COMMENTARY

Cardiovascular translational imaging: from bench to bedside

MARIO J. GARCIA

BRONX, NY

Over the last 4 decades, heart disease mortality has declined at a rate of 2.5% per year.[1] This remarkable achievement has been attributed primarily to advances in the management of cardiovascular risk factors, the treatment of myocardial infarction and heart failure, and the prevention of sudden cardiac death. Undeniably, cardiac imaging has played a significant role in this decline by leading to the early identification of patients at risk and helping in establishing a rapid, accurate, and complete diagnosis of cardiovascular syndromes. Cardiovascular imaging has also become an important tool for patient selection and evaluation of outcomes in clinical trials. Even though the ultimate proof of efficacy of a new drug, device, or therapeutic strategy is a reduction in mortality and improved quality of life, imaging endpoints, such as improved ventricular function and myocardial perfusion, are easier to identify earlier in smaller trials and usually translate into improved clinical outcomes. Thus, clinical trials with imaging endpoints can accelerate the process substantially and reduce the cost of clinical research by selecting which new therapeutics interventions are most likely to provide improved benefits and reduced risks, prior to conducting large randomized clinical trials with clinical endpoints.

The role of imaging in translational research varies from the bench to the bedside. At the bench, molecular imaging aims to visualize specific biochemical structures or biologic processes that influence disease progression and the response to treatments at the cellular level using ultrasound, single-photon emission computed tomography, positron emission tomography, computed tomography, magnetic resonance imaging, and/or catheter-based optical methods. The field of cardiovascular molecular imaging has advanced rapidly over the last few decades. In 2009, the National Heart, Lung, and Blood Institute (NHLBI) convened a working group of experts in this field to (1) assess the current state of molecular imaging and its application to cardiovascular diseases, (2) identify areas where cardiovascular molecular imaging was likely to have an impact, and (3) explore barriers to the translation of molecular imaging toward clinical application.[2] At the bedside, imaging aims to evaluate the anatomic and functional expression of cardiovascular disease and the impact of therapeutic interventions at the organ and system levels.

In this issue of *Translational Research*, 3 articles describe specific applications of imaging in cardiovascular medicine. In the first article, Inaba and Lindner[3] review novel applications of targeted contrast ultrasound imaging for the evaluation of atherosclerosis, thrombosis, detection of ischemia, necrosis, and neoangiogenesis. Imaging with contrast-enhanced ultrasound relies on the detection of microbubbles that are targeted to specific sites and disease processes. This review provides an overview of the development of target-specific microbubbles, the validation of methods for their detection *in vitro* and *in vivo*, and their application for evaluating the mechanisms of disease progression and response to novel therapeutic agents.

In the second article, Longenecker and Hoit[4] review the role of imaging in the evaluation of atherosclerosis in HIV. With the development of novel antiretroviral agents, the life expectancy of patients with HIV has been extended beyond the point where manifestations of atherosclerosis occur. The dyslipidemia associated to the use of antiretroviral therapy and/or the effects

From the Montefiore-Einstein Center for Heart and Vascular Care, Bronx, NY.

Reprint requests: Mario J. Garcia, MD, FACC, FACP, Montefiore-Einstein Center for Heart and Vascular Care, Cardiology – Silver Zone, 111 East 210th Street, Bronx, NY 10467; e-mail: mariogar@montefiore.org.

1931-5244/$ - see front matter

doi:10.1016/j.trsl.2011.11.006

of chronic immune activation and inflammation are associated with an increased risk of atherosclerosis in this population and a high incidence of cardiovascular events. This review examines the role of measurement of carotid intima-medial thickness by ultrasound, magnetic resonance imaging of the great vessel walls, coronary calcium scoring, and contrast-enhanced computed tomography for the anatomic imaging of the atherosclerotic plaque. It describes also the application of imaging methods for functional assessment, including the measurement of flow-mediated brachial artery dilation, arterial stiffness, myocardial perfusion and metabolism, and atherosclerotic plaque inflammation.

The third article by Burri et al[5] reviews the novel clinical applications of real-time 3-dimensional (3-D) echocardiography. Through technologic advances in the design of ultrasound imaging transducers and the increase in computer processing speed, 3-D visualization of the heart can be obtained at the patient's bedside, providing a complete assessment of chamber volumes and ejection fraction, as well as a detailed anatomic visualization of the cardiac valves, including assessment of stenotic and regurgitant lesions. The authors provide a comprehensive review of the applications of 3-D echocardiography for the functional evaluation of global contractility, regional contractility, and dyssynchrony. The review also investigates the live guidance of complex interventional procedures such as the correction of anatomic defects and the transcatheter implantation of prosthetic valves.

The number of applications of imaging methods in translational cardiovascular research is increasing rapidly. The technologic advances in ultrasound, magnetic resonance imaging, computed tomography, and nuclear scintigraphy, as well as the development of novel targeted contrast agents, provide a vast array of tools for evaluating the mechanisms of disease progression and the cardiovascular response to therapeutic interventions. Imaging methods are fundamental for the understanding of the anatomic and functional aspects in vascular biology, valvular heart disease, and heart failure. These methods are complementary to other fields such as electrophysiology. In this issue of *Translational Research*, we cover only a few of the potential applications of cardiovascular imaging from the bench to the bedside, and many more are left to our imagination.

REFERENCES

1. Jemal A, Ward E, Hao Y, Thun M. Trends in the leading causes of death in the United States, 1970-2002. JAMA 2005; 294:1255–9.
2. Buxton DB, Antman M, Danthi N, et al. Report of the National Heart, Lung, and Blood Institute Working Group on the Translation of Cardiovascular Molecular Imaging. Circulation 2011;123: 2157–63.
3. Inaba Y, Lindner JR. Molecular imaging of disease with targeted contrast ultrasound imaging. Transl Res 2012;159:140–8.
4. Longenecker CT, Hoit BD. Imaging atherosclerosis in HIV: carotid intima-media thickness and beyond. Transl Res 2012;159:127–39.
5. Burri M, Gupta D, Kerber RE, Weiss RM. Review of novel clinical applications of advanced real-time three-dimensional echocardiography. Transl Res 2012;159:149–64.