LETTERS TO THE EDITOR

PET = Positron+Electron Transmutation

Historically, Einstein taught us 75 years ago (*1*) that matter and energy are but different forms of the same physical entity. The proportionality constant he derived to relate them is the velocity of light squared, and the equality becomes $E = mc^2$. This famous simple equation implies that, under appropriate conditions, matter may be transmuted into energy, and vice versa. A minuscule bit of matter disappears as such by transmutation *spontaneously* into any of the various forms of energy, the manifestations of which make the nuclear disintegrations of radionuclides useful to us in "nuclear" medicine. In fact, Einstein implied in his brief paper (*1*) that proof of his theory might be found in radium salts where the changes in mass may be sufficiently great to be demonstrable.

And even Newton is said to have commented (*2*) centuries before Einstein upon the delight of nature in transmutations in respect to the changing of bodies into light, and light into bodies when he posed the question as to whether gross bodies and light are convertible one into the other.

Instruments and technologies rapidly are emerging that depend upon *events that follow* the emission of a positron, usually. The discovery of this mode of radioactive decay was involved coincidentally with the discovery of artificial radioactivity by F. Joliot and I. Curie in Paris in 1934 (*3*) when they found that phosphorus-30 and nitrogen-13 emitted positrons. Whenever a positron is emitted from the nucleus of a "positron emitter" [$^{+}\beta$-nuclide] into matter, such as tissues and organs, it very *rapidly* loses its kinetic energy by repeated encounters with negative electrons until it coalesces transiently with one of them and the positron+electron pair then transmutes from matter into energy. Predominantly, this energy manifests itself as two $^{\pm}\gamma$-quanta each of which usually has an energy of 511 keV, the energy equivalent to the mass of an electron, in accordance with Einstein's equation, $E = mc^2$. Here, m is 9.1×10^{-28} g, the mass of each electron, at rest. To conserve momentum, the two $^{\pm}\gamma$-quanta are emitted "back-to-back" at 180 ± 0.3 degrees to each other. Obviously, then, *transmutation* of matter into energy occurs; but "annihilation" does not, for we continue to recognize the same entity *in another physical form.* Obviously, too, the term, "annihilation," is a misnomer, although it has come into fairly common usage. In a consideration of the word, *transmute,* in a standard dictionary (*4*), Gerard Piel states ... "energy converts into matter as naturally as matter transmutes into energy."

Exploitation of the inherent "directionality," usually available incidental to emission of the two $^{\pm}\gamma$-quanta to locate the positions taken by accumulations of $^{+}\beta$-nuclides in biomedical matter, first was advocated and demonstrated three decades ago (*5*). Several advances in the pertinent instrumentation have taken place since then (*6*) and a plethora of terms have appeared to symbolize the same phenomena.

Since the basic physical process involved is the *transmutation* of a positron+electron pair predominantly into the two 511-keV $^{\pm}\gamma$-quanta, it seems appropriate that the acronym, PET, might be adopted to serve as a suitable succinct symbolic abbreviation for the compound term, "Positron+Electron Transmutation." "PET camera" more realistically indicates the inherent physical phenomena upon which the instrument depends than does "positron camera." "PET Tomography" (*6*) also more aptly expresses the nature of the process, which rapidly is becoming a significant part of nuclear biomedicine, than does "Positron Emission Tomography." To be sure, the emission of a positron is involved; but, it is the transmutation *subsequently* of the positron+electron pair into the $^{\pm}\gamma$-quanta pair, which is the essential central feature of the process that interests us.

Then, out of respect for, and our appreciation of, the intuition of Einstein (*1*), as we enter the second century following his birth, the current historian of The Society of Nuclear Medicine suggests that we annihilate "annihilate" from our terminology when we wish to indicate the occurrence of "Positron+Electron Transmutation" by adopting the acronym, PET, to symbolize the phenomenon. It seems desirable that we would wish to choose a symbolism that approaches as nearly as possible to "where the action is" of the physical process we are exploiting.

In this way we will avoid the pitfalls stemming from loose terminology, described long ago (*7*) ... "Come, let us go down, and there make such a babble of their language that they will not understand one another's speech." ... Incidentally, this historian was unable to find an *earlier* reference to support his point of view.

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Formatter Linearity

The recent publication of the Nuclear Section of the Diagnostic, Imaging and Therapy Systems Division of NEMA represents a major stride toward industry uniformity with their publication, *The NEMA Standard Publication/No NU 1-1980 "Performance Measurements of Scintillation Cameras."* The industry has long needed such a set of standards for reference for the manufacture, sale, and maintenance of scintillation cameras.

Workers in the field realize that spatial resolution, field-flood uniformity, and spatial linearity are important parameters for the