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Genetic Effects of Atomic Bombs

The evaluation of the genetic implications for humans of increasing exposures to ionizing radiation and complex chemicals presents one of the most difficult epidemiologic issues ever faced by biomedical science. In an article in this issue we report the results of a 34-year follow-up study of children born to the survivors of the atomic bombings of Hiroshima and Nagasaki. We found no clearly statistically significant effects of parental exposures on the offspring characteristics which we studied, but the various indicators of possible genetic damage all are in the direction expected if an effect was indeed produced. On the basis of the enormous body of data concerning the genetic effects of radiation on experimental organisms, we feel there can be no doubt that some genetic damage was sustained by the survivors of the bombings; hence we have taken the findings in their children as the basis for an effort to estimate the genetic doubling dose of acute radiation for humans. This involves assumptions concerning the contribution, in each generation, of spontaneous mutation to the indicators in question. Although we feel that we have been suitably conservative in this regard, these assumptions may have to be altered as understanding of human genetics improves. Despite the duration of the study and the expense and labor involved, we can only regard the present estimate as preliminary.

The estimate of the genetic doubling dose for humans is 156 rems. This is approximately four times higher than the estimate in current usage based largely on experiments with selected strains of mice. Accordingly, the estimate has the kinds of implications for regulations regarding permissible exposures, and for legal actions brought on the suspicion of genetic damage from inadvertent exposures, that are certain to elicit discussion.

Where do we go from here? Certainly, all possible efforts must be made to improve the data base on which the estimate rests. These include not only continuing studies along the lines described in the accompanying article, but the application of a number of new techniques for screening for protein variants. Time, however, is running out. The cooperation of the citizens of Hiroshima and Nagasaki has been magnificent, but because both parents must be available for study in case of a suspected mutational event, the sample size is shrinking year by year.

Should similar studies be undertaken on other populations of children at suspected genetic risk from parental exposures? It must at this point be clear to any responsible government official that the issues are highly complex; there are no easy answers to the question of induced, transmitted genetic damage. In particular, the relevance of positive findings in the body cells (say, lymphocytes) of exposed persons to the prediction of transmitted genetic damage in their offspring is highly ambiguous. Chromosomal damage has been obvious in the lymphocytes of survivors of the atomic bombings, but the demonstration of corresponding genetic damage has been difficult.

On the basis of present knowledge, it seems unlikely that any other study can be more revealing than that in progress in Japan. On the other hand, so widespread and pervasive are public concerns, and so great their impact on government actions and regulations, that a case can be made for additional studies of carefully selected groups. The issues are now as much social and political as scientific. There is, in this context, no such thing as a "negative" study; every epidemiologically sound study helps put the problem in perspective. The issue of credibility is major; in some quarters any government-financed, government-directed study will be suspect. We recommend that a blue-ribbon committee, of wide representation, be appointed by either the executive or the legislative branch to consider the entire issue of additional studies. In these deliberations, the opportunities for international collaborative efforts should not be overlooked. The human and financial costs, reckoned in various ways, of not conducting additional studies may far outweigh those of continuing to try to extrapolate from present knowledge.—JAMES V. NEEL, *Department of Human Genetics, University of Michigan Medical School, Ann Arbor 48109.*