Part 13: PRINCIPLES OF SCINTILLATION DETECTION

By James R. Halama, Ph.D.
Loyola University Medical Center
Maywood, IL

1. Mark true or false before each of the statements below regarding gamma camera imaging.

___ a) Spatial resolution is better in a 9.4 mm thick NaI(Tl) crystal than for a 6.4 mm crystal.
___ b) Energy resolution is better for imaging I-131 than for Tc-99m.
___ c) The intrinsic efficiency for counting I-131 photons is greater than for Tc-99m photons.
___ d) Spatial resolution is better in imaging Tc-99m than for Tl-201.
___ e) The Compton scatter component in images of Tc-99m is greater that in Tl-201 images.
___ f) Spatial resolution is better in gamma cameras with 75 PMT's than with 37.

2. The intrinsic spatial resolution of current generation Anger cameras is _____ mm FWHM.

a) 1-2
b) 2-3
c) 3-4
d) 4-5
e) 10-12

3. Mark True or false before each of the statements below regarding dead time in gamma camera imaging:

___ a) The gamma camera system is non-paralyzable.
___ b) The dead time of current generation gamma cameras is on the order of 0.3 microsecond.
___ c) Imaging protocols should exceed 100,000 counts per second in order to prevent significant count rate losses due to dead time.
___ d) A gamma camera with 75 PMT's exhibits greater dead time than for 37 PMT's.
___ e) Intrinsic image resolution is best when the gamma camera operates near its maximum possible count rate.

4. Mark True or false before each of the statements below regarding gamma camera collimators:

___ a) Compared to high energy collimators, low energy collimators have thin lead septa.
___ b) Long bore collimators exhibit better spatial resolution than short bore collimators.
___ c) High energy collimators have better spatial resolution than low energy collimators.
___ d) High energy collimators have greater sensitivity than low energy collimators.
___ e) Diverging collimators for imaging small sources have greater sensitivity than parallel hole collimators.
___ f) The sensitivity of parallel hole collimators decreases slightly as the distance between the source and collimator increases.

5. The system spatial resolution of current generation gamma cameras fitted with a high-resolution low-energy collimator for imaging of Tc-99m at a distance of 10 cm is approximately ____ mm FWHM.

a) 4
b) 7
c) 10
d) 12
e) 16

6. Mark true or false for each statement below regarding field uniformity characteristics of gamma cameras.

___ a) PMT tube balance is the most important factor in maintaining good field uniformity.
___ b) Setting a photopeak energy window asymmetrically high results in flood images that show the PMT pattern as cold spots.
___ c) Count differences of at least 6% must exist for non-uniformities in a routine flood image to be seen by visual inspection.
___ d) Field uniformity improves as the count rate increases.
___ e) Field uniformity is independent of photon energy.

7. Specifications for gamma camera performance are reported for its useful-field-of-view (UFOV) and central field-of-view (CFOV), which are defined to be ___ of collimated field-of-view, respectively.

a) 95% and 75%
b) 100% and 75%
c) 90% and 50%
d) 75% and 50%
e) 100% and 80%

8. Mark true or false before each statement below regarding gamma camera imaging and Compton scattered radiation.

___ a) Acceptance of small-angle scattered radiation reduces image contrast.
___ b) Rejection of scatter is most problematic for high energy photons.
___ c) The scatter component in gamma camera images is located at the high energy end of the photopeak.
___ d) Scatter does not affect the measurement of gamma camera dead time.
___ e) Backscattered radiation affects image quality more than low-angle scattered radiation.

9. The following combination of quality control tests are to be carried out on gamma cameras daily:

a) field uniformity, linearity, spatial resolution
b) field uniformity, photopeaking
c) photopeaking, linearity, spatial resolution
d) photopeaking, field uniformity, sensitivity
e) photopeaking, field uniformity, linearity, spatial resolution

10. The typical energy window used for imaging Tc-99m on gamma cameras is

a) 1%
b) 5%
c) 20%
d) 30%
e) 45%

11. Answer True/False to the following statements.

a) The most important effects involved in producing scintillations in a sodium iodide crystal include Compton effect and pair production.
b) Most gamma camera crystals are highly purified thallium iodide (sodium).
c) Each stage of dynodes in a photomultiplier tube typically increases the number of electrons by a factor of ~ 4.
d) When gamma rays strike the photoemissive surface, photoelectrons are produced.
e) The crystal in a gamma camera is usually ~ 1 inch thick.
f) The image quality obtainable with Xe-133 is better than that obtainable with Tc when imaging with a scintillation camera.

12. The optimal distance from the collimator to the patient's body surface for a scintillation camera equipped with a parallel-hole, multi-aperture collimator is:

a) ½ the collimator diameter
b) one collimator diameter
c) 2 times the collimator diameter
d) 4 inches
e) contact

13. A scintillation camera is equipped with a pinhole collimator. As the subject to be imaged is moved away from the pinhole along the center axis, the count rate:

a. increased rapidly
b. increases slowly
c. does not change
d. decreases
e. first increases, then decreases

14. If a photomultiplier tube has 10 dynodes and each has a multiplication factor of 4, what is the overall photo-multiplicative power of the tube?

a. 40
b. 10^4
c. 4^{10}
d. 10×4^2
e. 4×10^2