The Boice Report #15

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Low Doses in Madison—July 2013 Health Physics Society Annual Meeting in Madison, Wisconsin

How low can you go? What is low anyway? Isn't dose rate more important than low dose? Does anybody care? You should!

Policy continues to be set to protect people against the presumed chance (aka risk or probability) that low doses may cause bad things in the distant future. Assumptions are made as to the level of risk associated with doses below about 100 mSv where epidemiology cannot provide answers because of inherent statistical limitations (the signal is too weak to detect) and because of the impossibility to control for subtle confounding factors that have more influence on cancer occurrence than the exposures to be studied (ICRP 2005). Low doses are ubiquitous and policies are set to protect workers, to compensate prior workers, to clean up former radiation legacy sites, to protect the public living near nuclear facilities, and to address patient exposures in this burgeoning era of medical advances. Protection is not cheap and huge resources are expended in these arenas.

The 58th Annual Meeting of the Health Physics Society (HPS) was again a whirlwind of information on issues important to the radiation professional (HPS 2013). The HPS and American Nuclear Society (ANS) special session on low-dose radiation research is summarized below.

- **Paul DeLuca – Welcome.** The provost and vice-chancellor at the University of Wisconsin at Madison and vice-chair of the International Commission on Radiation Units and Measurements mentioned some of the giants who inhabited the hallowed halls: John Cameron (medical physics—hormesis), Jack Fowler (radiation biologist—fractionation in therapy), Seymour Abrahamson (radiation geneticist and 1996 National Council on Radiation Protection and Measurements [NCRP] Taylor Lecturer), and Kelly Clifton (radiation biologist—adaptive response). The deposition of energy in tissue and cells is important (Goodhead 1988) but more so is the biological response. In the absence of epidemiologic evidence for low-dose effects, science and biological understanding is key to policy development. Cost-benefit comparisons with other societal risks are relevant so that scarce resources are optimally expended. De minimis thresholds are "practical thresholds" below which outcomes are assumed too low to be of concern and may provide more than adequate protection of public health.
- **Wolfgang Weiss – MELODI a hopeful tune.** Wolfgang, honorary member of MELODI (the Multidisciplinary European Low Dose Initiative) and former chair of the United Nations Scientific Committee on the Effects of Atomic Radiation, provided a stimulating overview of the challenges and opportunities for radiation protection and low-dose risk research. Europe had the foresight in 2009 to develop MELODI as a broad-based research program to meet the future needs of the member nations, given the dwindling numbers of radiation professionals and research opportunities (www.melodi-online.eu/doc/melodi_doc_1.pdf). The United States is way behind in this regard, although NCRP has just launched a broad-based initiative —"National Crisis: Where Are the Radiation Professionals? (WARP)"—in an attempt to address the current and future needs of the nation. Radiation protection requires radiation biology and radiation epidemiology to address the (1) shape of the dose-response curve for cancer, including the refinement of DDREF (dose and dose rate effectiveness factor) defined for radiation protection

to adjust high-dose acute exposure risks for low-dose and chronic exposure circumstances), (2) tissue sensitivities for cancer induction since tissues respond differently, (3) the effects of radiation quality, (4) individual variability, and (5) internal radiation exposure. There's much still to be done!

- **John Boice – The Million U.S. Worker Study.** This national effort is to understand radiation risk when exposures are delivered gradually over time (Boice 2012). The study has identified nearly nine million workers or atomic veterans and one million selected for study. It is 10 times larger than the atomic bomb survivor study and has more high-dose subjects! There will not be a need for DDREF adjustments since the doses are all received in small amounts over many years. It will directly address the dose-rate issue in humans and whether the risk from 100 mSv or 1,000 mSv received over years is the same, lower, or higher in comparison with brief exposures such as to the atomic bombings in Japan. Results will be directly applicable to radiation protection, compensation, and risk projection in medical and environmental circumstances. NCRP committees are developing plans on how to integrate the new radiation biology with the new emerging epidemiology.

- **Gayle Woloshack** (Northwestern University) had a marvelous presentation on an untapped resource of animal archived data. Mega-mouse lifespan studies designed to address DDREF and other biological responses have yet to be analyzed and have the potential to provide much-needed insights into biological mechanisms (Haley 2011).

- **Brant Ulsh** (M.H. Chew & Associates) provided an informative and entertaining overview of low and slow (low-rate) doses. Biological responses appear different following low and slow doses compared with high and fast (high-rate) doses. While the deposition of low-LET radiation may be linear, the tissue response is certainly nonlinear for many outcomes (Morgan 2013).

- **Kathy Higley** (Oregon State University) reminded us that the protection of nonhuman biota has come to center stage throughout the world, but not as yet in the United States. Radiological impacts following Chernobyl and Fukushima appear to be occurring at levels lower than previously recognized, and organisms exposed "in the wild" (their natural habit) may be more sensitive than their laboratory cousins exposed in controlled experiments (Callaway 2013).

- **Jerry Puskin** (Environmental Protection Agency) gave a clear and concise overview of the regulatory issues involving low radiation doses. Again, what do we do when the epidemiology can't inform us at the levels that regulation requires? We use Japanese atomic bomb survivor data, but this is unsatisfactory because of statistical limitations coupled with generalizing from a 1945 population to American populations today. For regulatory purposes, an "effective" or "practical threshold" might be adopted if there were compelling evidence that, below some dose (rate), the risk is much lower than predicted by the linear no-threshhold theory and of minimal health concern. More work is needed to combine radiation biology with epidemiology to guide the regulatory process in the low-dose domain.

- **Paul Locke** (Johns Hopkins University) stressed the need to integrate low-dose radiobiology with policy decision making (Locke 2011). Without sound communication of content, skilled communicators of message, and effective outreach to the proper audiences (policy setters, public, patients, professionals), the message perishes. We must do better!

Credits for masterfully organizing the session go to Bill Morgan (Pacific Northwest National Laboratory), Bryan Bednarz (University of Wisconsin-Madison), and Dimitri Tamalis (Florida Memorial University).

References

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Low Dose HPS and ANS Session
July 2013 Health Physics Society Annual Meeting, Madison, Wisconsin

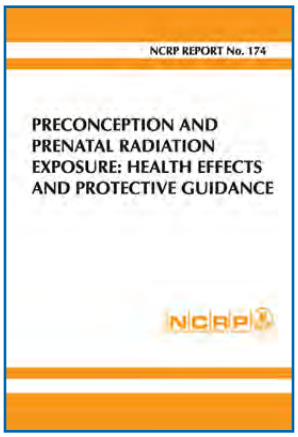
Left to right: John Boice (NCRP, Vanderbilt University), Brant Ulsh (M.H. Chew), Bryan Bednarz (University of Wisconsin-Madison), Wolfgang Weiss (MELODI), Gayle Woloschak (Northwestern University), Paul Locke (Johns Hopkins), William Morgan (PNNL), Dimitri Tamalis (Florida Memorial University), Jerry Puskin (EPA). Missing from photo: Paul DeLuca (University of Wisconsin-Madison) and Kathy Higley (Oregon State University).

Photo by Casper Sun

NCRP News

NCRP Report No. 174, *Preconception and Prenatal Radiation Exposure: Health Effects and Protective Guidance*

NCRP press release



National Council on Radiation Protection and Measurements (NCRP) Report No. 174, *Preconception and Prenatal Radiation Exposure: Health Effects and Protective Guidance*, updates and expands NCRP Report No. 54, *Medical Radiation Exposure of Pregnant and Potentially Pregnant Women* (1977). Scientific knowledge has increased and public concerns have changed in the 36 years since NCRP Report No. 54 was published. The scope of NCRP Report No. 174 covers both ionizing radiation sources and specific nonionizing sources (i.e., magnetic-resonance imaging [MRI], ultrasound imaging, and radiofrequency [RF] fields).

This report provides information on the types, sources, and magnitudes of ionizing radiation exposures of reproductive relevance. Ionizing radiation exposures from medical care (diagnostic and therapeutic procedures, including radiopharmaceuticals) are addressed, as well as occupational sources, common environmental exposures, and accidental or deliberate (e.g., a terrorist act) releases of radionuclides. The ionizing radiation sources discussed consist predominantly of low linear energy transfer radiation (e.g., x rays from prenatal medical procedures).

The risks from ionizing radiation exposure are examined in detail from preconception through pregnancy and during the nursing of infants. Outcomes and associated risks from preconception exposure that were evaluated include infertility, stillbirths, birth defects, genetic alteration, and cancer. Outcomes and associated risks from exposure during pregnancy that were evaluated include congenital malformations, growth retardation, embryonic and fetal death, mental retardation and neurobiological effects, and cancer. Also discussed is the risk to the nursing infant from the transfer of radioactive material through the mother's milk (e.g., milk from a mother who received a radiopharmaceutical) as well as from direct exposure due to radionuclides present in the mother's body. Methods for managing dose and reducing risk from various medical procedures are also addressed.

For nonionizing sources (MRI, ultrasound imaging, and RF fields), the focus is on prenatal exposure, with limited coverage of childhood and adult exposure. Outcomes and associated risks during pregnancy that were evaluated, as relevant to exposure from a particular nonionizing source, include low birth weight, delayed speech, dyslexia, nonright-handedness, and impaired intellectual performance.

Effective methods of counseling and communicating the various risks are described, along with examples of consultations concerning risk prior to and during pregnancy. In particular, the report provides specific conclusions and recommendations concerning the health effects discussed and associated protective guidance.

Report No. 174 is available from the NCRP website, NCRPpublications.org, in both PDF and hard-copy formats. Health Physics Society members receive a 20 percent discount when ordering online using a code found in the Members Only section of the HPS website at https://hps.org/membersonly/publications/index.html. An additional 10 percent discount is given if the order is for both electronic and hard-copy formats.