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Guest Editorial
Radiation Dosimetry and Exposure in Nuclear Medicine

This issue of *Seminars in Nuclear Medicine* presents an overview of the state-of-the-art in radiation dose assessment (also sometimes referred to as "dosimetry") in nuclear medicine, its relevance to radiobiology, the observed effects of radiation doses received, and information about radiation exposures received from these procedures as currently practiced. We are joined in this effort by several of the most learned professionals and leaders in several important fields of study. We believe that the information provided by these authors will be of frequent use to the scientific community, as the works are broad in scope and touch on many topics of clinical relevance to this practice. Radiation dose assessment is now rapidly growing in importance to the practice of therapy with radionuclides, and there is a constant need for refinement of techniques and regular updating of our knowledge base regarding data gathering methods, means of interpreting the data, and how to relate calculated dose values to observed and predicted biological effects. The practice of dose assessment for radiopharmaceutical therapy is not as mature as that for external radiation therapy, but is growing rapidly and catching up, as is clear from the material in many of the excellent contributions in this issue.

After an overview of basic methods and models that are routinely used for internal dose calculations, including brief discussions of current experience with several types of therapeutic agents, other authors provide treatment of specialized topics in the field. Dr. George Sgouros and colleagues of Johns Hopkins University provide a summary of the newest models and methods in dose calculations based on individualized, image-based methods for data acquisition. Such three-dimensional, patient-specific methods will lead to increased experience with accurate dose calculations, with sophistication similar to that achieved in external radiation therapy. They give an overview of the state of the practice in many centers, and then give substantial detail and several examples of the exciting progress they have achieved at their institution in several collaborative efforts. They also note the important link between the calculation of physical quantities and biological response, and describe the current thinking on how to calculate dose quantities that can be best related to human response to radiation. Vicini and coworkers provide an in-depth review of the history and current practice of kinetic modeling methods, as applied to internal dose calculations. The history of the development of tracer and compartment models is supplemented with explanation of several important examples of biokinetic models that describe systems important to radiopharmaceutical dynamics. Some special models and tools of particular interest to this area of science are also described.

Dr. Ruby Meredith and colleagues and Dr. Amin Kassis then provide detailed discussions of the current state of knowledge regarding observed radiation toxicity and tolerance dosing, and radiation biology in nuclear medicine, respectively. Meredith and coworkers briefly review the theoretical basis of dose/response models, and then provide an extensive review of the current experience with radionuclide therapy and its relation to current knowledge regarding externally delivered radiation, including a discussion of the associated uncertainties. Dr. Kassis reviews the nature of the different forms of radiation employed in radiopharmaceutical therapy and provides an insightful summary of the vast literature base that defines our current knowledge of this complex and difficult area. He also describes clinical experience with a number of specific agents and the knowledge gleaned about radiobiological principles from this experience. Dr. John Roeske and colleagues then describe the state-of-the-art in the methods for calculating dose at the tissue and cellular levels, which is essential to understanding the biological responses described by the other authors herein. They relate so-called "small scale" dose calculation methods to the more routine organ dose methods, and show several example calculations. They describe both analytical and Monte Carlo–based approaches to these calculations for beta-emitters in homogeneous or heterogeneous media, and also review "microdosimetric" methods for very short-range emitters, such as alpha particles and specific methods for calculations with Auger electron emitters.

Dr. Fred Mettler and colleagues then provide a summary of documented nuclear medicine exposure in the United States between 2005 and 2007, describing the number of procedures and collective and average per capita doses. Standard

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doses for many radiopharmaceuticals are provided, combined with reported statistics from the nuclear medicine community regarding the frequency of studies in many regions. The reported data are evaluated in the context of the changes observed over the past few decades, to provide a historical perspective. Dr. Henry Royal then reviews the extensive literature regarding the relation of radiation dose in general to radiation effects, particularly in the "low dose" area where uncertainty is highest and controversy continues. Epidemiological, medical, occupational, and environmental studies in the literature are reviewed and related to current knowledge in this area. Cancer risk models and basic radiobiological principles are reviewed and related to medical radiation exposures.

The experience and expertise of these authors is impressive, as is the sheer volume of literature that each has reviewed in bringing this special issue to print. It is exciting to have all of this information in a single place, and it should be referenced frequently by the scientific community for many years.

Michael G. Stabin, PhD, CHP
A. Bertrand Brill, MD, PhD
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