Green College Lectures

Environmental factors and disease: the man made environment

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Our human species has proved exceptionally able to survive and breed in a wide range of natural environments. In part this is because we are able to maintain an acceptable microenvironment in the face of climatic and other extremes; but also our genetic design tolerates very varied lifestyles and diet. Recently, however, the changes (particularly those affecting diet and chemicals in the environment) have been not only more rapid but also different in kind.

The net effect on health of recent environmental changes has been strongly beneficial: people are living longer and physically healthier lives than ever before; and cancer trends overall are not alarming, despite environmental pollution. This is "qualified reassurance"; but the net benefit conceals some serious adverse items (possibly more than we can identify).

The recognition that our health depends on how and where we live dates back to Hippocrates and beyond, but it flowered in the public health movement of the last century. In 1854 John Snow showed that drinking raw Thames water caused cholera. Within three years there was legislation to require its filtration, and the problem was solved. (So speedy a response would not be possible nowadays.) This was followed by legislation over a wide range of hygiene, sanitation, housing, and occupational hazards, which effectively controlled the worst environmental excesses.

As a result of nineteenth century concern with public health, environmental control in this century came to be regarded as largely a routine maintenance operation, and in developed countries medical interest moved to quite different topics.

Microenvironment: determinants of individual cases

In both teaching and research epidemiology in this half century has shifted away from the old public health approach towards a concern with individuals and their microenvironment, habits, and susceptibilities. The case-control study has become the commonest type of epidemiological inquiry, its whole basis being to discover how sick and healthy individuals differ. Equally many cohort studies search for "risk factors" as a way towards preventing disease in high risk individuals.

This individual centred approach, which has come to dominate both aetiological research and medical thinking on prevention, is naturally attractive to clinicians because they deal with individual patients. It is also the focus of interest of molecular biologists and other laboratory workers who are concerned with deranged mechanisms in sick individuals (that is, with pathogenesis). Over a broad front thinking in medicine has shifted away from public health towards concern with individual susceptibility and the mechanisms of disease.

In environmental studies this has concentrated attention on the

individual's local situation (the microenvironment). Occupational diseases are sought among the heavily exposed; personal sexual practices are seen to determine the pattern of occurrence of cervical cancer and AIDS; coronary risk factors identify those most likely to have heart attacks; and so on, with a corresponding concentration of preventive efforts among the worst exposed and the most susceptible.

Macroenvironment: determinant of population exposure and incidence rates

There are two kinds of aetiological question: the first seeks the causes of cases and the second seeks the causes of incidence. "Why do some individuals have hypertension?" is a quite different question from "Why do some populations have much hypertension, while in others it is rare?" We were perhaps misled by the example of smoking and lung cancer, which has been taken as a general model for the epidemiological study of causes. It was in fact an exceptional situation, in which there was large heterogeneity of exposure both within and between populations. If everyone in the country had smoked 20 cigarettes a day then clinical, case-control, and cohort studies alike would have led us to conclude that lung cancer was a genetic disease; and in one sense that would have been true, since if everyone is exposed to the necessary external agent then the distribution of cases becomes wholly determined by individual susceptibility.

We reach then this paradox, that the more widespread is a particular environmental hazard, the less it explains the distribution of cases. The cause that is universally present has no influence at all on the distribution of disease, and it may be quite unfindable by the traditional methods of clinical impression and case-control and cohort studies; for these all depend on heterogeneity of exposure.

In some respects environment and lifestyle within Britain are becoming less diversified. Most of the population is urbanised or semiurbanised, most buy food from supermarkets which purvey similar mass produced factory made foods, and increased mobility conceals the impact of local environmental variations. All these trends impede epidemiology, which requires a diversity of exposure. This may explain why for so many diseases we know about individual risk factors but we remain ignorant of the prime mover—the external agent to which certain individuals are susceptible. Yet there is hardly a common disease which is not uncommon somewhere else; and in the rapidly changing world of the twentieth century most incidence rates are in a state of flux. These wide differences, coupled with the findings from the study of migrants, imply that the incidence rates of most diseases are strongly influenced by environmental and lifestyle factors. If these factors could be identified then perhaps they might be controlled.

Might there be an ideal environment and lifestyle, which would combine all the healthy features and minimise all disease rates? Or are some health promoting factors mutually exclusive? That might be so, but when we observe a more than threefold mortality differential between men at the top and the bottom of the civil service¹ then clearly many people in Britain are still a long way from

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realising achievable health. That this is a general feature of the British scene is confirmed by the Office of Population Censuses and Surveys Longitudinal Study, which finds that all causes mortality is 70% higher among those living in local authority housing in inner cities than among owner occupiers in new towns,² and by many other indicators of inequality in health.³

These large socioeconomic differences apply to most of the leading causes of death and morbidity. This has been thought to imply a clustering in certain groups and environments of multiple adverse factors (bad housing and nutrition, smoking, and so on), each being a specific agent for specific diseases. But perhaps this was too narrow a focus; maybe some specific factor—such as a nutrient deficiency or intoxication antenatally or in childhood—might have a lasting and non-specific effect on health, influencing susceptibility to a variety of conditions. It is highly important for preventive medicine to know whether that is so.

Risk: the individual and the population

Individuals exposed to an exceptional risk obviously need special surveillance and help, whether they are men with hypercholesterolaemia or workers exposed to toxic substances. The amount of public concern and media attention, however, bears little relation to the size of the problem. In the Sellafield inquiry we identified, close to the nuclear reprocessing plant, just seven cases of childhood leukaemia arising over 22 years⁴; but the public alarm was great. The leukaemia problem itself was tiny, and the overall mortality rate for children in the area was satisfactory; but the concern was with cancer and radiation, each of which scares people and makes them feel insecure and vulnerable. Protest may be a displacement activity, diverting attention from an unacknowledged and closer fear. The strength and number of these environmental protests betoken a widespread fear of our modern environment, and particularly of those of its perceived threats which are invisible, such as radiation and chemical pollution.

To emphasise the problem of a minority is reassuring for the majority. In the chemical industry this approach focuses attention on a small group of workers exposed to higher doses; this makes the rest feel more secure. In regard to alcohol and road traffic accidents it punishes a small minority of drivers with high blood alcohol concentrations and thereby exonerates the many who drink and drive but with concentrations inside the legal limit. In mental illness it diverts attention from the baffling problems of widespread minor neurosis and depression by confining psychiatric attention to "cases." And in coping with the disturbing violence in our society many find relief in agreeing with our politicians and police chiefs that the problem is just that small minority of hoodlums. Distributions commonly deny ownership of their tails! It would be more comfortable if only the world really were divided into those with problems and the rest of us, but the evidence gives little support to this view. Among radiation workers there is a continuous distribution of exposures, and the decision where to place an upper safety level is quite arbitrary. The distribution of alcohol intakes in the population is certainly continuous, and one supposes that the same would be true of the blood alcohol distribution of drivers. Depression is not "a disease" but—like hypertension—just the tail end of a continuum. And so on.

How far is it effective to focus concern so largely on small high risk groups? The limitations in regard to diet, serum cholesterol concentration, and coronary heart disease have been clearly shown: the underlying problem is the *average* diet of the nation, not the habits of an imprudent minority.^{5,6} This led to the general proposition that *a large number exposed to a small risk may generate more trouble than a few at a high risk*, implying that control measures aimed at the high risk minority may fail to touch the greater part of the population's problem. If the roots are in mass characteristics—the determinants of population means and incidence rates—then the solution must entail mass measures.

In our studies of radiation workers we examined the proportions of the total population dose which arose among groups with different levels of individual dose (figure).⁷ Men who had acquired a

cumulative dose of 50 rems or more—the main concern of occupational health services—accounted for under 10% of the total population dose; half of that total dose arose in individuals who had each received only 10-49 rems; and the rest (about 40%) came from individuals who individually had received a total of less than 10 rems over their working years. If dose and risk are linearly related (and there is no conclusive evidence that they are not) then these proportions represent the expected distribution of excess cancers. This implies that the total exposure burden is the critical factor, but this does not seem to be the emphasis of control policy. Strict control is maintained over the maximum annual dose to individual

Distribution of approximate cumulative radiation dose received by Atomic Energy Authority workers, with percentage of total arising within each exposure band.⁷

for both workers and public, but the total harm may depend more on the number of people exposed and on the lifetime rather than the annual exposure. In addition to setting a maximum permissible risk for individuals we also need a maximum permissible burden for the whole workforce and the whole population. This argument applies also to chemical exposures.

It would have been useful to make similar calculations on the relation between blood alcohol concentrations and road traffic accidents, or between alcohol intake and social problems; but the data do not seem to be available. This again indicates our blinkered approach, which sees the alcohol problem only as the problem of heavy drinkers. We do not know how many accidents arise from the large numbers of drinking drivers who keep below the legal limit and therefore we cannot know the limitations of current attitudes to control.

There is a continuous spectrum of depression in the community with a corresponding spectrum of disability; the conspicuous minority of "cases" probably accounts for only a minority of the population burden of disability. We need to study the determinants of the overall level of the depression distribution, for it is not enough to know why some individuals are so sick as to go to a psychiatrist.

Preventive implications

Efforts to control the extremes of exposure must be integrated into a general population control strategy. Lowering the whole exposure distribution may in fact be the most effective way of reducing the prevalence of high levels. In a normal distribution half of those in the top decile will move to below that level if the mean falls by as little as one third of a standard deviation. A reduction in the population's average intake of alcohol would surely reduce the number of heavy drinkers. Football hooliganism may diminish only when the population's whole distribution of aggression changes.

Such mass changes call for a knowledge of the mass determinants of means and incidence rates—the factors in society and the environment which favour smoking, alcoholism, depression, bad housing, bad hygiene, violence, militarism, and environmental pollution. At this point medical research merges into social research, and the two cannot properly exist apart. Similarly with policy: the Departments of the Environment and of Agriculture and the Treasury are more potent determinants of the nation's health than the Department of Health.

Measuring small risks

Measuring small risks raises two problems. The first is the limited power of epidemiological studies. In the UK Atomic Energy Authority mortality study we examined 328 000 person years of experience among radiation workers,⁷ but it was still many times too small. It provided "best estimates," but with unsatisfactorily wide confidence intervals. We have to accept that we cannot measure some small but important risks. The second problem is in the interpretation of low order risks, owing to the complexity of study situations. In examining the relation of cigarettes to lung cancer we were dealing with an almost unifactorial aetiology and the answer came out clearly. In a multifactorial disease a factor which increases

the risk by less than half will almost certainly be undetectable. We must learn to live with uncertainty and to make room for it in policy judgments. This will not be popular.

In summary, to seek to limit the hazards for high risk workers and critical population groups is admirable; but for the population as a whole it may have little relevance in circumstances where the dose response curve has no threshold and low level exposure is widespread. In that case the only effective control is mass control. The problem then arises that an order of risk which might be important for the population is likely to be undetectable. In that state of uncertainty we have to avoid both the panic of the professional protesters and the unfounded but seemingly unshakeable confidence of the professional experts.

And, finally, a postscript—but an important one. Of all the threats to environmental health, incomparably the greatest is nuclear war. It is surely not inevitable; but, so long as present policies continue, I judge it to be likely. If we fail in this direction then all our other efforts to improve the public health will have been quite wasted. The prevention of nuclear war should be overwhelmingly the first concern for doctors, environmentalists, and everyone else.

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The BMA is holding its scientific congress in Kuala Lumpur in October. What diseases are endemic in the area and what vaccinations are advisable for visiting Malaysia in October?

Kuala Lumpur is free of malaria, as are other cities of Malaysia, so malaria prophylaxis would not normally be needed. Prophylaxis would, however, be needed for an overnight stay in a rural area, and in those circumstances the current recommendation is to take two tablets of chloroquine phosphate 250 mg once a week, and two tablets of proguanil hydrochloride 100 mg once a day, beginning a week before exposure, while there and for four weeks after. As there is some chloroquine resistance in Malaysia, this combination will not be 100% effective but it is free of serious toxic effects. It is a wise precaution for visitors to the tropics or subtropics to make sure that their polio immunisation is up to date. If a traveller has been immunised before a single oral dose of trivalent Sabin vaccine is all that is necessary. If the traveller has never been immunised against polio three doses spaced at least four weeks apart are necessary to establish complete immunity. Booster doses are needed every five years. Hepatitis A is prevalent in virtually all of the tropics and subtropics, and virtually complete protection for an eight week period may be given by a single intramuscular injection of 250 mg pooled γ globulin. Protection begins immediately after the injection is given. Travellers known to have had an attack of hepatitis A in the past may be assured of life long immunity. The Public Health Laboratory Service will test serum for hepatitis A antibodies. A single dose of typhoid vaccine will give a fairly high degree of protection for up to six months, admittedly at the expense of a slightly sore arm and minor febrile symptoms. The traveller must decide whether this is worth while, bearing in mind that typhoid is easily treatable and the chances of catching it must be small. Cholera vaccination is so feeble, even after two injections, that it is doubtful if it is worth recommending. There is no evidence that it gives more than 40% protection, and if the traveller does acquire cholera despite the injection the disease is not reduced in severity.—DION R BELL, reader in tropical medicine, Liverpool.

Popular French medical textbooks suggest a prevalence of listeriosis in pregnant women of around 1 in 250. The "Oxford Textbook of Medicine" quotes a prevalence of 1 in 37 000 births in Britain. Does such a big difference exist, and if so what might the reasons be?

Listeriosis, which is caused by a Gram positive bacterium, causes abortion in cattle and sheep and can spread to people through food, including milk.² Infection may be symptomless or may produce a flu like illness with a mild fever. Pregnant women are particularly at risk, and infection may cause abortion, intrauterine death, premature delivery, or neonatal illness that may be immediate or delayed.² In 1978 the Communicable Disease Surveillance Centre reported the incidence of listeriosis as 1 in 37 000 births in England and Wales. Some observers commented, however, that listeriosis was probably underdiagnosed or underreported,³ and in 1984 the centre reported an incidence of 1 in 18 000 births, the increase possibly reflecting greater awareness of the condition.² Several reports have suggested that the incidence in various countries, including Britain, is higher than this. For example, in St Mary's Hospital, Manchester, where listeriosis is suspected in women presenting with flu like illness, with evidence of intrauterine or cervical infection, or with intrauterine death seven cases of perinatal listeriosis were diagnosed in one year from June 1982, an incidence of about 1 in 650 deliveries.⁴ By contrast, the incidence quoted in the French textbooks might be slightly too high: a recent survey of one Parisian maternity hospital reported 36 cases between 1975 and 1984, an incidence of 1 in 1000 births.⁵ There seems to be no good evidence of a genuine difference in incidence between Britain and France.—JAMES OWEN DRIFE, senior lecturer in obstetrics and gynaecology, Leicester.

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