that unites them all. Proposals for an academy of medicine were turned down 30 years ago, but it might be worth considering them again or, perhaps, something more akin to the American Institute of Medicine.

Thirdly, we need to exemplify what we teach: for it is in this way that we show most compellingly our assessment of the balance of costs and benefits, of current pleasures and future penalties, and of the value of screening, immunisation, and prophylactic medication.

In reaching these conclusions I have been conscious of the danger of classing myself with that distinguished lecturer, to whom Sir William Osler referred in his Harveian Oration of 1906,⁶⁰ who, dwelling on the remarkable achievements of surgery 23 years before, concluded that the art had all but reached its limit "little reckoning that within a mile from where he spoke the truth . . . (already) in the hands of Joseph Lister would revolutionise it." Not that I have suggested that preventive medicine has reached its zenith, but I may well have ignored discoveries, comparable with Lister's, that will transform its face before the end of the century; for our two main enemies, cancer and ischaemic heart disease, are both essentially avoidable. If I have so much the better, for progress will be even quicker than I have anticipated.

I am grateful to many colleagues for advice about the prospects for prevention in their specialties, but particularly to Dr Joan Faulkner and Mr Richard Peto to whom I owe many ideas and who read and criticised constructively early drafts of the text. I am grateful also to Miss Kate Hughes for statistical calculations and to Miss Cynthia Bates, Miss Christine Lewis, and Mrs Gale Mead for secretarial help.

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A 17 year old girl with quadriplegia has a permanent catheter. She has the usual chronic urinary tract infection, which seems resistant to most antibiotics, but she also forms an inordinate amount of calculus in the form of encrustations on her catheter, which is a silastic one. This means far more frequent changes of catheter than might otherwise be necessary. She also gets renal colic, presumably due to passage of small stones. What methods could be used to discourage the formation of these?

This problem is the most difficult of all in the treatment of urinary tract infection. The first question is, does this patient really need a permanent catheter? Has every effort been made to restore rhythmicity to her bladder? Stroking the lower abdomen or inner thigh, or both, four hourly will often restore spontaneous bladder emptying and allow the catheter to be removed and so solve the infection problem. On the assumption that this was tried and failed, it is vital that the patient drinks at least three litres a day, preferably more. This will make stone formation less likely and aids the hydrokinetic defence against infection. If the organism is resistant to most antibiotics organic acids—for example, methenamine mandelate or hippuric acid—might be tried, for resistance to these agents is unknown. For these drugs to work urinary pH must be less than 5.8 so that the organic acids are undissociated and able to penetrate the bacterial cell wall. This may be achieved by high protein intake and ingestion of dl-methionine or vitamin C in large quantities. If there is already an acidification defect it may not be possible to achieve low urinary pH value and it may even be dangerous to attempt treatment with acidifying agents, since a serious metabolic acidosis might result. In patients with infective stones due to urease-producing pathogens, urease inhibitors such as acetohydroxamic acid¹ reduce stone formation. Unfortunately, these drugs are carcinogenic and have therefore not been marketed. It is to be hoped that less toxic urease inhibitors will become available in due course.

One matter that puzzles me about this case is that I was not aware that quadriplegic patients can actually feel renal colic. Nevertheless, since there is a suggestion that renal stones may be present in the upper tract I would advise that the patient has an excretion urogram performed to exclude the possibility of calculous obstruction to the urinary tract.² If this were found the stone that is causing obstruction must be removed. Finally, if all else fails a urinary diversion procedure might be indicated so as to establish good drainage and avoid the serious effects of continuing infection and stone formation, as these if left unattended are likely to lead to kidney failure from chronic obstructive pyelonephritis, which may also be associated with the development of local amyloid deposits.³—A W ASSCHER, professor of renal medicine, Cardiff.

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Do electrical devices for "toning-up" muscles have any effect on the platysma and small muscles of the face?

It is certainly possible to cause contraction of the facial muscles by stimulating them directly (galvanism) or through the facial nerve (faradism), and, so far as I know, all techniques available to the general public use the latter type of current. I know of no evidence that these techniques have any measurable cosmetic effect or influence the outcome of facial nerve or upper motor neurone lesions.

In any case, sustained and persistent voluntary exercise would be expected to have a similar effect. In severe facial palsy attempts can be made to minimise muscle stretching by splintage or strapping, and there may be some advantages in teaching the sufferers from severe facial palsy an active exercise regimen, even assisted by electrical stimulation. More important is the use of electrodiagnostic methods in forming an early idea of prognosis so that a decision may be made about definitive treatment.—J A MATHEWS, consultant physician (rheumatology), London.

Is there any association between a high tonal hearing loss and hypothyroidism in an apparently healthy 61 year old woman without other evidence of hypothyroidism apart from loss of axillary hair? She reached the menopause at the early age of 38. Her sister, five years older, also had an early menopause and also has a high tonal deafness.

Deafness is described in hypothyroidism and may be due to conductive or sensorineural defects or a combination of both. Sensorineural deafness is usually high tonal. If, however, the patient is apparently healthy the hypothyroidism is unlikely to be contributing to her hearing loss. Loss of axillary hair is not uncommon in 61-year-old women, and an early menopause is much more likely to be familial (as it is in this case) than related to hypothyroidism. Minor degrees of thyroid failure are unlikely to be associated with deafness, and in any case may be excluded by measuring serum thyrotrophin concentrations.—R HALL, professor of medicine, Cardiff.

A patient was bitten on the left forehead, possibly by some marine organism, when holidaying in Portugal. After about 48 hours he began to feel considerable discomfort over the area, and this later spread to the whole of the left frontal, parietal, and temporal regions of the head. The discomfort continued to develop for the next few days and lasted five weeks. There was considerable hyperaesthesia over the whole area and it felt as if the hair had been pulled out by the roots. The bite appeared to consist of multiple "puncture" wounds but otherwise there was nothing abnormal. What might have caused this episode?

The most probable organism responsible for the symptoms belongs to the *Physalia* genus or jelly fish. Other free swimming marine organisms that could produce such prolonged symptoms are almost entirely confined to the tropics. The Portuguese Man of War *Physalia physalis* consists of a body cavity surrounded by tentacles containing nematocysts. These cysts release a coiled thread containing a neurotoxin that produces a burning sensation on contact. There may also be constitutional symptoms with nausea and abdominal pain. The reaction appears to be toxic rather than a hypersensitivity. It is, however, unusual for the symptoms to last for several weeks. Other organisms that may produce quite a severe reaction include marine animals such as *Alcyonidium gelatinosum*, which causes "Dogger Bank itch." Free living coral organisms in temperate waters, known as the "sea chervil," can cause painful reactions, which are usually short-lived. It is assumed that there was no question of contact with the sea floor but the description of multiple puncture wounds is suggestive of contact with a sea urchin or echinoidea. This usually occurs on the feet and produces severe burning pain and bleeding with reactions lasting for many weeks or months.—P K BUXTON, consultant dermatologist, Edinburgh.

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