Using advanced technology to reduce the dose of SPECT MPI radiation

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During the past several years, there has been considerable concern expressed in both the medical literature and the lay press about the dose of radiation from medical imaging procedures. Doses for nuclear cardiology procedures are among the highest in medicine and have therefore been the subject of wide discussion. Reducing radiation dose to our patients, while maintaining high diagnostic accuracy, is a laudable goal and is the one that has been championed by ASNC and other medical societies.¹ Radiation sparing strategies are being increasingly adopted, although perhaps at a rate that is not yet optimal.

New technologies can make an enormous impact in this effort to lower radiation dose. For example, the addition of attenuation correction to SPECT allows more patients to be tested with stress-only protocols and solid state detector systems allow higher resolution with lower radiation dose and acquisition times compared with standard Anger cameras.^{2–4}

In this issue of *the Journal*, Lyon et al demonstrate that with a particular commercial solution, IQ-SPECT, one can acquire images with the same diagnostic content in half the time and half the dose as with a standard LEEP collimator.⁵ The IQ-SPECT solution incorporates a newly designed collimator, a cardio-centric orbit, and optimized computer software to achieve this

improvement in counts and resolution over standard systems. The study by Lyon et al is significant because it was conducted in patients, rather than phantom models, with each patient being imaged on two systems with a single radionuclide administration. The investigators also employed a clever method of simulated dose reduction. Of note, in the protocol used in this study, the investigators modified the iterative reconstruction algorithm from the standard one so that images more closely resembled standard SPECT displays. New technologies that require physicians to learn different patterns of normal display may not be readily accepted and so this modification should arguably become the standard setting for this imaging system. Also of note, the non-diagnostic CT scan obtained for attenuation correction in study was set at a relatively high dose, estimated at 2.5 mSv *E*. The CT settings can and should be reduced substantially in order to lower the radiation dose in routine clinical practice.

All of the recent technological advances in SPECT imaging can be utilized to either lower radiation dose or to reduce the image acquisition times, oftentimes both. For most laboratories, lowering radiation dose should be the emphasis. There usually are other rate-limiting steps to laboratory workflow and so very short image acquisition times of 2–7 minutes may not translate into commensurate laboratory efficiency. The study by Lyon et al demonstrates that substantial dose reduction is imminently feasible with the system they tested.⁵ However, more investigative work is needed in order to work out the optimal algorithms for acquisition and radiotracer dosing.

Table 1 illustrates major features of a common radiation sparing protocol in use at the Mid America Heart Institute (MAHI) laboratory compared to the protocol implied in the study by Lyon et al. The MAHI SPECT protocol utilizes attenuation correction (AC) and advanced post-processing. The implied IQ-SPECT protocol not only utilizes AC and advanced post-processing, but also multi-focal collimation and a

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Table 1. Comparison of radiation dose and other key protocol features of a radiation sparing SPECT protocol at the Mid America Heart Institute using attenuation correction and post-processing with the implied protocol using IQ-SPECT described by Lyon et al

	N	Stress dose (mCi)	Acq time (minutes)	AC source	AC dose (mSv)	Total dose (mSv)
MAHI SPECT	2747	9.4	24	Scanning rod	.05	2.6
Lyon et al	100	12–15	7	CT	2.5	5.8–6.6

MAHI SPECT, Mid America Heart Institute protocol for single-photon emission computed tomography imaging using line source attenuation and advanced post-processing; *Acq time*, image acquisition time; *AC*, attenuation correction; *CT*, x-ray computed tomography.

cardio-centric orbit. With a stress dose of 9.4 mCi of Tc99m and ≈ 24 minutes acquisition, this MAHI protocol has been utilized in over 2700 patients. Using the proposed stress half dose of 12–15 mCi, the IQ-SPECT protocol acquisition time is about 7 minutes. Presumably, doubling the acquisition time to 14 minutes and reducing the dose to 6–7.5 mCi would obtain image quality similar to this. Presumably. Protocols such as this should be tried out in clinical practice. There is more work to do.

The equipment described in the study by Lyon et al is not inexpensive. However, it can be purchased as add-on equipment by laboratories that already own most of the nuclear cameras made by this specific manufacturer. Many physicians indicate that the cost of new SPECT technologies is the major barrier to implementation. Currently, reimbursement rates and the number of SPECT tests performed in the US are indeed both lower than several years ago. For example, Medicare reimbursement in the outpatient setting for CPT code 78452 (SPECT MPI: multiple studies) was \$684.81 in 2007 and is about \$467.00 in 2016. The number of SPECT procedures performed per year in the US is estimated to be down at least 12.5% since 2007, based on Medicare claims data. There is also no incremental payment for the use of advanced imaging equipment. Thus, it may be

challenging for nuclear laboratories to purchase advanced imaging solutions unless they change their workflow or decrease the number of cameras utilized. As a community, we should make these sorts of changes. Lowering radiation dosage while maintaining or enhancing high-quality imaging is the right thing to do.

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