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Phelps M E, Hoffman E J, Huang S-C & Kuhl D E. ECAT: a new computerized tomographic imaging system for positron-emitting radiopharmaceuticals. *J. Nucl. Med.* 19:635-47, 1978.
[University of California, Los Angeles, CA]

The principles, design criteria, and experimental verification used in phantom and human studies are presented for a new positron emission tomography (PET) system. The paper demonstrates the quantitative accuracy of PET for imaging and measuring biological processes *in vivo* in humans using substrates labeled with positron-emitting radioisotopes. [The *SCI*® indicates that this paper has been cited in over 210 publications.]

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In 1970 I joined the faculty of the Washington University School of Medicine and began working in Michel Ter Pogossian's lab. This lab, as well as a number of others, had recognized the potential of using positron-emitting isotopes of natural elements (C, N, and O) to label substrates and drugs for *in vivo* kinetic studies of biological processes in humans. Yet the use of positron-labeled compounds for tracer assay methods awaited an analytic imaging system adequate to the task.

In 1972 we developed a system consisting of ^{32}NaI detectors surrounding the subject's head; it was called the "lead chicken" for reasons apparent upon seeing it. At this time, we learned of a crucial breakthrough in medical imaging: the development by Godfrey Hounsfield of the X-ray computed tomography (CT) scanner. Although it was itself of paramount importance, it also demonstrated the general principle of mathematically reconstructing tomographic images from angular projections of an object, a principle that I thought could provide the solution we had been seeking.

The following year, Edward Hoffman, Ter Pogossian, and I set out to develop an instrument to exploit this new insight. Jerome Cox, Donald Snyder, and Henry Huang provided help on the CT reconstruction algorithm. We disassembled the "lead chicken" for its parts, and with some electronics and software help from Nizar Mullani and Carol Coble, built the first positron CT device.[1] I affectionately named it PETT (positron emission transaxial tomography); later it was shortened to PET.

These were exciting times: working day and night, having faith in the value of what I knew would result, and turning dreams into reality. In this quest, nature was our ally because positrons are uniquely suited for CT: when they decay, pairs of 511 keV photons are emitted in opposite directions. The principle of electronic coincidence at opposing detectors within a circumferential detector array provided a properly sampled set of angular projection data and correction for photon attenuation by the body. These data allowed the reconstruction of quantitative tomographic images of the tissue concentration of intravenously injected labeled compounds. Combining this with a tracer kinetic model allowed us to turn PET into an analytic assay instrument for imaging and measuring the rates of biochemical and biological processes in the living human. Although the first prototypes were primitive by modern standards, they allowed us to quickly develop the principles of PET.

In 1974 we began developing the first human PET scanner (PETT III).[2] By the time we received support from the National Institutes of Health to construct this device, we had already designed and built it and performed the first human studies, thanks to a departmental loan (from Ronald Evens) and to a "good faith" equipment loan from Terry Douglass at ORTEC, Inc. Nowadays, when I have so much more tangible support by comparison, I try to remember those early days when so much was accomplished in such a short time with limited resources but with unlimited faith in what was possible.

This paper is frequently cited because it describes the first commercial PET scanner that became the "workhorse" of worldwide PET programs. In recent years, PET has been used to bridge basic and clinical sciences in providing new knowledge about biochemical mechanisms of normal and diseased processes of the human body.[3,4] Today PET is bringing *in vivo* biochemistry and pharmacology to clinical medicine, making examinations of biological processes basic to health and disease tangible realities for the physician and the patient for the first time.

Although many awards have honored the development of PET (for example, the Von Hevesy Prize, Von Hevesy Foundation; Aebersold Award, Society of Nuclear Medicine; E.O. Lawrence Presidential Award, Department of Energy; Sarah Poiley Memorial Award, New York Academy of Sciences; Rosenfeld Award, American College of Physicians; Jennifer Jones Simon Endowed Chair), my greatest reward has been that derived from people working together for the benefit of others.

1. **Phelps M E, Hoffman E J, Mullani N A & Ter Pogossian M M.** Application of annihilation coincidence detection to transaxial reconstruction tomography. *J. Nucl. Med.* 16:210-24, 1975. (Cited 170 times.)
2. **Phelps M E, Hoffman E J, Mullani N A, Higgins C S & Ter Pogossian M M.** Design considerations for a positron emission transaxial tomograph (PETT III). *IEEE Trans. Nucl. Sci.* 23:516-22, 1976. (Cited 45 times.)
3. **Phelps M E & Mazziotta J C.** Positron emission tomography: human brain function and biochemistry. *Science* 228:799-809, 1985.
4. **Phelps M E, Mazziotta J C & Schelbert H R, eds.** *Positron emission tomography and autoradiography: principle and applications for the brain and heart.* New York: Raven Press, 1986. 690 p.