Cardiac PET and PET/CT Imaging
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Editors

Marcelo F. Di Carli, MD
Chief of Nuclear Medicine, Co-Director of Cardiovascular Imaging, Brigham and Women’s Hospital, Associate Professor of Radiology and Medicine, Harvard Medical School, Boston, Massachusetts, USA

Martin J. Lipton, MD, FACR, FACC
Director of Education, Non-Invasive Imaging, Brigham and Women’s Hospital, Professor of Radiology, Department of Radiology, Harvard Medical School, Boston, Massachusetts, USA
This textbook is dedicated to our families:

Maritxu, Gilda, and Milena Di Carli
and
Jacquelyn and Sam Lipton
When the history of medicine in the latter half of the twentieth century is written, the advances in cardiovascular diagnosis, therapy, and prevention will stand out as one of the most important achievements. Although the age-corrected death rate secondary to coronary artery disease has declined substantially in industrialized nations during this period, the prevalence of these conditions remains stubbornly high because of the aging of the population. Importantly, the incidence of coronary events and of one of their most important sequela—heart failure—is rising alarmingly in the developing world. When viewed from a global perspective, cardiovascular disease is assuming a progressively greater importance, and it is estimated that by 2025 it will be, for the first time in human history, the most common cause of death.

Clearly, rather than resting on the laurels of our achievements, an intensification of the battle against cardiovascular disease must now be undertaken. Cardiovascular imaging will, without question, play a critical role in this battle. The appropriate selection of therapeutic measures, be they pharmacologic, catheter-based, surgical, alterations in lifestyles, or some combination of these, depends on accurate assessments of both cardiac structure and function. Increasingly, the changes that dictate management are quite subtle and require a level of precision that was not available to clinicians heretofore. Positron emission tomography (PET), especially when combined with contemporary techniques of computed tomography (CT), allows virtually simultaneous assessment of cardiac and coronary arterial structure together with myocardial perfusion and metabolism. The combination of these noninvasive approaches provides information that is an order of magnitude greater than that obtained previously.

As these new technologies move rapidly from the research laboratory to clinical practice, it is vital to train cardiologists, radiologists, and specialists in nuclear medicine in their appropriate use. To achieve this important goal, Drs. Di Carli and Lipton and their talented contributing authors have provided in *Cardiac PET and PET/CT Imaging* a most valuable resource for this training. In addition to summarizing—in a manner understandable by clinicians—the theoretical underpinnings and instrumentation of these techniques, they lay out clearly the array of clinical situations in which these two imaging modes, as well as cardiac magnetic resonance imaging, provide information that is of enormous value for clinical management. This remarkable book also has a keen eye on the future. Advances in molecular imaging, which will certainly find its way into practice in the second decade of the twenty-first century, are also discussed lucidly and are well illustrated.
The editors, Drs. Di Carli and Lipton, and the contributing authors deserve thanks and congratulations for providing this important new textbook. It will be appreciated by trainees, clinicians, and investigators in this field.

*Eugene Braunwald, MD*

Harvard Medical School

Brigham and Women’s Hospital

Boston, Massachusetts, USA
The field of cardiovascular imaging in general, and cardiovascular nuclear medicine in particular, is witnessing dramatic change, especially with emerging new technology such as positron emission tomography/computed tomography (PET/CT). Relatively recent FDA approval of PET radiopharmaceuticals and changes in reimbursement in oncology and, more recently, in cardiology continue to fuel exponential growth in the deployment of integrated PET/CT cameras, especially throughout the United States, Europe, and Asia (Japan and Korea). As a result, clinical PET and PET/CT imaging are no longer the domain of university hospitals. This is the good news. The bad news is that there is now an enormous gap between the growth of these technologies for diagnosis and management of patients with heart disease and the limited knowledge base obtained by cardiologists, nuclear medicine specialists, and radiologists lacking clinical experience in performing and interpreting these procedures. This gap is self-evident in cardiac PET and PET/CT imaging. Although currently only a handful of teaching programs offer specialized training in cardiac PET and PET/CT, the number of these programs is expected to grow fairly rapidly.

The books on PET and, more recently, PET/CT are almost exclusively dedicated to imaging applications in oncology. In those textbooks, cardiac imaging is narrowly focused on myocardial perfusion and viability from a highly research-oriented perspective. Those isolated chapters are designed only to illustrate the possible applications of PET and PET/CT in cardiology and not to provide the trainee or imaging specialist with a systematic approach to the complexities of cardiac imaging.

*Cardiac PET and PET/CT Imaging* is intended to narrow the gap between technology and the practical clinical knowledge base. The goal of this book is to educate, stimulate, and serve as a resource to cardiology, radiology, and nuclear medicine trainees, as well as imaging and medical specialists, with the most up-to-date information regarding the current practice for cardiac PET and integrated PET/CT, including the advanced applications of CT coronary angiography. To this end, we have assembled a multidisciplinary group of clinical and imaging experts from cardiology, radiology, and nuclear medicine to provide a systematic, practical, and in-depth approach to imaging with PET and CT, as well as correlative imaging with magnetic resonance imaging (MRI). We hope that the thoughtful and forward-thinking conception of this text, with its 40 tables and 234 figures, will allow its content to remain current even in an era of rapid technical and scientific evolution.

Part I includes the general principles of cardiac imaging and instrumentation with chapters on PET, CT, and integrated PET/CT. In addition, this section also includes a chapter on the principles of quantification and tracer kinetic modeling with PET.
Part II includes comprehensive reviews on PET radiopharmaceuticals for cardiac imaging and iodinated contrast agents for CT angiography. It also contains unique chapters on cross-sectional anatomy of the heart and vessels and on the increasingly important issue of patient and occupational radiation dosimetry.

Part III is devoted entirely to the diagnosis of coronary artery disease, which accounts for the vast majority of heart disease in developed countries. The chapters include comprehensive reviews on patient preparation and stress protocols for perfusion imaging, myocardial perfusion imaging protocols and quality assurance, myocardial perfusion imaging with PET, and the use of quantitative myocardial perfusion imaging for evaluating coronary artery disease. This section also contains comprehensive reviews on the use of contrast and noncontrast CT for diagnosing coronary disease, a critical review of the relative merits of coronary imaging with CT and MRI, and the integration of myocardial perfusion and coronary anatomy for diagnosis and management of coronary artery disease (CAD).

Heart failure has emerged as one of the most important problems in cardiology, and imaging plays a key role in diagnosis and treatment planning. Part IV includes chapters on the principles of myocardial metabolism, evaluation of myocardial viability with PET and with MRI, a critical review of the role of imaging in evaluating ischemia and viability in diagnosis and management of heart failure, and the emerging role of imaging of cardiac innervation and receptors in heart failure.

Part V provides a forward look at the emerging role of molecular imaging in cardiology. It includes comprehensive reviews on imaging of the vulnerable plaque with PET/CT and MRI, imaging of gene products and cell therapy, and imaging of angiogenesis.

Part VI includes a library of cardiac PET/CT cases illustrating a broad spectrum of common clinical scenarios from identification of normal scans and recognition of artifacts to identification of high-risk scans, assessment of myocardial viability, integration of perfusion and coronary anatomy, and the importance of recognizing incidental findings.

We are thankful for the skilled assistance of Jeselle Gierbolini. We would also like to acknowledge the dedication and help of our technical staff in nuclear medicine, CT, and MRI. We are also grateful for the expert editorial assistance of our development editor, Merry Post, who has tolerated our frequent requests for changes that we believe made the book even better. Finally, we would also like to acknowledge our Radiology Department chair at Brigham and Women’s Hospital, Steven Seltzer, for his unflagging support of innovation in imaging and his encouragement to write this textbook.

Marcelo F. Di Carli, MD
Martin J. Lipton, MD, FACR, FACC
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Contributors

Frank M. Bengel, MD
Director of Cardiovascular Nuclear Medicine, Visiting Associate Professor of Radiology, Johns Hopkins University Medical Institution, Baltimore, MD, USA

Myrwood C. Besozzi, MD
Clinical Professor of Medicine, University of Tennessee Medical Center, Knoxville Cardiovascular Group, PC, Knoxville, TN, USA

Lawrence M. Boxt, MD
Professor of Clinical Radiology, Albert Einstein College of Medicine of Yeshiva University, Director of Cardiac MRI and CT, North Shore University Hospital, Manhasset, NY, USA

Douglas P. Boyd, PhD
Adjunct Professor of Radiology, Heartscan Headquarters, University of California at San Francisco, Walnut Creek, CA, USA

Javed Butler, MD, MPH
Associate Professor of Medicine, Cardiology Division, Emory University, Atlanta, GA, USA

Jonathan P.J. Carney, PhD
Assistant Professor of Radiology, University of Pittsburgh Medical Center, Pittsburgh, PA, USA

Frank P. Castronovo, Jr., RPh, PhD
Director of Health Physics and Radiopharmacology, Associate Professor of Radiology, Brigham and Women’s Hospital, Harvard Medical School, Boston, MA, USA

Sharon E. Crugnale, MS, RCEP
Section Head, Exercise Physiology, Division of Nuclear Medicine, Brigham and Women’s Hospital, Harvard Medical School, Boston, MA, USA

Zelmira Curillova, MD
Fellow in Cardiovascular Imaging, Brigham and Women’s Hospital, Harvard Medical School, Boston, MA, USA
Santo Dellegrottaglie, MD
Instructor of Medicine (adjunct), Cardiovascular CT/MRI Program, The Zena and Michael A. Wiener Cardiovascular Institute, The Marie-Josée and Henry R. Kravis Cardiovascular Health Center, Mount Sinai School of Medicine, New York, NY, USA

Marcelo F. Di Carli, MD
Chief of Nuclear Medicine, Co-Director of Cardiovascular Imaging, Brigham and Women’s Hospital, Associate Professor of Radiology and Medicine, Harvard Medical School, Boston, MA, USA

Frank P. DiFilippo, PhD
Director of Nuclear Imaging Physics, Department of Molecular and Functional Imaging, Cleveland Clinic Foundation, Cleveland, OH, USA

Vasken Dilsizian, MD
Professor of Medicine and Radiology, University of Maryland School of Medicine, Director, Cardiovascular Nuclear Medicine and Cardiac Positron Emission Tomography, University of Maryland Medical Center, Baltimore, MD, USA

Lawrence W. Dobrucki, PhD
Post-Doctoral Research Fellow, Section of Cardiovascular Medicine, Yale University School of Medicine, New Haven, CT, USA

Sharmila Dorbala, MD
Associate Director of Nuclear Cardiology, Brigham and Women’s Hospital, Instructor in Radiology and Medicine, Harvard Medical School, Boston, MA, USA

Georges El Fakhri, PhD
Associate Professor of Radiology, Harvard Medical School, Physicist, Nuclear Medicine Division, Brigham and Women’s Hospital, Boston, MA, USA

Zahi A. Fayad, PhD
Director, Imaging Science Laboratories, Director, The Eva and Morris Feld Cardiovascular Research Laboratory, Professor, Departments of Radiology and Medicine (Cardiology), The Zena and Michael A. Wiener Cardiovascular Institute, The Marie-Josée and Henry R. Kravis Cardiovascular Health Center, Mount Sinai School of Medicine, New York, NY, USA

John Finley IV, MD
Instructor in Medicine, Tufts-New England Medical Center, Tufts University School of Medicine, Boston, MA, USA

Valentin Fuster, MD, PhD
Director of the Zena and Michael A. Wiener Cardiovascular Institute, Director of the Marie-Josée and Henry R. Kravis Cardiovascular Health Center, Richard Gorlin, MD/Heart Research Foundation Professor of Medicine, Mount Sinai School of Medicine, New York, NY, USA

Robert J. Gropler, MD
Professor of Radiology, Medicine, and Biomedical Engineering, Lab Chief, Cardiovascular Imaging Laboratory, Mallinckrodt Institute of Radiology, Washington University School of Medicine, St. Louis, MO, USA

Takahiro Higuchi, MD
Research Fellow, Nuklearmedizinische Klinik der Technischen Universität München, Munich, Germany
Udo Hoffmann, MD  
Co-Director MGH Cardiac MRCT PET Program, Massachusetts General Hospital, Assistant Professor of Radiology, Harvard Medical School, Boston, MA, USA

Fabien Hyafil, MD  
Research Fellow, Imaging Science Laboratories, Departments of Radiology and Medicine (Cardiology), The Zena and Michael A. Wiener Cardiac Health Institute, The Marie-Josée and Henry R. Kravis Cardiac and Vascular Health Center, Mount Sinai School of Medicine, New York, NY, USA

Raymond Y. Kwong, MD, MPH  
Co-Director of Cardiac CT and MRI, Instructor in Medicine and Radiology, Brigham and Women's Hospital, Harvard Medical School, Boston, MA, USA

Martin J. Lipton, MD, FACR, FACC  
Director of Education, Non-Invasive Imaging, Brigham and Women's Hospital, Professor of Radiology, Department of Radiology, Harvard Medical School, Boston, MA, USA

Josef Machac, MD  
Director of Nuclear Medicine, Professor of Radiology and Associate Professor of Medicine, Mount Sinai School of Medicine, New York, NY, USA

Warren J. Manning, MD  
Chief of Non-Invasive Cardiac Imaging (Cardiology), Beth Israel Deaconess Medical Center, Professor of Medicine and Radiology, Harvard Medical School, Boston, MA, USA

Stephen C. Moore, PhD  
Director of Nuclear Medicine Physics, Associate Professor of Radiology, Brigham and Women's Hospital, Harvard Medical School, Boston, MA, USA

Koenraad J. Mortele, MD  
Associate Professor of Radiology, Harvard Medical School, Associate Director, Division of Abdominal Imaging and Intervention, Director, Abdominal and Pelvic MRI, Director, CME Department of Radiology, Brigham and Women's Hospital, Boston, MA, USA

M. Raquel Oliva, MD  
Fellow in Radiology, Brigham and Women's Hospital, Harvard Medical School, Boston, MA, USA

John A. Rumberger, MD  
Medical Director, HealthWISE Wellness Diagnostic Center, Clinical Professor of Medicine, Ohio State University, Columbus, OH, USA

Javier Sanz, MD  
Assistant Professor of Medicine/Cardiology, Clinical MRI/CT Program, Cardiovascular Institute, Mount Sinai Hospital, New York, NY, USA

Heinrich R. Schelbert, MD, PhD  
George V. Taplin Professor, Department of Molecular and Medical Pharmacology, David Geffen School of Medicine at UCLA, Los Angeles, CA, USA
A. Robert Schleipman, RT, CNMT, MSc
Instructor, Health Physics and Radiopharmacology, Brigham and Women’s Hospital, Boston, MA, USA

Markus Schwaiger, MD, PhD
Professor of Nuclear Medicine, Director, Nuklearmedizinische Klinik der Technischen Universität München, Munich, Germany

Ahmad Y. Sheikh, MD
Research Fellow, Department of Cardiothoracic Surgery, Stanford University Medical Center, Stanford, CA, USA

Albert J. Sinusas, MD
Professor of Medicine and Diagnostic Radiology, Director, Animal Research Laboratories, Section of Cardiovascular Medicine, Director, Cardiovascular Nuclear Imaging and Stress Laboratories, Yale University School of Medicine, Yale New Haven Hospital, New Haven, CT, USA

Ahmed A. Tawakol, MD
Co-Director, Cardiac MR-PET-CT Program, Co-Director, CIMIT Cardiovascular Disease Program, Instructor in Medicine, Harvard Medical School and Massachusetts General Hospital, Boston, MA, USA

David W. Townsend, PhD
Professor of Medicine and Radiology, Director, Cancer Imaging and Tracer Development Research Program, University of Tennessee, Graduate School of Medicine, Knoxville, TN, USA

James E. Udelson, MD
Associate Chief, Division of Cardiology, Director, Nuclear Cardiology Laboratory, Co-Director, Heart Failure and Transplant Center, Tufts-New England Medical Center, Associate Professor of Medicine, Tufts University School of Medicine, Boston, MA, USA

Joseph C. Wu, MD, PhD
Assistant Professor in Medicine and Radiology, Stanford University, Stanford, CA, USA