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Design and Performance Characteristics of a Whole-Body Positron Transaxial Tomograph

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We have designed, built, and tested a device that allows the reconstruction of transaxial tomographic images of the distribution of positron-emitting radiopharmaceuticals in the human head and torso. This is the third in a series of devices that we call positron-emission transaxial tomographs (PETT). The PETT III can measure quantitatively the distribution of any positron-emitting radiopharmaceutical in a cross-sectional slice of the human body. This paper presents: (a) a description of clinically useful PETT; (b) a report on its capabilities in terms of resolution, accuracy, and efficiency; and (c) documentation of the imaging capability of PET III with both patients and volunteers.

Phantom Studies

A uniformity phantom, consisting of a 25-cm diameter by 5-cm deep plexiglas container filled with a ^{68}Ga solution, was scanned with PETT III. The shadow shields were in place and the discriminators set at 100 keV. The distribution of the activity values per pixel in a 15-cm diameter central region of the image was used to evaluate their standard deviation over the field in the reconstructed image: it was found to be ±7.5% of the mean value. The theoretical error for this image, assuming only statistical error, is ±5.3%. Another plexiglas phantom was also imaged to evaluate the quantitative recovery of information in a PETT III image. Within statistical error, the value of the hot spot in the reconstructed image is twice that of the main body and the cold spot is zero.

Initial Patient Studies

A patient with a 2-wk-old cerebral infarct was studied with $^{13}NH_3$, ^{68}Ga-EDTA, and ^{11}CO. The shadow fields were removed to maximize the counting rate. The patient was administered 8 mCi of each of the first two radiopharmaceuticals and 20 mCi of ^{11}CO by inhalation. The images required 8-20 min per slice (20 min for ^{68}Ga), with about 10^6 counts per image. The infarct was prominent in the $^{13}NH_3$ image, while the ^{68}Ga and EMI scans indicated abnormalities adjacent to the actual infarct due to impairment of the blood-brain barrier.

Conclusions

The initial patient studies showed great potential for clinical imaging. The depth-independent resolution, quantitative recovery of radiopharmaceutical distributions, and removal of superimposition of structures give PETT III advantages not present in conventional nuclear medicine imaging systems. With the development of better radiopharmaceuticals, the PETT III system should be able to give better images in shorter times at lower doses. ■

SPRING 1961

From an abstract submitted for the 8th Annual Meeting of The Society of Nuclear Medicine

The Future of Nuclear Medicine

John McAfee

Despite considerable interest during the past decade, radioisotopes used both diagnostically and therapeutically have failed to create a sizable impact upon the practice of medicine. Many large institutions continue to regard radioisotope laboratories as a research luxury rather than as a necessity for good patient care. Within the next decade, this attitude will probably change drastically, as the gap narrows between nuclear physics and instrumentation and their medical applications. The use of radioisotopes in clinical research will parallel the impact of radiotracers on basic biochemistry. The role of radioactive tracers in clinical medicine of the future will probably become equal in importance to that of x-ray diagnosis and therapy.

For nuclear medicine to live up to these expectations, many difficulties in present day practice must be overcome. Laboratories must develop additional facilities designed solely for the training of personnel. Full-time professional staffs must devote more time to adequate training of physicians. Radionuclides and labeled compounds available for the physician's use, currently quite limited in number, must be increased in number. The present day instrumentation facilities of most laboratories include only a few types of gamma detectors. Other instruments will be required to permit the use of a wide variety of compounds labeled with beta emitters in diagnostic studies. The rapid advances in instrumental design may reach a plateau in the years ahead, but the era of radiochemistry as applied to medical problems has just begun. ■