REDUCTION OF RADIOACTIVE IMPURITIES IN RADIOPHARMACEUTICALS

The reduction of radioactive impurities in radiopharmaceuticals is highly desirable. One way to encourage an improvement is by publishing data on impurities—an effort my colleagues and I have been engaged in for several years. It is therefore quite regrettable that I must take issue with the recent article by Wood and Bowen (*1*).

In a recent paper (*2*) we identify the principal radioactive impurities in eluates from ^{99}Mo-^{99m}Tc generators. A typical gamma-ray spectrum consisted of 26 gamma-ray peaks when measured with a Ge(Li) detector. The poor resolution of the 2 × 2-in. NaI(Tl) crystal used by Wood and Bowen and the low photofraction for high-energy gamma rays severely restrict the quality of the data obtained from complex gamma-ray spectra.

In our work with ^{99m}Tc elutions we have found that even a selected high-resolution 3 × 3-in. NaI(Tl) detector could not resolve the many gamma-ray peaks present in the eluates. In my opinion, an analysis of the radionuclides present in these eluates is not possible using a 2 × 2-in. NaI(Tl) crystal.

Wood and Bowen support their identification of ^{124}Sb and ^{95}Zr by referring to a "half-life" measurement which is not explained. The "half-life" of a mixture of seven or more radionuclides emitting 26 gamma rays as measured with a well-crystal detector would appear to be difficult if not impossible to interpret. In our work we have determined the half-life of major peaks with correction for the continuum on which each peak rests. The peaks near 0.6 and 0.76 MeV had a half-life obviously greater than 1 yr and therefore entirely inconsistent with a 60-day half-life.

In our studies, we found ^{124}Sb to be a very minor contaminant, and ^{95}Zr was not present. The two peaks attributed to ^{124}Sb and ^{95}Zr by Wood and Bowen are primarily from gamma rays emitted by ^{134}Cs ($T_{1/2}$ = 2.05 years) which *is* the principal radioactive contaminant and the one which produces the greatest patient dose. The ^{124}Sb was present in eluates in a concentration approximately 1/1,000 of the ^{134}Cs concentration. In short, the results reported by Wood and Bowen differ markedly from all of our studies. Regardless of what may have been in the samples they studied, the results they have reported are not typical of the impurities in eluates from present-day generators.

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REFERENCES

1. WOOD DE, BOWEN BM, ^{95}Zr and ^{124}Sb in ^{99}Mo-^{99m}Tc generators. *J Nucl Med* 12: 307–309, 1971

2. BARRALL RC, SMITH SI, FINSTON RA, et al: Impurities in ^{99m}Tc used in medical diagnosis. Second International Symposium on Nuclear Medicine, May 11–14, 1971, Karlovy Vary, Czechoslovakia.

AUTHORS' REPLY

Dr. Barrall is correct in stating that clear delineation of the spectra of radioactive contaminants is best performed by Ge(Li) detectors. While all radionuclide generators have, to a greater or lesser degree, contaminants, our report recorded an interesting anomaly. In the period between April and September of 1970, 30 generators, 20 of which were purchased from Supplier I, were studied. As stated in our article, minor peaks could be noted for several contaminants in all eluents. However, major peaks were noted at 600 and 760 keV in the eluents of Supplier I. These peaks were significantly greater than found at the same energy in the eluents of generators of Suppliers II, III, and IV.

Dr. Barrall correctly noted that our published $T_{1/2}$ data were an approximation. We can now be more precise. Our $T_{1/2}$ calculations are based on counting carried out on generator eluents over an 18-month period. Samples which had been allowed to decay for 1 year were counted for over a further 6-month period. The $T_{1/2}$ plot of the latter values obtained at 600 and 760 keV approached 2.05 years. Presuming this therefore to be ^{134}Cs, we calculated the ^{134}Cs contribution to the earlier counts and subtracted these values from the observed count. The remaining activity at 600 keV had an apparent $T_{1/2}$ of 60 days, and at 760 keV an apparent $T_{1/2}$ of 65 days. We suggest that these represent ^{124}Sb and ^{95}Sr.

Their contribution to the activity at the time of elution varied between 70 and 99% depending on several factors including the extent to which the column had been washed.

In that our study of Supplier I's generators terminated in December 1970, when the article was accepted for publication, Dr. Barrall may well be correct in stating that our results are not typical of impurities in eluents from "present-day" generators. However, the most recent generator from Supplier I which we studied was received on December 14, 1970. The activity in the initial eluent of this generator was approximately one-thousand-fold greater at 600 keV than in the eluent of a generator from Supplier II. The half-life of the 600-keV peak after subtraction of the ^{134}Cs component was 60 days. The ^{134}Cs component contributed 22% of the activity at the time of elution. It is our opinion that this generator had significant ^{124}Sb contamination. No ^{95}Zr was identified.

It is important to reiterate that both Dr. Barrall and our laboratory have the same objective. We have identified different major contaminants in different generator eluents. Samples studied in our laboratory from one supplier's generator revealed ^{124}Sb and ^{95}Zr as the major contaminants, along with some ^{134}Cs. In Dr. Barrall's sample, the principal contaminant at these energies was ^{134}Cs. Both laboratories intend, by identification of impurities, to improve the quality of radiopharmaceuticals.

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UNIDIRECTIONAL SCANNING

Many people remain unaware of the outstanding advantage that is achieved by the use of unidirectional scanning. We cannot emphasize too strongly that this is not a matter of academic interest but one which affects in a radical manner the quality of the results achieved whenever a rectilinear scanner is in use. We have used unidirectional scanning and long space constants in this hospital for several years past, and our experience leaves no room for doubt of the great gain that has resulted.

Dr. Simons and Dr. Kereiakes find it difficult to accept our statement (*1*) that, for a given total scan time, better statistics can always be obtained by unidirectional rather than by bidirectional scanning provided the display is modulated solely by the ratemeter output. They claim we are in error because we have overlooked the dependence of information density on scan speed. That this does not, in fact, affect our argument can be simply demonstrated by considering a conventional variable dot color scan. In such a display, the dots are derived directly from the detected pulses, and the variations in dot density relate linearly to the variations in information density. The color changes, however, are produced solely by the ratemeter output fluctuations which depend only on the pulse rate and the time constant and are independent of scan speed. The quality of the contours derived from the color changes are therefore independent of changes in information density when the latter occur as a consequence of variations in scan speed. If the tapper is now activated at an appropriate constant rate from a pulse generator instead of by the detected pulses, then the display becomes totally independent of scan speed. However, an upper limit is imposed ultimately for any given choice of ratemeter time constant by the inability of the ratemeter output to follow faithfully changes to its input.

Constant dot color scans are, in any case, to be preferred to variable dot scans because the dot spacing in the latter results in a dissipation of the colors. Furthermore, the dot-density image is spatially separated from the color image by a distance equal to the product of the scan speed and time constant, i.e., by the space constant, and this must lend confusion to the display.

The photoscan differs from the color scan in that both the triggering pulse rate and the ratemeter output modulate the same parameter, i.e., the film exposure. Nevertheless, if the light source is operated at an appropriate constant pulse rate and the light intensity variation is derived solely from the ratemeter output, then the argument that the display is independent of the scan speed still applies.

The statement that the result of a scan conducted under the conditions outlined is independent of the speed of the scan might appear at first sight to be fallacious because clearly if the scan speed is reduced the count density is increased. It is a fair question to ask what happens to this additional information. In fact it is absorbed by the improvement in the spatial resolving power of the display system. However, if this is already much finer than that of the detecting system, there is no resultant visible improvement in the scan display. Thus a major part of the information gathered in a bidirectional scan