# Meetings

## Bone-Seeking Radionuclides

Radiation-induced cancer was the central theme of the international symposium on delayed effects of bone-seeking radionuclides, held 12 to 14 September 1967 at Sun Valley, Idaho. Six countries were represented in the 28 invited papers.

H. Spiess (University Children's Clinic, Göttingen, Germany) outlined his follow-up of about 1000 of some 2000 German patients injected with $^{224}$Ra in the years 1944 to 1951. His was the first presentation of these studies to an English-speaking audience, and there was very keen interest. To date, 50 bone sarcomas have appeared, 35 of them in the 206 patients irradiated as children. For the bone sarcoma cases, the smallest total injected amount was about 400 microcuries of $^{224}$Ra (in an 8-year-old child and also in a 70-year-old adult). When the dose-conversion factors of Maletskos are used, the radiation dose for the adult's skeleton was between 20 and 200 rad. Short-lived $^{224}$Ra (3.6 days) appears considerably more toxic rad-for-rad than the long-lived $^{226}$Ra (1600 years). The greater effectiveness of $^{224}$Ra may be due to the fact that it decays quickly, before the apposition of new bone mineral can shield the living cells from $\alpha$-irradiation.

A. J. Finkel (Argonne National Laboratory) reported 23 bone sarcomas and 16 neoplasms of the skull in 217 radium-containing persons. In all but one of these tumor cases, the residual amount of $^{226}$Ra in the body exceeded 0.5 $\mu$c. In this one case, the amount of $^{226}$Ra at tumor diagnosis (about 40 years after the start of exposure) was about 0.16 $\mu$c. This patient's peak content while dial painting was an estimated 1.2 $\mu$c.

R. D. Evans (Massachusetts Institute of Technology) summarized the studies at M.I.T. on persons exposed to $^{226}$Ra and $^{228}$Ra. There have been 28 bone sarcomas and 9 head carcinomas in the 90 persons whose skeletal dose exceeded 1200 rad. However, none of these tumors has been observed in the 406 persons of this series whose doses were lower. A linear nonthreshold relation for the induction of these tumors seems extremely unlikely. Evans calculates that for a residual 1 $\mu$c of $^{226}$Ra in the body after 40 years, the cumulative radiation dose to the 7-kg skeleton of a standard man is about 2300 rad, and about 3200 rad to the 5-kg skeleton of a standard woman.

R. Mole (Harwell, England) assembled experimental data supporting his hypothesis that the radiation dose from a given radionuclide required to produce a given incidence of bone cancer is rather similar for a variety of mammals including man.

R. O. McClellan (Lovelace Foundation, Albuquerque, N.M.) presented an excellent and detailed review of the neoplasms induced by high doses of $^{90}$Sr in experimental animals. When single high doses of $^{90}$Sr are given to adult experimental animals, osteosarcomas frequently predominate. However, when repeated doses of $^{90}$Sr are received early in life, the hematopoietic neoplasms may form a greater risk.

G. N. Taylor (University of Utah) reported that in beagles injected as adults, squamous-cell carcinomas in the head sinuses have been induced from $^{239}$Pu, $^{226}$Ra, and $^{90}$Sr; liver tumors from $^{239}$Pu; and eye melanomas from $^{228}$Ra and $^{226}$Ra. In all cases these tumors arose within heavily irradiated tissue. The induction of these soft-tissue tumors was much less frequent than the induction of osteosarcomas.

Y. I. Moskalev (Ministry of Public Health, Moscow) provided the concluding paper, which was read in English by C. Comar (Cornell University). For many in the audience, this was an introduction to Russian radiobiology. Experiments on the delayed effects of internally deposited radionuclides were reported for 5000 animals, mostly rats. Whereas no osteosarcomas were observed in 722 control rats or in 1365 rats injected with 0.005 to 2.5 $\mu$c of $^{90}$Sr per kilogram of body weight, osteosarcomas developed in 5 (7.4 percent) of 68 rats given orally 0.5 $\mu$c of $^{239}$Pu daily from 3 months of age until death 370 days later. The average radiation dose to the bone was only 57 rad at death, and the inducing dose was likely much lower. Skeletally deposited $^{239}$Pu is very effective in inducing bone cancer. Radiation protectionists throughout the world should take note of this finding.

Other senior authors were: D. Berliner, B. I. Bleaney, H. D. Bruner, L. K. Bustad, W. J. Clarke, T. Domanski, J. H. Dougherty, P. W. Durbin, M. P. Finkel, M. Goldman, W. S. S. Jee, C. J. Maletskos, L. D. Marinelli, J. H. Marshall, C. W. Mays, J. Müller, M. Rosenthal, F. W. Spiers, B. J. Stover, D. M. Taylor, and J. Vaughan.

This symposium was organized under the direction of T. F. Dougherty, head of the Radiobiology Division of the Anatomy Department at the University of Utah. It was supported by the U.S. Atomic Energy Commission. The proceedings, to be published by the University of Utah Press, should appear about October 1968.

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## Calendar of Events

### National Meetings

### September

*9–13.* American **Fisheries** Soc., 98th, Tucson, Ariz. (R. F. Hutton, 1040 Washington Bldg., Washington, D.C. 20005)

*12–15.* American **Electroencephalographic** Soc., San Francisco, Calif. (P. T. White, Marquette Univ. School of Medicine, 8700 W. Wisconsin Ave., Milwaukee, Wis. 53226)

*12–17.* Pacific **Dermatologic** Assoc., Coronado, Calif. (M. S. Falk, P.O. Box 1268, Reno, Nev. 89504)

*13–15.* Mid-Continent **Psychiatric** Assoc., Little Rock, Ark. (W. Young, 3504 Hill Road, Little Rock 72205)

*15–21.* **Electron Microscope** Soc. of America, 26th, New Orleans, La. (School of Chemical Engineering, Olin Hall, Cornell Univ., Ithaca, N. Y. 14850)

*16–19.* American Acad. of **General Practice**, Las Vegas, Nev. (M. F. Cahal, Volked Blvd. at Brookside, Kansas City, Mo. 64112)

*18–20.* **Cancer,** 6th natl. conf., Denver, Colo. (R. N. Grand, 219 E. 42 St., New York 10017)

*19–22.* American **Medical Writers** Assoc., Washington, D.C. (E. G. Dailey, P. O. Box 267, Arlington, Va. 22210)

*22–25.* American **Fracture** Assoc., Houston, Tex. (H. W. Wellmerling, 610 Grieshim Bldg., Bloomington, Ill. 61701)