
Preface

Over the past three decades, nuclear cardiology has evolved from a research tool into a well-established clinical discipline. Approximately nine million nuclear cardiology procedures are performed annually in the United States. The field has excelled in the noninvasive evaluation and quantification of myocardial perfusion, function, metabolism, and innervation. Unlike anatomically oriented approaches to diagnostic medicine, the strengths of nuclear techniques are based on physiologic, biochemical, and molecular properties. The ability to define myocardial perfusion, viability, and ventricular function from a single study has become a powerful diagnostic and prognostic tool. As a result of its important contribution to the management and care of cardiac patients, nuclear cardiology is now recognized as a distinct clinical entity.

Nuclear cardiology first originated as a discipline in the early 1970s. A major breakthrough in the field came with the development of myocardial perfusion radiotracers, such as ^{201}Tl , which permitted noninvasive detection and physiologic characterization of anatomic coronary artery lesions. First-pass and equilibrium radionuclide angiography allowed for the noninvasive assessment of regional and global left ventricular function. The field blossomed further with incorporation of the concepts of exercise physiology, demand-supply mismatch, coronary vasodilator reserve, and systolic and diastolic left ventricular dysfunction in nuclear testing. Pharmacologic vasodilators, such as dipyridamole, adenosine, and the more recent introduction of the selective A_{2A} receptor agonist regadenoson, widened the application of myocardial perfusion studies to patients who were unable to exercise, had uncomplicated acute coronary syndromes, or were undergoing intermediate- to high-risk noncardiac surgical procedures. Subsequently, the field advances from detection of coronary artery disease to risk stratification and prognosis. As such, nuclear cardiology procedures have become the cornerstone of the decision-making process to appropriately select patients for medical or interventional therapy, as well as monitoring the effectiveness of that therapy.

Parallel advances in both radiopharmaceuticals and instrumentation have further fostered the growth of nuclear cardiology. The introduction of ^{99m}Tc -labeled perfusion tracers in the 1990s improved the count rate and image quality of myocardial perfusion studies, which allowed for electrocardiogram-gated acquisition and simultaneous assessment of regional myocardial perfusion and function with a single radiotracer. Because ^{99m}Tc -labeled perfusion tracers demonstrate minimal redistribution over time after injection, they have been used in the emergency room and in the early hours of an infarct to estimate the extent of myocardium in jeopardy. A follow-up study, performed several days later, provides information on final infarct size and myocardial salvage. PET has broadened the scope of the cardiac examination from perfusion and function alone to assessment of metabolic substrate utilization, cardiac receptor occupancy, and adrenergic neuronal function. By allowing the quantification of blood flow in absolute terms, PET has led to a better understanding of the physiologic mechanisms underlying cardiovascular diseases beyond discrete epicardial coronary artery disease, such as coronary vasomotor function in the early stages of coronary atherosclerosis development, hypertrophic cardiomyopathy, and dilated nonischemic cardiomyopathy. The ability to image the shift in the primary source of myocardial energy production from fatty acids toward glucose utilization in the setting of reduced blood flow has helped explain the pathophysiology of

hibernation and myocardial viability, as well as management of patients with chronic ischemic left ventricular dysfunction and heart failure for the assessment of myocardial viability. Targeted molecular imaging and image-guided therapy will further improve the management of heart disease by identifying patients for whom the response to medical therapy would be optimal, or perhaps not beneficial at all, as we move closer to personalized medicine.

The aim of the fourth edition of the *Atlas of Nuclear Cardiology* is to elucidate the role of cardiovascular nuclear procedures in the clinical practice of cardiology. Diagnostic algorithms and schematic diagrams integrated with nuclear cardiology procedures are generously interspersed with color illustrations to emphasize key concepts in cardiovascular physiology, pathology, metabolism, and innervation. In the first chapter, the principles of nuclear cardiology imaging along with an introduction to instrumentation and image acquisition are presented. The next three chapters (Chaps. 2, 3, and 4) detail SPECT and PET radiopharmaceuticals, hybrid SPECT/CT and PET/CT imaging techniques, and physiologic and pharmacologic stressors for the detection of coronary artery disease. In Chap. 5, the potential benefits of quantitative approaches that measure myocardial blood flow and its changes in response to interventions are presented in absolute and relative terms. In Chap. 6, the techniques of first-pass and equilibrium radionuclide angiography and gated myocardial perfusion SPECT are reviewed for assessment of cardiac function. Chapter 7 details current evidence for the use of myocardial perfusion imaging for risk stratification in patients with chronic coronary artery disease; in special populations such as women, diabetics, the elderly, and patients of diverse ethnicity; and for identifying survival benefits with revascularization versus medical therapy. The next two chapters (Chaps. 8 and 9) focus on the role of imaging cardiac metabolism in identifying ischemic and viable myocardium as well as new neurohumoral targets for prevention of heart failure and left ventricular remodeling. Chapter 10 addresses the role of cardiac imaging in the diagnosis and risk stratification of patients suffering from acute coronary syndromes. The last two chapters (Chaps. 11 and 12) examine the latest approaches of radionuclide techniques for the advancement of cardiovascular research: myocardial innervation and molecular imaging of atherosclerosis.

In the next century, innovative imaging strategies in nuclear cardiology will propel the field into molecular imaging and personalized medicine while it continues to build on its already well-defined strengths of myocardial perfusion, function, and metabolism. Realization of these ideas and progress in the diagnosis, treatment, and prevention of cardiovascular disease will depend not only on new discoveries but also on meaningful interaction between clinicians and investigators. It is our hope that the fourth edition of the *Atlas of Nuclear Cardiology* will serve as a foundation for clinicians and a reference guide for scientists within and outside the field.

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