The Boice Report #65

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Oak Ridge, Space Exploration, and Michael

The past, the present, and the future came together in Oak Ridge, Tennessee, in November 2017. Oak Ridge National Laboratory (ORNL) and Oak Ridge Associated Universities (ORAU) have been on the forefront of radiation research since the dawn of the Atomic Age. Such efforts continue with partnerships with Vanderbilt University and the National Council on Radiation Protection and Measurements (NCRP). A three-day working group meeting was held in Tennessee to continue the epidemiologic studies of Manhattan Project workers included in the Million Person Study (MPS) and to develop and apply biokinetic models to estimate organ dose from intakes of radionuclides. The working group covered statistics, dosimetry, and epidemiology, all intertwined. How does the past inspire innovative research today that will be of notable value for tomorrow?

Working group at meeting in Tennessee, left to right: Michael Bellamy (ORNL), Shaheen Dewji (ORNL), John Boice (NCRP, Vanderbilt), Katie Bales (ORNL), Phil Wallace (Oak Ridge Institute for Science and Education [ORISE], retired), Betsy Ellis (ORISE), David Girardi (ORISE), Keith Eckerman (ORNL, retired), Ashley Golden (ORISE), Rich Leggett (ORNL), and Mike Mumma (International Epidemiology Institute, Vanderbilt). Not in picture: Sarah Cohen (EpiStat), Cait Milder (NASA), Donna Cragle (ORISE), and Derek Hagemeyer (ORISE).
Photo courtesy of John Boice

Statistics. Statistics don't lie; liars use statistics! Perhaps too harsh, but the assumptions and models used to analyze radiation epidemiologic data can influence findings and interpretation. ORAU, in partnership with Vanderbilt University, is completing a large effort to evaluate statistical packages, model assumptions, and adjustment variables. The five MPS populations (*n* >400,000) include aboveground nuclear weapons test participants, workers at the Mound Facility in Ohio, nuclear power plant workers, industrial radiographers, and Mallinckrodt uranium processors. Cox proportional hazards models were optimal for risk estimation. In addition to age and sex, adjusting (or not) for socioeconomic status and duration of employment could change both the estimate of risk and the level of significance. An overview of these statistical approaches was presented at the 2017 Health Physics Society (HPS) Annual Meeting in Raleigh, North Carolina.

Dosimetry. The key to good epidemiology is good dosimetry. The Mallinckrodt Chemical Works study provides an informative example of the challenges. Six sources of exposure were examined to obtain organ-specific doses: external gamma rays from the decay of radionuclides contained in the pitchblende being processed; medical x rays required for occupation; intakes of radionuclides, particularly radium, as estimated from radon breath analyses; occupational doses received at other facilities; and ambient radon and progeny concentrations within the work environment.

Another goal is to estimate radiation dose to the brain from high-linear-energy-transfer alpha-particle emitters. The National Aeronautics and Space Administration (NASA) has a special interest in evaluating the possible neurological and behavioral consequences of exposure to high-velocity heavy ions, galactic cosmic rays that emanate from the explosion of a supernova. There are no human analogs for such exposure, but many Manhattan Project workers had intakes of plutonium, polonium, radium, americium, or uranium—radionuclides that cross the blood-brain barrier and irradiate brain tissue with alpha particles for years. Evidence that this occurs comes from autopsy examinations by the U.S. Transuranium and Uranium Registries (USTUR) and other laboratories. Additional validation will begin using synchrotron-based hard x-ray fluorescent microscopy on workers' brain tissues from USTUR. The MPS epidemiologic studies are evaluating dementia, Alzheimer's disease, Parkinson's disease, and motor neuron disease as possible adverse outcomes from intakes of these radionuclides. These human studies will complement rodent studies where exposure is for about a minute, but to high-energy heavy ions similar to galactic cosmic rays.

Populations. NASA is also interested in reexamining the sex-specific risks associated with radiation-related lung cancer. This is because NASA limits for crew members are based on individual lifetime risk of cancer estimates for radiation received in space. Women, based on atomic bomb survivor data, show a nearly three times higher risk of radiation-related lung cancer than males. This limits the time women are allowed in space. As such, a study was initiated of 173,000 medical radiation workers where half are females and their dose distribution is broad and includes about 30,000 workers with cumulative doses >100 mGy. Because of the complexity of the dosimetry, a working group of medical physicists was convened and will provide guidance on the optimum ways to estimate organ doses, particularly for the lung.

Two hopes for the future. Hopefully, congressional interest in restoring low-dose radiation research will take traction and result in the resources needed to rejuvenate U.S. declining programs. Hopefully, I'll see you in Denver at the 2018 HPS Midyear Meeting on a terrestrial problem: radioactive waste management!

In Memoriam. R.J. Michael Fry (1925–2017) died peacefully the day after Thanksgiving. He was a rare individual: a gentle scientific giant, trailblazer, and true gentleman. He was also a world-class radiation biologist and leader. Michael came from the land of the leprechauns and enjoyed entertaining both children and adults. He had a keen sense of humor and made you laugh. He and I started on NCRP committees in 1977 and worked on many NASA-related reports. The NASA Human Research Program owes Michael a lasting debt, as do so many of us who were able to walk with him.

R.J. Michael Fry (1925–2017)
Photo courtesy of family

Jean M. St. Germain (1945–2017) died 7 December. She was a member of HPS since 1967. She was a certified health physicist and a fellow of the Society. She was a renowned medical physicist and radiation safety expert. She served on and chaired several NCRP scientific committees. Jean claimed me as a de facto member of the Greater New York Chapter of HPS—because I was born in Brooklyn and went to Rensselaer Polytechnic Institute in Troy, New York (and perhaps because we were friends). Her leadership, encouragement, and friendship will be sorely missed.

Jean Mary St. Germain (1945–2017)
Photo courtesy of Memorial Sloan Kettering Hospital