

QUESTION 11

A pharmaceutical representative has just completed a presentation on the merits of a new radiopharmaceutical for the study of the blood perfusion of heart muscle in patients with suspected or known coronary artery disease. The new radiopharmaceutical is labeled with ^{99m}Tc (trade name Tetrolite). The radiopharmaceutical that has been the standard in heart perfusion imaging for years is $^{201}\text{Tl-Cl}$ (trade name thallium). One of the selling points that the salesperson uses is the favorable dosimetry of Tetrolite relative to $^{201}\text{Tl-Cl}$. After the presentation, your nuclear medicine manager asks you to explain why one can inject nearly 10 times more Tetrolite than thallium into the patient without increasing the patient's effective dose equivalent.

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The protocol for the heart muscle blood perfusion studies are as follows:

^{201}Tl - Patient is physically stressed and 4 mCi $^{201}\text{Tl-Cl}$ is injected at peak stress. An image is made immediately following the end of stress. About 2 hours later an image is obtained representative of the rest condition. No additional $^{201}\text{Tl-Cl}$ is injected

$^{99m}\text{Tc-Tetrolite}$ - Patient in rest condition is injected with 10 mCi of Tetrolite and one hour later a rest image is obtained. About 3 hours later, the patient is stressed physically and at peak stress, an additional 20 mCi is injected and an image representative of the patient's physical stress condition is obtained about 40 minutes later.

From the literature you discover that both radiopharmaceuticals distribute themselves uniformly throughout the body and that the half lives for biological elimination from the body are 10 days. The physical half life for ^{99m}Tc is 6 hours. The physical half life for ^{201}Tl is 73 hours.

Reference man weights 70 kg.

Assume that the distribution and kinetics of elimination of the two radiopharmaceuticals is about the same during both the rest and stress phase of the diagnostic protocol.

Energies and frequencies and Absorbed Fractions and absorption coefficient in air of major photons emitted from decay of ^{99m}Tc and ^{201}Tl ; (Contributions of Auger and internal conversion electrons to patient dose are considered insignificant.)				
^{201}Tl				
Radiation Type	Energy (kev)	Frequency	Absorbed Fraction**	Absorption coefficient in air (cm^2/gm)
X-ray $\text{K}\alpha_1$	68.9	0.27	0.47	0.0262
X-ray $\text{K}\alpha_2$	70.8	0.465	0.47	0.0262
X-ray $\text{K}\alpha\beta$	80.3	0.205	0.47	0.0236
^{99m}Tc				
Radiation Type	Energy (kev)	Frequency	Absorbed Fraction**	Absorption coefficient in air (cm^2/gm)
Gamma	140.5	0.891	0.36	0.0245
**The fraction of the energy of a photon originating in the whole body (the source organ) which is absorbed in the whole body (target organ). From Snyder et al., 1969, MIRD Pamphlet No. 5.				

POINTS

- 15 A. What are the three major factors which one would use to define the committed effective dose equivalent received by the patient who has been injected with either of these radiopharmaceuticals? **Number your responses. Only the first three will be graded.**
- 30 B. What are the RELATIVE contributions of each factor in determining the nearly 10-fold difference in effective dose equivalent per mCi between the thallium and Tetroline radiopharmaceuticals? **Show all work.**
- 10 C. If the biological half life of ^{99m}Tc -Tetroline in the gall bladder is 7 days, what is the effective half life for ^{99m}Tc in the gall bladder? **Show all work.**
- 20 D. The gamma camera used for production of a nuclear medicine image functions in much the same manner as a solid scintillation survey meter. Assume that the injection activities given for the protocols above result in 20 times more counts being acquired with ^{99m}Tc -Tetroline than with $^{201}\text{TlCl}$. What is the relative variability in the counts which are acquired using the two radiopharmaceuticals? (Variability is defined by the standard deviation of the number of counts divided by the number of counts.) **Show all work.**

- 25 E. What is the RELATIVE extremity dose to a nuclear medicine technician who is performing injections of the thallium and the Tetrolite for heart perfusion studies? The protocol is the same as that identified above. The injection process requires about 1 minute of syringe handling time for the thallium procedure and about 2 minutes of syringe handling time for the Tetrolite procedure.