3. HUANG S-C, PHELPS ME, HOFFMAN EJ, et al: Noninvasive determination of local cerebral metabolic rate of glucose in man. *Am J Physiol* 238:E69-E82, 1980
4. GRAHAM M, SPENCE AM, LARSON SM: Glucose metabolic rates in transplanted astrocytic gliomas in rats. *J Cereb Blood Flow Metab* 3:SI:S41-S42, 1983
5. WELCH MJ: New radiopharmaceuticals for studying liver function. *J Nucl Med* 23:1138-1139, 1982
6. SOKOLOFF L: The deoxyglucose method: theory and practice *Eur Neuro* 20:137-145, 1981
7. HUANG S-C, PHELPS ME, HOFFMAN EJ, et al: Error sensitivity of fluorodeoxyglucose method for measurement of cerebral metabolic rate of glucose. *J Cereb Blood Flow Metab* 1:391-401, 1981
8. BROOKS RA: Alternative formula for glucose utilization using labeled deoxyglucose. *J Nucl Med* 23:538-539, 1982
9. HAWKINS RA, PHELPS ME, HUANG SC, et al: Effect of ischemia on quantification of local cerebral glucose metabolic rate in man. *J Cereb Blood Flow Metab* 1:37-51, 1981

Reply

We thank Dr. Gjedde for supporting our point that variability in rate constants for deoxyglucose is not a serious problem. Further, as mentioned in our letter (*1*), we agree that the more important problem is possible variations in the lumped constant. In our brain-tumor article (*2*), we emphasized that the results (showing high uptake in high-grade gliomas) were obtained strictly with F-18 deoxyglucose (FDG) and do not necessarily reflect actual glucose utilization. Nevertheless we are perhaps more sanguine that such a correlation exists (i.e., that the lumped constant is relatively unchanged). In tissue-culture lines obtained from six of the patients, we indeed found a strong correlation between the in vitro glucose uptake and the tumor FDG activity observed in situ by positron emission tomography (*3*).

We emphasize, however, that the usefulness of the brain-tumor study rests primarily on the empirical correlation with tumor grade and not on the theoretical indication of glucose utilization. In fact, if it should unexpectedly turn out that glucose utilization, unlike FDG, is not increased in high-grade tumors, then the use of FDG would be *de rigueur* for this application.

Finally, we wonder whether "oversimplification," like beauty, lies mainly in the eye of the beholder.

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REFERENCES

1. BROOKS RA, DI CHIRO G, PATRONAS NJ: Re: In vivo methods for measuring regional glucose metabolic rate (GIMR). (reply) *J Nucl Med* 24:367, 1983
2. DI CHIRO G, DELAPAZ RL, BROOKS RA, et al.: Glucose utilization of cerebral gliomas measured by [^{18}F] fluorodeoxyglucose and positron emission tomography. *Neurology* 32:1323-1329, 1982
3. KORNBLITH PL, CUMMINS CJ, SMITH BH, BROOKS RA, Patronas NJ, Di Chiro G: Correlation of experimental and clinical studies of metabolism by PET scanning. In *Progress in Experimental Brain Tumor Research.* Rosenblum ML, Wilson CB, eds. Basel, S. Karger AG: in press

Re: Time-of-Flight Positron-Emission Tomography Status Relative to Conventional PET

In the editorial by Thomas F. Budinger, some of the analyses of the factors affecting the usefulness of time-of-flight positron-emission tomography may lead, if not properly interpreted, to erroneous conclusions (*1*). Table 1 includes a comparison of the sensitivities of BGO (0.62) and BaF_2 (0.30) crystals for the coincidence detection of annihilation photons. From these values the statement is made that "the poor efficiency of the scintillation detector detracts from the relative sensitivity gain of TOFPET over conventional PET." The values tabulated are for crystals 30 mm in depth, and that thickness was apparently selected as "representative of contemporary approaches." There is no good reason for selecting this particular crystal thickness for TOFPET detectors. Indeed, the three TOFPET devices that have been constructed so far use crystals from 40 mm (LETI) to 45 mm (Washington University and University of Texas) thick. If Table 1 were to include a sensitivity figure for a BaF_2 (or a CsF) crystal 45 mm deep, the crystal's efficiency coincidence would be about 0.74 (*2*). While it is true that the linear absorption coefficients for 511-keV photons in CsF or BaF_2 are lower than for BGO, it does not follow that sufficiently thick CsF or BaF_2 crystals cannot yield an efficiency comparable to thinner BGO crystals. Mullani et al. (Ref. 14 in the above editorial) have demonstrated experimentally that the difference in efficiency yielded between properly designed CsF and BGO crystals is small.

In the above editorial (p. 76), an expression for the spatial error resulting from a difference in interaction depths in opposing detectors is incorrect and incomplete. The maximum timing error for crystals of length z and refractive index n is:

$$\Delta t = \frac{z}{c}(n - 1) \tag{1}$$

and from Eq. 1 of the editorial

$$\Delta x = \frac{z}{2}(n - 1) \tag{2}$$

not

$$z - \frac{z}{n} \tag{3}$$

as shown in the editorial.

Equation (2) provides the value of Δx for one coincidence event. For a number of events the maximum value for Δx is bounded by:

$$z(n - 1) \tag{4}$$

In addition, this expression is inadequate because it does not take into account the exponential absorption of the annihilation photons, whereby this maximum error becomes a very low-probability event. In a thorough analysis of this effect, Gregory has calculated a 53-psec FWHM contribution to time-of-flight uncertainty for 5.13-cm CsF detectors (*3*).

In the editorial, the heart is used as an example of an organ for which the utilization of TOF would yield marginal gains because of the small size of the distribution of the activity. While it is established that the TOF gains decrease with the size of the area imaged, the human heart is an unfortunate selection of an example of that situation because this choice overlooks an important practical aspect of cardiac imaging. In the overwhelming majority of human subjects, a portion of the heart is coplanar in transverse tomographic planes with the liver (see Fig. 1), and the liver often highly concentrates the radiopharmaceuticals (such as labeled