Tuesday, March 6

8:15 am **NCRP Annual Business Meeting**

9:30 am **Break**

Second Thomas S. Tenforde Topical Lecture

9:45 am

Do the Epidemiologic Data Support Use of the Linear Nonthreshold Model for Radiation Protection?
Roy E. Shore

Low, potentially significant, exposures to low linear-energy transfer (LET) radiation among medical and industrial workers and medical patients have become very common. Historically, we have used the linear nonthreshold (LNT) model for estimating low dose risks and applying standards to protect workers and the public from undue health hazards of radiation.

Is the LNT model still an appropriately prudent basis for radiation protection for low-LET radiation? NCRP Scientific Committee (SC) 1-25 was given the charge to evaluate recent epidemiologic data relevant to the LNT model, primarily covering the past 10 to 15 y which represents the time since the epidemiologic data used by the National Academies' Health Risks from Exposure to Low Levels of Ionizing Radiation (BEIR VII) and the United Nations Scientific Committee on the Effects of Atomic Radiation 2006 reports were compiled. A distinguishing feature of this commentary is that it concentrates on epidemiologic data from low doses or low dose rates (LD/LDR). However, the Life Span Study (LSS) of Japanese atomic-bomb survivors is also reviewed, primarily to characterize the risk in the relatively low-dose range when it was delivered as a brief, one-time exposure rather than in the protracted or highly fractionated fashion characteristic of the LD/LDR studies.

Support for LNT does not necessarily imply that the risk estimates from LD/LDR data be identical to those based on single brief doses in the high-dose range. Rather, there may also be a low dose or low dose-rate effectiveness factor (DDREF) such that the slope of the dose response is reduced, but positive, for low or protracted exposures. A particular concern in evaluating low-dose epidemiologic studies is that the statistical power of a study and the statistical precision of its risk estimate are much less for a low-dose study than a high-dose study. It is therefore challenging to evaluate the implications of studies with low doses or low dose rates.

SC 1-25 evaluated 29 independent studies or groups of studies that reported quantitative results, nearly all of which were based on dose-response analyses of LD/LDR data. The focus was on the endpoint of all solid cancer (or all cancer except leukemia), though we also reported the leukemia results of those studies. Secondarily, the Committee provided brief reviews of whether the LNT model was applicable to *in utero* and childhood exposures, heritable genetic effects, and circulatory disease risk. SC 1-25 critiqued and rated each LD/LDR study of solid cancer on the quality of its dosimetry, epidemiology and statistical analysis and the potential for data biases, which were all part of

the Committee's determination of the strength of support the study provided for the LNT model. The best quality, large studies tended to provide the strongest support for the LNT model, and over 75 % of the studies were rated as providing at least some support for the LNT model.

Analyses of whether there was preferential support for other dose-response models was noted whenever relevant results were available. The LSS cohort showed mixed support for a linear-quadratic (LQ) model, but none of the 10 LD/LDR studies with LQ analyses showed statistically significant support for that model. All five studies that evaluated a threshold dose-response model yielded threshold estimates compatible with zero dose (*i.e.*, no dose threshold).

SC 1-25 concluded that there was sufficient epidemiologic evidence consistent with the LNT model to continue to recommend it as a practical and prudent guide for radiation protection purposes. Ultimately, however, it will be necessary to base judgments on the complementary epidemiologic and animal LD/LDR data and to understand the causal and protective mechanisms for radiogenic cancer.

Fostering Innovations

Kimberly E. Applegate & Donald L. Miller, *Session Co-Chairs*

10:15 am

Medical Physics 3.0 to Ensure Quality and Safety in Radiation Medicine

Ehsan Samei
Duke University / American Association of Physicists in Medicine

Radiation protection in medicine is only a component of the broader calling of healthcare professionals: fostering human health. As such, radiation risk needs to be put into context of the broader mandate of improved outcome in healthcare. Medical physicists play a significant role to contribute to this mandate. Facing the new realities of value-based, personalized, and evidence-based practice, Medical Physics 3.0 defines a standard to engage proactively and meaningfully in patient care. This exhibits itself in physicists engaged to ensure precise and optimized use of radiation. Optimization takes place knowing the defining attributes of the technology in use, the specifics of the patient, and the goals of the intervention. Safety as well as the quality of the procedure is ascertained quantitatively and optimized prospectively, ensuring that the proper balance between quality and safety offers the maximum potential benefit to the patient. The results of the procedures across the healthcare operation are then retrospectively analyzed to ensure that each procedure, in actuality, has delivered the targeted quality and safety objectives. Characterizing quality and safety in quantitative terms, objectively optimizing them in the practice of the personalized care, and analyzing the results from clinical operations are unique expertise of precision and innovation that physicists bring to the development and practice of medicine.