Environmental Epidemiology

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It is no easy task to identify a causal association between an environmental hazard and a health effect. The task can be aggravated by society's lack of familiarity with the rigorous criteria that must be applied before an appropriate epidemiological study is undertaken. Extensive coverage of claims that particular agents induce unusual health events is often given before the definitive studies can be undertaken.

Media excitability is one of the major problems in the proper investigation of environmental influences on health as illustrated by its reportage of the Chernobyl disaster. I was actually in Russia at the time, but I was unaware that I was under the so-called "atomic cloud" until a concerned telephone call from my wife informed me that I was in great danger. Even the Minister of Health, whom I was with, had no knowledge of recent events. Of course when I arrived back in Britain I had no trace of an exposure, but could understand my wife's alarm from reading the newspapers. The media often gets excited over environmental problems regardless of the extent of their impact in practice. That is not to understate the importance of the Chernobyl disaster, but merely to emphasise the media's lack of selectivity in reporting the danger.

It is relatively easy to identify a hazard with the onset if its effect is rapid or excessive, such as an outbreak of food poisoning or the rise in deaths from respiratory conditions following the London smogs. It is much more difficult if the effect appears many years after the exposure, for example, the effect of certain drugs, or is cumulative and only appears when a certain threshold is exceeded, for example the possible effects of pesticides, or induces a relatively small increase in a common condition, for example the association between passive smoking and the incidence of bronchitis.

Hazards are usually identified either because prior knowledge of their potential impact exists, or because suspicion is aroused by the appearance of a few cases of a rare nature, following anecdotal reportage. A classical example is the discovery of the association between the birth of babies with congenital malformations and the prescription of thalidomide to women during early pregnancy. A General Practitioner in North East Scotland noticed three cases of a rare congenital malformation in his practice and, as he kept good records, was able to associate this with the drug that he had prescribed the mothers during pregnancy⁽¹⁾. However, the interpretation of clustered cases of a rare condition also has its problems, for example cases of leukaemia proximal to nuclear power plants⁽²⁾. It is extremely difficult to exclude the possibility that such patterns arise by chance.

I have no intention, in this talk, to summarise the discussion on the analysis and interpretation of clusters, as this has done far better in recent publications in the *American Journal of Epidemiology*⁽³⁾. I will however attempt to deal with some of the general problems of the development of methods of identification of environmental hazards.

To get away from reliance on haphazard observation, potential long term health effects need to be anticipated and systems of surveillance for environmental health hazards need to be established. This is relatively easy if the concern is a new industry or a new process for which a register of those exposed can be set up and outcome recorded, or a defined group followed over time, for example patients administered a new drug or undergoing a new procedure. An outstanding example of a specific register is the Boston Collaborative Drugs Surveillance Programme which was established to monitor all drug exposures and all adverse health events whether or not these are related⁽⁴⁾. Recent studies in the EEC have attempted to develop a simpler system for use in European hospitals⁽⁵⁾. The pilot work has, however, shown that the methodology developed in the EEC for identifying the effect of industrial processes is likely to be far too insensitive unless it can be undertaken in a very large number of institutions. Thus its usefulness is limited to the formulation of hypotheses or for raising awareness. Ideally, all systems require a suitable control, this can best be provided by running a randomised controlled trial although this is not always feasible.

The concerns of epidemiology include the causation of disease and abnormalities of function. Its methodology, however, is not sufficiently rigorous and can often only suggest associations. Only rarely have all criteria for a good investigation been satisfied and often no evidence for an association is found after other factors are taken into account. For example, studies of the health effects of air pollution in the USA neglected the confounding of smoking for years. There is no doubt that people in towns have higher levels of respiratory disease than people in country areas, but explaining this in terms of air pollution is only justified if the smoking habits of the two populations are adequately considered. Town dwellers tend to smoke more heavily and from an earlier age than individuals living in the country⁽⁶⁾.

The discipline of epidemiology is, however, unpopular because it threatens to unearth associations which will necessitate remedial action from industry or government. It is only rarely favoured by pressure-groups because it is often unable to confirm associations from anecdotal evidence which attracts media attention.

Epidemiologists employ five methods of analysis in their investigation of potential causal association. The analysis of routine statistics such as mortality or morbidity data; prevalence studies; case control studies; prospective studies; and experimental studies. Examples of each method's use in identifying hazards are given.

1. *Analysis of routine statistics:* Most countries collect demographic and vital statistics regularly. From looking at statistics an association was observed between a rising death rate from asthma and the sale of pressurised aerosols⁽⁷⁾.

2. *Prevalence studies:* These are cross-sectional surveys of a representative sample of the population or a specific sub-group at one point in time. The prevalence of respiratory symptoms among English post-office workers and telephone workers was compared with that among American telephone workers and found to be higher in the former group. This was explained by the difference in level and type of air pollution experienced by the populations⁽⁸⁾. The particular study was extended to investigate similar types of workers in Japan as well⁽⁹⁾. Further examples are the investigation of the association between monosodium glutamate consumption in the diet and a series of neurological symptoms in the Honolulu Heart Study⁽¹⁰⁾, and the association between children's intellectual ability and blood lead levels⁽¹¹⁾.

3. *Case control studies*: Such studies identify individuals with a specific condition and compare each with a control individual matched for as many characteristics as possible, except the illness. This approach demonstrated the association between maternal benedictin use in the first trimester of pregnancy and infant pyloric stenosis⁽¹²⁾.

4. *Prospective studies*: Such studies follow a defined population sample to identify future health events. This approach quashed the suspicion that vasectomy is associated with a variety of immunologically mediated conditions⁽¹³⁾.

5. *Experimental studies*: The investigator studies or determines the preferably random exposure to an agent for a given population. A classical example is Snow's identification of the coterminous nature of the relationship between the distribution of cholera cases in the London outbreak in the 19th Century and customers of the Suffolk and Vauxhall Water Company, and the removal handle of the pump which was associated with the outbreak⁽¹⁴⁾.

Epidemiologic methods exist to identify long term health effects, but if associations between hazard, exposure and health events are to be detected it is necessary for there to be an appropriate level of suspicion and proper investigation of suspected hazards. This will only be achieved if epidemiologists are given access to and allowed to scrutinize data collected by government and industry. An excellent example of such a study was the study of nasal cancers in wood workers in the furniture industry which was only possible through the ability to link records from one event to another.

In discussing the problem of environmental factors in health to an International Epidemiological Association meeting it is important to emphasise the importance of sanitary conditions. This is what started off the science of epidemiology in England through the work of John Snow, as I have shown. It is, however, still one of the most important causes of ill health in developing countries, as has been recorded in a recent article by WHO⁽¹⁵⁾. There are still many areas of the world which do not have an adequate water supply or adequate sanitation. It is this aspect of the environment that is one of the major causes of mortality and morbidity in many parts of the world.

Let me conclude, however, by considering the necessary conditions for the assessment of environmental health effects.

These are:

- a) a level of suspicion
- b) proper investigation of suspected hazards
- c) the use of available data
- d) keeping proper records

REFERENCES

1. McBride, W.G.: Thalidomide and congenital abnormalities. *Lancet*, ii: 1358, 1961.
2. Darby, S.C., Doll, R.: Fallout, radiation doses near Dounreay and childhood leukaemia. *Br. Med. J.*, 294: 603, 1987.
3. Proceedings of the National Conference on Clustering of Health Events. Atlanta, Georgia, February 16-17, 1989. Published as a Supplement to the *American Journal of Epidemiology*, Volume 132 (1), (Suppl.) July, 1990.
4. Jick, H., Mietinnen, O.S., Shapiro, S. et al.: Comprehensive drug surveillance. *JAMA*, 213: 1455, 1970.
5. Rona, R., Mosbech, J.: Validity and repeatability of self-reported occupational and industrial history from patients in EEC countries. *Internat. J. Epidemiol.*, 18: 674, 1989.

6. Holland, W.W., Bennett, A.E., Cameron I.R. et al. Health effects of particulate pollution: reappraising the evidence. *Am. J. Epidemiol.*, 110: 527, 1979.
7. Inman, W.H.W., Adelstein, A.M.: Rise and fall of asthma mortality in England and Wales in relation to use of pressurised aerosols. *Lancet*, ii: 279, 1969.
8. Holland, W.W., Teid, D.D., Seltser, R. et al.: Respiratory disease in England and the United States. Studies of comparative prevalence. *Arch. Environ. Health*, 10: 338, 1965.
9. Comstock, G.W., Stone, R.W., Sakai, Y. et al.: Respiratory findings and urban living. *Arch. Environ. Health*, 27: 143, 1973.
10. Go, G., Nakomura, F.H., Rhoads, C.C. et al.: Long term health effects of dietary monosodium glutamate. *Hawaii Med. J.*, 32: 13, 1973.
11. Fulton, M., Thomson, G., Hunter, R. et al.: Influence of blood lead on the ability and attainment of children in Edinburgh. *Lancet*, i: 1221, 1987.
12. Aselton, P., Jick, H., Chentow, S.T. et al.: Pyloric stenosis and maternal Benedictin exposure. *Am. J. Epidemiol.*, 120: 251, 1984.
13. Massey, F.J., Bernstein, G.S., O'Fallen, W.M. et al.: Vasectomy and health. Results from a cohort study. *JAMA*, 232: 1023, 1984.
14. Snow, J.: Snow on cholera. New York: Hafner Publishing Company, 1965.
15. Huttly, S.R.: The impact of inadequate sanitary conditions on health in developing countries. *World Health Statistics Quarterly*, 43: 118, 1990.