The recent publication by Shaw, et al, (1) regarding the present status and future prospects for myocardial perfusion imaging (MPI) fails to explore one of the most important facts essential to understanding this issue and this commentary fails to fully address the fundamental inadequacy of MPI as a first line diagnostic screening tool for CAD. Figure 2 of this article clearly presents the specificity for detection of CAD by standard rotational SPECT MPI to be 74%. This value has been previously corroborated by De Prez, et al (2) in a literature review commissioned by ASNC and published in the Journal of Nuclear Cardiology (JNC). The De Prez report examined the cost-effectiveness of MPI and stated that “1 in 4 of the normal patients undergoing MPI for detection of CAD is likely to have a falsely abnormal finding”. This reality has influenced all parties concerned about the clinical efficacy of MPI, including third-party payers, to critically scrutinize the degree to which MPI is being utilized for clinical diagnosis and calls into question its cost-effectiveness. Shaw, et al, fail to explore this issue.

Closer examination of the information in Figure 2 of (1) sheds further light on the most probable cause for this deficiency. Note that the adjacent bar graph for PET MPI shows the specificity to be 85% in comparison to the value of 74% provided for SPECT MPI. The tracers and study protocols for these two modalities (SPECT vs PET) are comparable and several clinical comparison studies have indicated diagnostic accuracies consistent with the values given in Figure 2 of (1). However, the literature lacks any coherent, testable explanation for this outcome. What needs to be kept in mind is that the most significant difference between these two technologies is that all PET imaging systems remain completely stationary during image acquisition, whereas standard rotational SPECT image data is acquired sequentially in a step-and-shoot fashion. Gantry rotation routinely takes 10 to 20 minutes allowing adequate time for many artifactual changes to take place.

A recent teaching editorial by Bacharach (3) also published in JNC discusses the inevitability of artifacts generated in rotational SPECT cardiac images resulting from “inconsistencies in the sequentially acquired
image data” resulting in turn from the propensity for patient movement, including coughing, creep, as well as data discrepancies resulting from stress induced physiologic changes in cardiac volume over time. This would include, for instance, the phenomenon termed transient ischemic dilation (TID). Available information clearly points to the mathematics of SPECT image reconstruction as being intrinsically prone to generate false positive findings in the presence of such inconsistencies. The frequency of such artifacts is obviously the engine that drives the unacceptably high false positive rate of rotational SPECT MPI. Efforts to train clinicians to “read around” such artifacts have not produced acceptable results.

Also appearing recently in JNC (4) is the description of two multi-pinhole SPECT devices that acquire MPI without movement of either the detector or the collimator. One of these devices (the Discovery NM 530c, GE Healthcare, Milwaukee, WI) has been commercially available since 2008 and published reports demonstrate “improved clarity” in the clinical images generated by this system but diagnostic accuracy is only stated to be “equivalent” to that of rotational SPECT MPI. Unfortunately, the Discovery NM 530c system utilizes expensive solid-state CZT detectors which exhibit spectral energy distortion characteristics that are very different from those of NaI(Tl) gamma detectors. The pixelated surface of the CZT detector results in partial absorption of the primary gammas which interact along the edges of each pixel resulting in energy downshifting. This creates ambiguity between photons undergoing Compton scatter and partially absorbed primary or unscattered photons. This has prevented the Discovery NM 530c device from providing adequate Compton scatter correction and, therefore, “simultaneous imaging of Tc-99m and TI-201” has not been achieved using the GE Discovery NM 530c device. When simultaneous Tc(rest)/TI(stress) SPECT MPI is accomplished using NaI(Tl) detectors, significant improvement in the imaging efficiency and diagnostic accuracy and clarity of MPI has been demonstrated by the MP-SPECT device also described in (4).

Reference (1) ends with optimistic anticipation by stating that the authors “look forward to the completion of the upcoming randomized trials and the development of the American Society of Nuclear Cardiology registries on radiation safety and Appropriate Use Criterion to further unfold the body of evidence on the utility of MPI as central to patient-centered imaging strategies of care.” Continuing to send 1 in 4 normal patients for unnecessary cardiac catheterization is not an appropriate use of ionizing
radiation. There has been a long standing predisposition in the field of nuclear cardiology to rely on sophisticated data base analysis in an attempt to differentiate true normals from falsely positive abnormals. Over time, nothing achieved by such data base manipulations has reduced the 26% reported rate of false positive MPI SPECT studies, leaving one to wonder about the source of the optimism expressed by Shaw et al (1)

Collectively, the information presented from JNC references (2-4) herein, along with the data contained in Figure 2 of reference (1) itself, point to the need for a coordinated review of all currently available data. Before we can embrace the rosy view of the future prospects for MPI contained in the conclusion of (1), there needs to be a comprehensive understanding of where nuclear cardiology actually is now and how it got there. With full acknowledgment of the factors that will continue to limit the diagnostic specificity of standard rotational SPECT MPI to 74%, we can begin to understand the benefits of stationary multi-pinhole SPECT systems when correctly designed and applied. The information presented in (1) provides no satisfactory explanation as to why the diagnostic specificity of SPECT MPI is so far below the 85% figure presented for PET MPI in (1) and inability to match this level of accuracy will continue to increase pressure to limit the clinical utilization of SPECT MPI.

What is needed now is for innovative scientists, clinicians, technologists and manufacturers to move forward, guided by a consistent, workable and testable understanding of the engineering principles and physiologic mechanisms which underlie MPI. The historic belief that rotational SPECT MPI as it presently exists can adequately meet the future needs to detect and manage CAD is flawed and retention of this misguided notion will contribute to further deterioration of the clinical role of SPECT MPI. As we enter an era of outcome guided medical management, simultaneous, dual-isotope MPI by multi-pinhole SPECT technique holds the key to accurate, reliable, cost-effective MPI.

References:

