

**Committee on Medical Internal Radiation Dose (MIRD)**

**Committee Report**

To the SNMMI Board of Directors

# May 2018

The MIRD Committee advances nuclear medicine and radionuclide therapy by developing standard methods, models, assumptions, and mathematical schema for assessing internal radiation doses from administered radiopharmaceuticals.

Committee Charges for 2017-2018:

1. Develop and improve a standardized framework and methodology for calculating internal radiation dose quantities in nuclear medicine.
2. Compile, evaluate and disseminate data needed to implement standardized internal dosimetry methods, including radionuclide decay properties and emissions, energy absorbed fractions, and anatomic models.
3. Collect and assess experimental and peer-reviewed data to prepare and publish dose estimate reports for selected new radiopharmaceuticals that significantly impact the current practice of nuclear medicine.
4. Provide peer-reviewed evaluations of proposed new dosimetry models and methods, including correlations of radiation dose with biological response for cellular, animal, and human clinical trials data.
5. Address other critical and timely dosimetry issues that may impact the current practice of nuclear medicine.
6. Develop, test, and publish computational software and internet tools that implement MIRD models and techniques for calculating internal radiation dose, including dose-response data, the biological effective dose, and equivalent dose quantities.
7. Work actively with other national and international scientific organizations and scientific committees through joint meetings and symposia to establish uniformity in dosimetry models, techniques, named special quantities, and units of dose, and biological response.

Committee Membership for 2016-2017

George Sgouros, Ph.D., Chair (Johns Hopkins Medical Institutions)

Rachael M. Bartlett, Ph.D. (NYU School of Medicine)

Wesley E. Bolch, Ph.D. (University of Florida)

A. Bertrand (Randy) Brill, M.D., Ph.D. (Vanderbilt University School of Medicine)

Yuni K. Dewaraja, Ph.D. (University of Michigan)

Frederic H. Fahey, D.Sc. (Children’s Hospital Boston and Harvard Medical School)

Darrell R. Fisher, Ph.D. (Versant Medical Physics and Radiation Safety)

Robert F. Hobbs, Ph.D. (Johns Hopkins Medical Institutions)

Roger W. Howell, Ph.D. (Rutgers New Jersey Medical School)

Ruby Meredith M.D., Ph.D. (University of Alabama Medical Center)

Pat Zanzonico, Ph.D. (Memorial Sloan-Kettering Cancer Center)

*Committee members represent a diverse demographics and balanced set of experience and skills needed to effectively accomplish assigned Committee charges, working goals, and objectives*

**Current Working Goals and Objectives (Referencing the SNMMI Strategic Plan):**

* Continue to develop and publish, for the nuclear medicine community, appropriate scientific methods for calculating internal radiation doses from diagnostic and therapeutic radiopharmaceuticals (Core Purpose; Core Values; Goal A to Advance Development and Approval of Nuclear Medicine; Goal C to Increase Use of Radionuclide Therapy; Goal D to Advance Quality, Value, and Safety of Nuclear Medicine; Goal E to Support the Professional Workforce).
* Compile and disseminate supporting data needed to implement such methods, such as radionuclide decay properties and emissions, energy absorbed fractions, and anatomic models (Goal A to Advance Development and Approval of Nuclear Medicine).
* Develop and publish software tools that implement MIRD calculations and models (Goal D to Advance Quality, Value, Safety of Nuclear Medicine; disseminate information on dose optimization; launch web-based dose calculators).
* Assess and publish dosimetry for new radiopharmaceuticals (Goal A to Advance Development and approval of Nuclear Medicine; Goal C to Increase Use of Radionuclide Therapy).
* Develop methods for correlating dose with response to evaluate the relevance of factors, in addition to absorbed dose, that influence biological response from internal emitters (Vision to Unify, Advance, and Optimize Nuclear Medicine and Radionuclide Therapy; Goal A to Advance Development and Approval of Nuclear Medicine; risk to benefit ratio of new radiotracers; disseminate positions and papers; publish pamphlets related to alpha emitters; standardized monographs).
* Address other critical and timely dosimetry issues that may impact the practice of nuclear medicine (Goal E to Support and Enhance the Professional Workforce; Training, Continuing Education, and Best Practices).
* Solicit nominations for the annual Society of Nuclear Medicine and Molecular Imaging Loevinger-Berman Award, named in honor of two founding members of the Medical Internal Radiation Dose Committee; review nominations and elect awardees (Core Values).
* Promote and advance the education of SNMMI members in dosimetry and related areas by organizing Continuing Educations sessions at the annual SNMMI meetings (Goal E to Support and Enhance the Professional Workforce).

**Additional Goals/Objectives Added for 2017-2018:**

1. Update and publish the popular *MIRD Primer on Absorbed Dose Calculations* as a substantially revised new edition.
2. Continue the series on SPECT Quantitative Imaging for Dosimetry. The next publication in this series will pertain to Y-90 quantification using SPECT; a new MIRD pamphlet on this topic is being prepared in partnership with European Association of Nuclear Medicine Dosimetry Committee.
3. In conjunction with SNMMI Dose Optimization Task Force, provide information and guidance on radiation dose optimization in nuclear medicine to imaging professionals, referring physicians, and the public.
4. Provide timely support to the Society on federal regulatory issues, including licensing guidance, training and education requirements for authorized users, critical organ and tissue dose limits, patient release criteria, regulatory compliance, and related scientific matters such as linearity of radiation dose-response relationships.

**Progress of Charge/Objectives/Goal to Date:**

1. 2017 Annual Meeting (Denver): The MIRD Committee selected the Loevinger-Berman Award recipient, Dr. Michael Lassmann, who leads the physics group in the Department of Nuclear Medicine at the University of Würzburg in Würzburg, Germany. The Loevinger-Berman award was presented during a special technical session organized by the MIRD Committee at the Annual Meeting on “Advances in Internal Dosimetry, International Standards, and Future Directions.”
2. The primary focus of the MIRD Committee during 2017 through 2018 has been rewriting and updating the *MIRD Primer on Absorbed Dose Calculations*. The currently available *Primer* has been a well-received and popular volume among nuclear medicine practitioners, students, and medical physicists. Since the *Primer* is more than 20 years old, the new *Primer* will provide updated content covering recent developments and newest approaches for medical internal radiation dosimetry. The new *Primer* will contain updated equations, mathematical notation, definition of terms, methods for data acquisition, analyzing imaging data, fitting imaging data to mathematical functions, radiation effects and radiobiological implications, and reviews of current software for performing Monte Carlo simulations and implementing the MIRD schema. The Committee worked on the *Primer* during one face-to-face meeting (Baltimore, March 2018) and during weekly telephone conferences throughout much of 2017 and 2018.
3. A special subcommittee has been developing a spreadsheet-based *MIRD-Calc* tool for internal dosimetry. Lead authors include Adam Kesner and Pat Zanonico of Memorial Sloan-Kettering Cancer Center, and Wes Bolch at the University of Forida. Features of *MIRD-Calc* will be presented at the 2018 SNMMI annual meeting in Philadelphia.
4. Darrell Fisher and Fred Fahey prepared and published a special review on “Appropriate Use of Effective Dose in Radiation Protection and Risk Assessment” that was published in the journal *Health Physics* (Health Phys. 113(2):102-109; 2017).
5. Plans were developed for the 2018 SNMMI annual meeting in Philadelphia: Recipient of the 2018 Loevinger-Berman Award will be Dr. Barry Wessels, a medical physicist at Case Western Reserve University in Cleveland, Ohio. The Committee also organized a Continuing Education session on Radionuclide Dosimetry, highlighting recent Committee work updating the MIRD Primer. Invited speakers will include: Dr. George Sgouros, Dr. Darrell Fisher, Dr. Yuni Dewaraja, Dr. Roger Howell, Dr. Wes Bolch, Dr. Pat Zonzonico, Dr. Ruby Meredith, Dr. Fred Fahey, Dr. Robert Hobbs, and Dr. Jonathan Gear.
6. Continuing the MIRD Committee international collaboration on improved methods for implementation of dosimetry based on SPECT/CT imaging, Yuni Dewaraja and others published a new report on “Improved Quantitative 90Y Bremsstrahlung SPECT/CT Reconstruction with Monte Carlo Scatter Modeling” in the journal *Medical Physics* (Dewaraja YK, Chun SY, Srinivasa RN, Kaza RK, Cuneo KC, Majdalany BS, Novelli PM, Ljungberg M, Fessler JA, *Med* *Phys*. 2017 Dec;44(12):6364-6376.).
7. As follow-up to publication of M MIRD Pamphlet No. 22: Radiobiology and Dosimetry of Alpha-particle Emitters for Targeted Radionuclide therapy, George Sgouros and Robert Hobbs published a timely review on “Dosimetry and Radiobiology of Alpha-Particle Emitting Radionuclides in the journal *Current Radiopharmaceuticals* (Sgouros G, Hobbs R, Josefsson A, *Curr Radiopharm*. 2018 Apr 26).
8. Several MIRD committee members have been active in international standards and scientific committees and regulatory agencies to transfer MIRD knowledge, recommendations, and work product to national and international standards:
   1. ICRP Committees and Task Groups - Wes Bolch and Darrell Fisher
   2. NCRP - Pat Zanzonico, Darrell Fisher, Wes Bolch, George Sgouros, Roger Howell
   3. Nuclear Regulatory Commission’s Advisory Committee on the Medical Uses of Isotopes (ACMUI) - Pat Zanonico
   4. ICRU Commission and Report Committees - Roger Howell, George Sgouros, Wes Bolch, Yuni Dewaraja.
   5. IAEA Report Committees – Yuni Dewaraja, George Sgouros
   6. Nuclear Regulatory Commission (NRC)’s Advisory Committee on Medical Uses of Isotopes (ACMUI) – Pat Zanzonico (Nuclear Medicine Physicist member and Vice Chair)
   7. 2018 NIH Targeted Radiopharmaceutical Therapy Workshop – George Sgouros, Wes Bolch, Yuni Dewaraja, Pat Zanzonico, Roger Howell

**APPENDIX – CURRENT MIRD TASK GROUPS**

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| **Task Group** | **Title** | **Chair** |
| TG1 | Quantitative tools for benefit/risk optimization in medical imaging  Draft pamphlet to be discussed at November meetings | Bolch |
| TG2 | Hybrid phantoms and skeletal models | Bolch |
| TG3 | Quantitative imaging for dosimetry calculations; Pamphlet 23 is published; Pamphlet 24 on I-131 has been published; Lu-177 with the dosimetry task force of EANM has been published by JNM. | Dewaraja |
| TG5 | Cellular and multicellular radiobiology and dose modeling  Recent expansion to two and 3-D cellular arrays since the Miami meeting. Pamphlet 25 has been published | Howell |
| TG6 | Influence of blocking agents on dosimetry of I-131-radionuclide conjugates; protocol for IRB approval in place; and multi-institutional recruitment for data sharing  is on-going | Meredith |
| TG7 | Radiobiological reference human  Received supplementary funding from NIH to hire an informationist with additional support from a Sgouros grant | Sgouros |
| TG9 | Clinical dosimetry for bone pain palliation agents  Waiting on funding from IAEA; animal protocols in place | Zanzonico |
| TG10 | Patient-to-family member and member of general public dosimetry as the basis for patient-release criteria | Zanzonico |
| TG11 | Regional and interstitial therapies | Zanzonico |
| TG12 | Voxel S values and Web-Based Generator Tool  Software completed, pamphlet being circulated | Bolch |
| TG13 | Revision of the MIRD Primer and other education materials  Launching effort to create Self-Assessment Module (SAM) for dosimetry and update to MIRD primer | Sgouros |