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This article describes advancements in hardware and software for myocardial perfusion imaging that are becoming commercialized today and their implication in clinical practice.

**Cardiac Positron Emission Tomography: Current Clinical Practice** **237**

Lucille Lalonde, Maria Cecilia Ziadi, and Rob Beanlands

In the last two decades, the field of nuclear cardiology has experienced significant progress. The introduction of positron emission tomography (PET) imaging represented a major breakthrough that has significantly contributed to a better understanding of physiology and pathophysiology of several heart diseases. Currently, PET imaging is recognized as a well-established method to assess cardiac perfusion, function, metabolism, and viability. This article summarizes the main clinical applications of state-of-the art cardiac PET technology.

**Hybrid Imaging: Integration of Nuclear Imaging and Cardiac CT** **257**

Marcelo F. Di Carli

The integration of nuclear medicine cameras with multidetector CT scanners provides a unique opportunity to delineate cardiac and vascular anatomic abnormalities and their physiologic consequences in a single setting. By revealing the burden of anatomic coronary artery disease and its physiologic significance, hybrid imaging can provide unique information that may improve noninvasive diagnosis, risk assessment, and management of coronary artery disease. By integrating the detailed anatomic information from CT with the high sensitivity of radionuclide imaging to evaluate targeted molecular and cellular abnormalities, hybrid imaging may play a key role in shaping the future of molecular diagnostics and therapeutics. This article reviews potential clinical applications of hybrid imaging in cardiovascular disease.

**Nuclear Imaging in Heart Failure** **265**

Jeroen J. Bax, Mark M. Boogers, and Joanne D. Schuijf

Heart failure is becoming the main clinical challenge in cardiology in the twenty-first century and is associated with high morbidity and mortality. Currently, several

therapeutic options are available for heart failure patients, including medical therapy, revascularization, advanced cardiac surgery, device therapy, and cardiac transplantation. Future therapies are directed at cell and gene therapy. In this article the role of nuclear imaging in the management of heart failure patients is discussed.

**Quantification of Myocardial Blood Flow: What is the Clinical Role?** **277**

Heinrich R. Schelbert

Quantification of regional myocardial blood flow and of its responses to targeted physiologic and pharmacologic interventions, which is now available with positron emitting tracers of blood flow and positron emission tomography (PET), extends the diagnostic potential of standard myocardial perfusion imaging. These noninvasive flow measurements serve as tools for quantifying functional consequences of epicardial coronary artery disease, as well as of impairments in microcirculatory reactivity that escape detection by standard perfusion imaging. Flow measurements are clinically useful for more comprehensively assessing the extent and severity of coronary vascular disease or impairments in microcirculatory function in noncoronary cardiac disease. Flow estimates in these disorders contain independent or unique prognostic information about future major cardiac events. Flow measurements are also useful for assessing the coronary risk, for predicting long-term cardiovascular events, and for monitoring the effectiveness of risk reduction strategies.

**Translation of Myocardial Metabolic Imaging Concepts into the Clinics** **291**

Adil Bashir and Robert J. Gropler

Flexibility in myocardial substrate metabolism for energy production is fundamental to cardiac health. This loss in plasticity or flexibility leads to overdependence on the metabolism of an individual category of substrates, with the predominance in fatty acid metabolism characteristic of diabetic heart disease and the accelerated glucose use associated with pressure-overload left ventricular hypertrophy being prime examples. There is a strong demand for accurate noninvasive imaging approaches of myocardial substrate metabolism that can facilitate the crosstalk between the bench and the bedside, leading to improved patient management paradigms. In this article potential future applications of metabolic imaging, particularly radionuclide approaches, for assessment of cardiovascular disease are discussed.

**Cardiac Neuronal Imaging at the Edge of Clinical Application** **311**

Mark I. Travin

Cardiac neuronal innervation plays an important role in normal cardiac function and is adversely affected in the presence of disease. In particular, radiotracer imaging of cardiac sympathetic function has been extensively investigated and not only provides a method of assessing the severity of disease but also has repeatedly been shown to be prognostically useful with a potential for helping to guide patient management. SPECT imaging of myocardial uptake of $^{123}$I-*m*IBG, an analog of the sympathetic neurotransmitter norepinephrine, has been the most studied, but PET neurotracers, such as $^{11}$C-HED, are also under investigation. The ability of cardiac neuronal imaging to visualize and measure underlying molecular processes should allow it to provide a perspective on cardiac disease that other testing modalities cannot.

**New Molecular Imaging Targets to Characterize Myocardial Biology** 329

Alan R. Morrison and Albert J. Sinusas

Molecular imaging represents a targeted approach to noninvasively assess biologic (both physiologic and pathologic) processes in vivo. Ideally the goal of molecular imaging is not just to provide diagnostic and prognostic information based on identification of the molecular events associated with a pathologic process but rather to guide individually tailored pharmacologic, cell-based, or genetic therapeutic regimens. This article reviews the recent advances in myocardial molecular imaging in the context of the cardiovascular processes of angiogenesis, apoptosis, inflammation, and ventricular remodeling. The focus is on radiotracer-based single photon emission computed tomography and positron emission tomography molecular imaging approaches.

**Radiotracer Imaging of Atherosclerotic Plaque Biology** 345

Maysoon Elkhawad and James H.F. Rudd

Traditional imaging modalities used in the assessment of atherosclerotic plaque have focused on anatomic characteristics of size, location and luminal encroachment. The ability to identify plaques that are at risk for rupture, and thus may go on to cause clinical events, remains limited, however. By labeling tracer compounds capable of identifying important cellular or molecular processes involved in plaque vulnerability with radioactive isotopes, there is now potential for the noninvasive identification of vulnerable plaques. This article discusses several radiotracers that can report on high-risk plaque pathophysiology.

**Role of Nuclear Imaging in Regenerative Cardiology** 355

Riikka Lautamäki and Frank M. Bengel

Advances in noninvasive imaging techniques may aid in the understanding of cardiac stem cell therapy. Nuclear imaging enables in vivo evaluation of myocardial perfusion, metabolism, and function, in addition to the stem cell fate. This article summarizes recent clinical and experimental nuclear imaging studies in cardiac stem cell therapy.

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