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Invited Perspectives

Highlights from the Updated Joint ASNC/SNMMI PET Myocardial Perfusion and Metabolism Clinical Imaging Guidelines

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Preamble

The SNMMI will periodically define new guidelines or update prior guidelines for nuclear medicine practice, independently or in collaboration with other organizations, to help advance the science of nuclear medicine and to improve the quality of patient care. In the 2016 September issue of the Journal of Nuclear Cardiology, an updated joint American Society of Nuclear Cardiology (ASNC) imaging guidelines and SNMMI procedure standard for positron emission tomography (PET) nuclear cardiology procedures is being published addressing the areas of PET myocardial perfusion and metabolism clinical imaging (1). The guidelines document is the outcome of close collaboration between SNMMI and ASNC and among experts in the field from both organizations, which has been subjected to extensive review, requiring the approval of several committees from both organizations, and ultimately the endorsement of both SNMMI and ASNC Board of Directors.

Introduction

To assure quality health care, the Centers for Medicare & Medicaid Services (CMS) has recently implemented quality initiatives that include: effective, safe, efficient, patient-centered, equitable, and timely care (2). The superior imaging properties of PET, that include higher myocardial count density at a shorter image acquisition time than SPECT and less scatter of activity from adjacent sub-diaphragmatic visceral structures into the myocardial region meet some of the CMS quality goals. PET myocardial perfusion imaging provides high diagnostic accuracy (effective), low radiation exposure (safe), short image-acquisition times (efficient), and accommodates ill or higher-risk patients, as well as those with large body habitus (patient-centered), providing equitable and timely care.

While SPECT assessment of stress and rest myocardial perfusion have been firmly established as important diagnostic and prognostic tools for the evaluation of myocardial ischemia and prior infarction, the interpretation of SPECT myocardial perfusion imaging studies has been primarily qualitative or semi-

quantitative in nature. The detrimental effects of soft tissue attenuation, which tends to degrade image quality and increase interpretive errors, have long been recognized with SPECT. PET provides better spatial and temporal resolution and allows reliable and accurate soft tissue attenuation correction when compared to SPECT, particularly in patients who are obese or have large body habitus (3). In concert with tracer-kinetic modeling and robust attenuation correction, PET permits the assessment of regional myocardial blood flow (MBF) of the left ventricle in absolute terms (milliliters per gram per minute) (4).

Progress in PET Imaging of Myocardial Perfusion: Absolute Hyperemic Blood Flow and Flow Reserve

Beyond the CMS quality initiatives, an additional driver for cardiac PET comes from a new health care trend in cardiovascular medicine that suggests a paradigm shift in the evaluation and management of patients with CAD from an anatomical gold standard (coronary angiography) to a functional one (fractional flow reserve). Quantitative assessment of PET MBF in absolute terms is concurrent with the recent shift in the management of CAD. PET absolute MBF provides a valuable noninvasive alternative to functional assessment of CAD, which may obviate the need for coronary angiography. Moreover, noninvasive quantification of MBF extends the scope of conventional myocardial perfusion imaging from detection of end-stage, advanced, and flow-limiting epicardial CAD to balanced reduction of MBF in all three vascular territories as well as early stages of atherosclerosis or microvascular dysfunction (5). Adding quantification of hyperemic MBF and flow reserve to the visual interpretation of PET regional perfusion defects has been shown to improve the detection of CAD burden and accurately risk stratify patients with varying clinical presentations (6-9).

Absolute quantitative MBF may provide further insight into coronary steal phenomenon, defined as an absolute decrease in vasodilator stress perfusion from resting blood flow in collateral-dependent myocardium as well as in hibernation, where low resting MBF may or may not increase with stress but is nonetheless viable requiring an assessment of myocardial metabolism (1). In the case of hibernation,

imaging of myocardial perfusion can be combined with myocardial metabolism imaging with ^{18}F-fluorodeoxyglucose (FDG) for the assessment of myocardial viability in areas of resting hypoperfusion and dysfunctional myocardium (10).

Progress in PET Imaging of Glucose Metabolism: Cardiac Device Infections and Sarcoidosis

In the last few years, PET scanners combined with computed tomography (CT) or magnetic resonance (MR) has proliferated. While the use for such combined scanners is primarily for oncological applications, co-registration of FDG metabolic imaging with morphological, functional, and tissue imaging attributes of CT and MR presents new opportunities for disease characterization, such as diagnosing active cardiac inflammation in sarcoidosis, hallmarked by inflammatory injury, non-caseating granuloma formation, and organ dysfunction (11-12). Another emerging application of FDG is for identification of cardiovascular infections, particularly prosthetic valve or device infections (13-18). Use of cardiac implantable electronic devices, including pacemakers, cardiac resynchronization therapy devices, and implantable cardiac defibrillators, as well as left ventricular assist devices, and prostheses, such as valves and annular ring implants, have become rather common in contemporary practice of cardiology (16). Depending on the disease process, measurements of FDG metabolism can reflect the rates of cellular glucose utilization from either cardiac myocytes or from pro-inflammatory cells that infiltrated the myocardium (1). Cardiac device infection and sarcoidosis carry a high risk of death if not identified early and treated appropriately. In-vivo labeling of metabolically active inflammatory cells at the infection site with FDG has the advantage of superior tomographic PET images with higher spatial and contrast resolution than the labor intensive in-vitro ^{111}In or ^{99m}Tc labelled white blood cell imaging, and at a lower radiation exposure to patients (16).

Epilogue

The SNMMI recognizes that the safe and effective use of diagnostic nuclear medicine imaging requires specific training, skills, and techniques. The updated cardiac PET perfusion and metabolism imaging guidelines is an educational tool designed to assist practitioners in providing appropriate care for patients. It is

important to keep in mind, however, that the practice of medicine entails not only the science of imaging, but also the art, of dealing with the prevention, diagnosis, alleviation, and treatment of disease.

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