SPECT and PET MPI: The future has arrived but it is unevenly distributed

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The ability to noninvasively predict the presence of hemodynamically significant coronary disease has been one of the golden calves of cardiology for decades. Since first entering mainstream clinical use in the late 1980s, stress testing coupled with myocardial perfusion imaging has experienced progressive refinement. The use of thallium has now largely been supplanted by technetium-based agents, leading to less radiation exposure and significant improvements in specificity.¹ ECG-gated SPECT (single-photon emission-computed tomography) techniques have similarly replaced planar imaging, leading to a dramatic improvement in spatial resolution, standardization of interpretation, and imaging quality.^{2,3}

These advances led to widespread utilization (and perhaps overutilization) of exercise nuclear testing, peaking in approximately 2003.^{4,5} Since then, however, centers across the country have seen a progressive decline in testing. The reasons for this decline are multifactorial, and although partly mediated by market forces (with a general decline in relative value units per study over this time frame) and by internal efforts to curb excessive use (e.g., the publication of the first appropriate use criteria for SPECT by the American College of Cardiology in 2005), there are also well-founded medical and evidence-based reasons for this decline.

Notably, despite a rise in multiple risk factors (including diabetes, hypertension, hyperlipidemia, and obesity) since 2003, the percentage of abnormal or high-risk SPECT studies has declined over a similar time frame.⁶ Partly driving this trend has been superior risk factor modification and the proliferation of better medication regimens for both primary and secondary prevention of atherosclerosis. Statin utilization has risen

significantly over this time; even low and modest intensity statin administration has been shown to correlate with a decrease in the overall ischemic burden as assessed by the summed stress score (SSS) on SPECT.^{7,8} Similarly, despite the rise in other risk factors, smoking rates have seen a steady decline.⁹

Compounding this, nuclear imaging technology in practice has not adequately kept pace with changing disease burdens and demographics. The specificity of SPECT for the detection of significant coronary disease declines sharply as BMI rises, from a baseline of approximately 64% in patients with a BMI < 30 to a nadir as low as 17% in patients with a BMI over 40.¹⁰ The monotonous rise in obesity, morbid obesity, and super morbid obesity makes this technical challenge continuously more relevant.¹¹ Although the use of CT attenuation correction may mitigate this loss of specificity, in a 2016 survey of nuclear cardiology providers only 5.6% of centers provided CT attenuation correction for SPECT studies.¹² This is further compounded by the loss in image quality naturally incurred with camera age; a recent analysis of nuclear cardiology labs applying for first-time accreditation or re-accreditation shows that the mean age of each lab's newest camera increased from 5.2 to 8.9 years between 2008 and 2012.¹³ This is unlikely to improve in the near future, as only 40% of nuclear laboratories have a scheduled equipment replacement policy, and declining profit margins are unlikely to spur further spontaneous investment in this field.¹² These facts paint an image that the past is well and alive in many nuclear laboratories.

Analysis of the temporal trends in population being referred for myocardial perfusion imaging time reveals progressively fewer asymptomatic patients as well as fewer patients with traditional angina are undergoing SPECT testing.⁵ Over a similar time-frame, more patients are also being evaluated via a pharmacologic stress rather than exercise testing, losing out on critical prognostic information. This shift in practice patterns likely reflects the advances in both medical management

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of atherosclerosis and percutaneous revascularization techniques, with at-risk asymptomatic patients being preferentially managed medically without further imaging and high-risk patients being referred for diagnostic angiography and possible intervention. On the other hand, more patients with atypical indications such as atrial fibrillation, palpitations, and syncope are being referred for testing of dubious value.

Simultaneously, advances in competing imaging technologies (PET) and coronary CT angiography threaten the remaining role for isolated SPECT assessment. Positron emission tomography (PET) has been shown to provide superior diagnostic accuracy and interpretive certainty relative to non-CT-corrected SPECT and provides increasingly more granular analysis of regional ischemia via myocardial blood flow analysis for PET and recently SPECT.¹⁴ Non-nuclear imaging techniques are also rapidly evolving; CT coronary angiography was shown to provide a mortality benefit over and above medical therapy alone in patients with stable angina.¹⁵

Nuclear cardiology is at a pivotal moment. If the field is able to respond to incorporate these changes and keep pace with the changing landscape by incorporating routine use of CT attenuation correction, PET with absolute flow measurements, and abandoning aging cameras, it will remain a key technology for the non-invasive assessment of coronary disease. The professional societies should ensure that and push for incorporating the most modern tools available in both SPECT-CT and PET into daily clinical practice as a measure of clinical utility and quality. This patient centric value proposal will insure that the “futuristic” tools in nuclear cardiology are evenly and equally distributed.

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