Commentary (I)

Recommendations for Quality Control of Gamma Cameras

A national symposium—Quality Assurance in Nuclear Medicine—took place on April 27–29, 1981, in Washington, DC, under the sponsorship of the Federated Council of Nuclear Medicine Organizations and the Bureau of Radiological Health. Of the nine workshops presented on the second day of the symposium, "Imaging Instrumentation and Quality Control," chaired by Valerie Brookeman, PhD, and William MacIntyre, PhD, is of particular interest (*1*).

Gamma-camera quality control has been the concern of many investigators for some time (*2*) and many of them were on hand to contribute to the extensive discussions among the 80 participants at this workshop. All facets of gamma-camera quality control were examined; for the first time a group of this size endorsed recommendations. Although the proceedings of the symposium will be published separately, a preliminary summary of these recommendations should be considered by all who use gamma cameras.

The recommendations are as follows:

☐ The *mechanical integrity* of a gamma camera should be assured at all times, including protection against collimator damage. All optical devices contributing to the production of the image should be kept immaculately clean.

☐ The *field uniformity* of a gamma camera should be checked daily. The window of the gamma camera's analyzer should be centered on the appropriate photopeak using a small source and the same window width as for clinical imaging. Subsequent shifting of the photopeak by "autopeaking" may cause some problems. With a collimator in place, preference was given to the use of a Tc-99m flood source. The liquid source in a plastic container provides sufficient scattering material for adequate testing of field uniformity; the analyzer window remains unchanged for Tc-99m clinical imaging. A disadvantage of the liquid flood source is the need for daily refilling with Tc-99m and uniform distribution of the activity. Some large plastic flood sources bulge at their center because of the pressure by the liquid and will produce an apparent nonuniformity.

The second choice, use of a Co-57 disk, eliminates some of the disadvantages of the liquid source but the photopeak must be adjusted before and after its use. The addition of a scattering material, about 2 cm thick, interposed between detector and Co-57 disk is recommended, but no backscattering material is required.

Exposure of a gamma camera's entire field of view by a small source (Tc-99m) at about 2 m from the uncollimated detector is rated as a third choice for field-uniformity quality control. A scattering material, about 2 cm thick, must be placed between source and detector. The backscatter from a small source on the floor is undetectable, as is the scattered radiation from a lead "pig" if used.

With 2–3 mCi sources, the count rate should not exceed 20K cps for the newer gamma cameras and must be limited to 10K cps for older ones. A total of 2.5 million counts should be collected with large-field cameras while 1.25 million counts appear sufficient for small-field cameras.

For gamma cameras with a uniformity-correction system, the field uniformity may be recorded with the correction on and off. Even with the correction off, no extreme nonuniformitites should be observed. The difference in time for collecting a fixed number of counts with the uniformity correction on and off should be noted. A change of this time difference may indicate problems.

- ☐ The *sensitivity* of a given camera-collimator system should remain stable. With a Co-57 disk source only its slow decay should be noticed. When a Tc-99m source is used, it should always have a known amount of activity and the ratio of counts per unit time over the activity should remain constant.
- ☐ The *spatial distortion* (linearity) of a gamma camera should be checked at least weekly, or more often depending on the system's stability. For that purpose transmission images of one of the commercially available orthogonal-hole patterns are recommended (*2,3*). The use of a 90° bar quadrant pattern or any lead bar or hole pattern that does not check linearity over the full field of view in at least one direction is not recommended. Orthogonal-hole test patterns should be imaged without a collimator or scattering material. The collimator may interfere with the the orthogonal-hole pattern. A small source at about 2 m from the detector provides a nearly uniform exposure of its field of view.
- ☐ The *intrinsic resolution* of a gamma camera should be checked periodically; changes in uniformity or spatial distortion or both usually precede noticeable change in resolution. Transmission images of orthogonal-hole patterns used for spatial distortion evaluation may indicate changes in intrinsic resolution as well, without additional images. Other test patterns may require multiple exposures with rotation or translation of the pattern.

For low-energy photons, such as from Tl-201, the gamma camera may perform differently. The intrinsic resolution is poorer and major changes in field uniformity have been observed occasionally. Transmission images of orthogonal-hole patterns will reveal changes in gamma-camera performance with radiation energy.

As summarized by Cradduck (*1*), an orthogonal-hole pattern of dimensions such that it would challenge the camera's spatial resolution seems to be the method of choice for gamma-camera quality control. It allows one to check field uniformity, linearity, resolution, and even sensitivity simultaneously.

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References

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3. Paras P, Hine GJ, Adams R. BRH test pattern for the evaluation of gamma-camera prformance. *J Nucl Med* 1981;22:468–70.