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Commentary

Shortcomings in Risk Projection

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Radiation physics and epidemiology are both relatively new sciences. They are related in an unusual way in that the effects of radiation exposure have provided epidemiology with some of its largest studies of health effects. The Institute of Environmental Medicine celebrates its 40th anniversary at about the same time as that of the detailed investigations into the health effects and risk from exposure to radiation.

Follow-up studies of dial painters to determine long-term effects of radium ingestion were begun in the 1940s, follow-up studies of underground miners exposed to radon and daughters, persons treated with X-rays for ankylosing spondylitis and the A-bomb survivors were initiated in the 1950s. These studies form the core of most of what is known concerning the long-term effects of radiation. The studies are still in progress, and each update is awaited anxiously as the newly published reports often provide surprising data usually bearing upon the biology of cancer.

One unusually important aspect of radiation epidemiology lies in risk projection. The understanding of the lifetime mortality that a single or chronic exposure imparts is becoming of particular value. It allows the risk to be evaluated relative to potential benefit such as improvement in patient management if the exposure is due to diagnostic medical practice. It determines whether particular occupational exposures are disproportionately hazardous compared with safe industries. The recent discovery that environmental exposure (particularly to indoor radon) can also be a significant radiation insult has driven large-scale survey programs to uncover areas where remedial action should be taken to lower radon exposure in homes.

The shortcoming of risk projection based on retrospective studies is that some of the input data used in the models (such as exposure data) may be poor, a fact that cannot be rectified except in future prospective studies. A major problem that requires correction is that the risk projection models do not faithfully reproduce the true time sequence and magnitude of cancer appearance in a population. The latter problem should receive particular attention from epidemiologists in the next decade.

Current modeling for lung cancer risk from exposure to radon, for example, has tended to favor a risk that is a constant proportion of a baseline lung cancer risk in the average population. Extensive software has been written to accommodate this type of model. The emerging temporal pattern of lung cancer following exposure to radon daughters is not one of a constant risk relative to the population baseline but of a risk that diminishes with time and is virtually undetectable in a population 15 to 20 years subsequent to occupational exposure. This has profound implications with regard to environmental exposure when attempting to extrapolate occupational data to home exposure.

Another area needing special attention, particularly with regard to indoor exposure to radon, is the combined effects of smoking and exposure. Unless the war against smoking is successful and virtually eliminates smoking, study of the combination of effects is a very high priority item. The current trend is to assume that effects of radon and smoking multiply. The follow-up studies of miners are not definitive, but it is clear that the effects of smoking and radon daughter exposure do not strictly multiply. Perhaps with more faithful models for radon risk it would be possible to deduce the form of the radon/smoking relationship.

One good reason for more accurate models is to place the exhaustive number of risks that confront humans in perspective. To effectively use the finite funds available to study the effects upon humans from pollutants in the environment, ways must be sought to identify the important risks. The lifetime risk of disease or mortality, particularly cancer mortality, is an effective way to rank priority of pollutants. Lifetime risk from environmental agents other than ionizing radiation may generally be small by comparison; however, risk projection for most substances other than ionizing radiation is in early developmental stages.

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Current models used in epidemiology can be considered mathematically sophisticated in their ability to examine one particular variable in the presence of many influencing factors. Unfortunately, the models are not as biologically sophisticated. To borrow terminology used by E. L. Doctorow, the current mathematical risk models could be called "high-tech baroque." Much work needs to be done to bring the biological and mathematical aspects of the modeling into accord.

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