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Editorial: Radiochemical Purity of New Radiopharmaceuticals

William C. Eckelman

Because of the carrier-free nature of the popular radionuclides, most radiopharmaceuticals cannot be studied by ultraviolet or infrared spectroscopy, nuclear magnetic resonance, or elemental analysis. Accordingly, chromatography has become the major analytic tool for determining the radiochemical purity of a radiopharmaceutical. However, the term "radiochemical purity" is much abused. The strict definition is the percentage of the radionuclide in question in the desired chemical form. The common mistake is to use a chromatographic system that can only separate one radiochemical impurity and then to report the radiochemical impurity on that basis. This is especially evident for ^{99m}Tc radiopharmaceuticals, which are often stated to be pure after anal-

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Selected manuscripts from the issues of *The Journal of Nuclear Medicine* published 15 and 30 years ago.

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ysis for pertechnetate. The cause of this misinterpretation is not clear: certainly pertechnetate is the obvious impurity in ^{99m}Tc radiopharmaceuticals, but as early as 1967 another impurity, variously called reduced unbound ^{99m}Tc or reduced hydrolyzed ^{99m}Tc , has been identified.

Because of the loose interpretation of "radiochemical purity", the conclusions of many articles have been difficult to interpret. Therefore, a set of guidelines are proposed to bring uniformity to the articles on new radiopharmaceuticals published in the *Journal*. To be reasonably sure that a radiopharmaceutical contains only the desired species, at least two chromatographic systems should be used,

with either different solvents, different solid-phase supports, or both. The two systems used to assay for radiochemical purity should show a single band of radioactivity and possess a partition coefficient such that the new compound is neither freely eluted nor strongly absorbed. Requiring this sort of information for each new radiopharmaceutical will provide a rational basis for judging the usefulness of the radiopharmaceutical. It is always judicious to note that radiochemical purity is not an absolute but is based rather on the known impurities. Still another radiochemical impurity might be detected in a radiopharmaceutical thought to be pure by using a more sophisticated separation technique, but two appropriate systems are usually sufficient. These guidelines will only apply to the radiopharmaceutical in vitro, although pertinent in vivo data on radiochemical purity are certainly needed for a full explanation of the mechanism of action and will be strongly encouraged. ■

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A Theoretical Evaluation of Brain Scanning Systems

Robert N. Beck

The fact that brain lesions and normal brain tissue tend to take up injected radioactive material to different degrees underlies all attempts to locate brain tumors with gamma ray detectors. Two fundamentally different collimated scintillation detector systems, responding primarily to photons produced in small diameter cylindrical regions through the head, have been successfully developed for this purpose. A systematic scan of the head by these detectors produced a two-dimensional mapping of the distribution of radioactivity.

The positron or 'coincidence' system responds primarily to simultaneously detected, oppositely directed, pairs of 0.511 MeV photons produced by positron annihilation in the cylindrical region between the detectors. In addition, a rela-

tively small spurious response is due to the occasional detection of simultaneous but unrelated 0.511 MeV photons from outside the region.

The focusing collimator or "singles" system responds primarily to single photons, which come from a region the precise shape of which depends on many design parameters. Here we shall deal only with focusing collimators consisting of identical, round, tapered holes in hexagonal array having a common apex at the focal distance. In such a case, the region of response has a circular cross section of radius R at the focal distance and a hexagonal cross section, somewhat larger, near the collimator. In addition, some gamma rays from outside this region enter the detector by penetrating the collimator septa.

In order to compare these systems, it has been necessary to develop:

1. A criterion based on the statistical nature of count rate information, which depends on both detector sen-

sitivity and the change in count rate over a tumor.

2. A theory of detector responses to distributed sources, which, for the focusing collimator system, takes into account gamma ray penetration of the septa.

Under the conditions previously discussed, it appears that focusing collimator systems can be designed for 0.511 MeV radiation that are superior to coincidence systems by factors of 2 to 10 (depending on resolution) for midline tumors. These factors increase for tumors not on the midline.

Making the further assumption of equal numbers of photons produced for all systems, the figure of merit for focusing collimator systems increases with decreasing gamma energy down to 0.200 MeV, the low-energy limit of this investigation. It can be generally concluded therefore that the advantages of low-energy gamma radiation for brain scanning have not yet been fully exploited. ■