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Letters

Leukemia and Radiation

Brues article "Critique of the linear theory of carcinogenesis" [*Science* 128, 693 (1958)] is an admirable and highly critical review which deals particularly with the relationship of human leukemogenesis to ionizing radiation. Many good points are made indicating that there may be a nonlinear relationship of radiation dose to leukemic end result. In the end, however, one is faced with the usual difficulty of trying to assess which of the different interpretations derived from the same sets of data is correct. Brues would be the first to admit, I am sure, that his interpretations, however well reasoned, may be as far from the mark as the next man's.

The statement is made (page 694) that "this steady increase [in incidence of leukemia in the United States] has been loosely attributed to an increase in human irradiation (17)" (italics mine). The reference is to an editorial of mine written in 1947 ["Is leukemia increasing?" *Blood* 2, 101 (1947)] in which some comment is made upon an article by Sacks and Seeman appearing in the same issue. Various possibilities for the apparent increase in incidence of leukemia are discussed, including those of radiation and chemical exposure. Indeed, most emphasis is placed upon various forms of chemical exposure and their possible leukemogenic effects. There is no mention (in this editorial) of "an increase in human radiation" as Brues rather "loosely" states. However, the prophetic statement is made, shortly after the event and before any cases of leukemia were described, that "it will be of interest to observe the Japanese survivors of the atomic bomb for future indications of proliferative disease of the white cells."

Brues may have reference to another editorial published more recently [W. Dameshek and F. W. Gunz, *J. Am. Med. Assoc.* 163, 838 (1957)] in which the suggestion was broached that the apparent increase in incidence of leukemia may be due, at least in some measure, to the increasing exposures of affluent populations to diagnostic and therapeutic x-radiation. Although some of the conclusions were admittedly speculative, it seemed fitting in this editorial to emphasize the potential dangers of radiation therapy for nonneoplastic disease and of unnecessary and frequently repeated diagnostic x-ray procedures.

In our recent book *Leukemia* [W. Dameshek and F. W. Gunz (Grune and Stratton, New York, 1958)] Gunz and I discuss the matter of leukemogenesis and ionizing radiation at length and conclude from all the available data

that only about 15 percent of the cases of leukemia can reasonably be ascribed to radiation and that there are other etiologic agents such as chemical exposure and heredity which it is just as important to emphasize. It may well be that the various leukemogenic agents that have been discussed (ionizing radiation, carcinogenic chemicals, viruses, heredity) act by inducing a modification or "deletion" of certain cellular enzymes, thus leading to an altered type of growth pattern for a certain number of cells, depending upon (i) the dose and (ii) the tissue. The leucocytic tissues, already "generalized," will respond in a generalized—that is, leukemic—fashion. However, it is also possible that a very small clone of abnormal cells may develop which is insufficient to do much damage or may indeed be overwhelmed.

Brues article, which is a model for a critical review, is well worth reading and carefully digesting.

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My blunder in attributing this view to Dameshek is the sort of thing that is the nightmare of anyone who prepares an extensive bibliography. While others have loosely attributed to radiation many things which are changing or thought to be changing, he is not one of them. I apologize particularly because he has maintained and voiced a balanced and reasonable view of the whole problem.

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Excessive Education Department Requirements

Recently I wrote a letter to *Science* [128, 1156 (1958)] mentioning, among other things, the excessive education department requirements for science teacher certification. It was implicit in the discussion that university science departments had produced thousands of fine science teachers who are barred from secondary-school teaching positions in most states because they would not spend a fifth to a quarter or more of their university time taking education department courses.

Subsequently, the 85th Congress passed Public Law 85-864, which by its own terms may be cited as the National Defense Education Act of 1958. Certain provisions of this act create concrete financial difficulties for student borrowers because of the excessive education department requirements.