$$SUV = C(T)/(\text{injected amount} \div \text{body mass})$$

$$= C(T)/(Cp(0)V_o), \quad \text{Eq. 2}$$

where V_o is an initial distribution volume implicitly defined here. V_o would be dimensionless if the convention of using activities per unit mass for C and Cp is adopted.

To further understand FUR usage, it is helpful to have an appreciation of the relationships among FUR, SUV and Patlak parameters. Dividing Equations 1 and 2 leads to:

$$FUR = SUVk_pV_o, \quad \text{Eq. 3}$$

where k_p is an average plasma clearance rate for time T:

$$k_p = Cp(0) \Big/ \int_0^T Cp(t)\,dt. \quad \text{Eq. 4}$$

If Cp were describable as $\Sigma A_i \exp(-a_i t)$, then at large T (somewhat greater the smallest a_i^{-1}) k_p approaches the reciprocal of a weighted sum of the a_i^{-1}'s.

To relate FUR to Patlak analysis, one only need multiply Equation 1 by the equivalent time $\int_0^T Cp(t)\,dt/Cp(T)$. Then FUR is seen as approximately the Patlak slope—to the extent that at large T the effective distribution volume term in Patlak analysis is not important.

In summary, the FUR should be recognized as an approximation to the Patlak slope, which is an easily obtained and preferable quantifier. FUR and SUV are proportional, related by plasma clearance rate and a dimensionless initial distribution volume. These proportionality constants also provide some understandings for the unexplained scatter seen in typical (*2*) Patlak slope and SUV correlations in a population of varying plasma dynamics: the former not having plasma variabilities.

REFERENCES

1. Ishizu K, Nishizawa S, Yonekura Y, et al. Effects of hyperglycemia on FDG uptake in human brain and glioma. *J Nucl Med* 1994;35:1104–1115.
2. Leskinen-Kallio S, Nagren K, Lehikoinen P, et al. Carbon-11-methionine and PET is an effective method to image head and neck cancer. *J Nucl Med* 1992;33:691–695.

Joseph A. Thie
University of Tennessee
Knoxville, Tennessee

REPLY: We entirely agree with Dr. Thie's concerns and appreciate the opportunity to further discuss this subject. In our study (*1*), we intended to obtain the quantitative parameter of FDG uptake in normal tissues as well as in tumors. Because the plasma clearance of FDG varies according to plasma glucose level, we introduced the concept of fractional uptake (FU) in order to normalize the variability of arterial input function. Dr. Thie indicated that FU is not a dimmensionless parameter and it has dimensions of reciprocal time. He also suggested calling this parameter fractional uptake rate (FUR) and we agree with his suggestion.

$$FUR = C(T) \Big/ \int_0^T Cp(t)\,dt\ (1/\text{min}). \quad \text{Eq. 1}$$

In this equation, T is the middle time of the PET scan. Because static PET scan was performed from 40 to 60 min after FDG injection in our study, T was 50 min for all patients.

Dr. Thie clarified the relationships among FUR, SUV and Patlak parameters and concluded that FUR was an easily obtained and preferable quantitative parameter. FUR may not be recommended for all quantitative studies because it needs serial arterial samplings. This procedure is, however, widely performed in many quantitative studies which evaluate, for example, rate constants with compartment model analysis, cerebral metabolic rate of glucose with Phelps' method or Patlak parameters (*2–4*). We believe that FUR can give additional, useful information about tracer uptake in these studies.

In FDG-PET studies especially, FUR can be converted to the more physiological parameter FURGlu by introduction of a lumped constant (*2*):

$$FURGlu = \frac{\text{plasma glucose concentration}}{\text{lumped constant}} \times FUR\ (\mu\text{mole}/100\ \text{g/min}). \quad \text{Eq. 2}$$

FURGlu does not represent glucose metabolic rate directly, but we think it is a reliable parameter of glucose uptake rate when the lumped constant is known or assumed to be a constant (*5*). We believe both FUR and FURGlu would be simple and reliable parameters and should be estimated before calculation of more complicated parameters.

REFERENCES

1. Ishizu K, Nishizawa S, Yonekura Y, et al. Effects of hyperglycemia on FDG uptake in human brain and glioma. *J Nucl Med* 1994;35:1104–1109.
2. Sokoloff L, Reivich M, Kennedy C, et al. The [^{14}C]deoxyglucose method for the measurement of local cerebral glucose utilization: theory, procedure and normal values in the conscious and anesthetized albino rat. *J Neurochem* 1977;28:897–916.
3. Phelps ME, Huang S-C, Hoffman EJ, Selin C, Sokolloff L, Kuhl DE. Tomographic measurement of local cerebral glucose metabolic rate in humans with [^{18}F]-2-fluoro-deoxy-D-glucose: validation of method. *Ann Neurol* 1979; 6:371–388.
4. Tamaki N, Yonekura Y, Kawamoto M, et al. Simple quantification of regional myocardial uptake of fluorine-18-deoxyglucose in the fasting condition. *J Nucl Med* 1991;32:2152–2157.
5. Lindholm P, Minn H, Leskinen-Kallio S, et al. Influence of the blood glucose concentration on FDG uptake in cancer—a PET study. *J Nucl Med* 1993; 34:1–6.

Koichi Ishizu
Yoshiharu Yonekura
Faculty of Medicine
Kyoto University
Kyoto, Japan

Early and Delayed Technetium-99m-ECD Brain SPECT in Stroke

TO THE EDITOR: We read with interest the article by Moretti et al. (*1*) dealing with the comparison of ^{99m}Tc-ethylcysteinate dimer (ECD) and ^{123}I-isopropyliodoamphetamine (IMP) for brain SPECT imaging in subacute stroke. The study was a part of a multicenter trial on ECD. The authors compared the washout from various brain regions during early and delayed SPECT acquisition. Early acquisition was started 50–120 min and delayed acquisition 130–420 min after tracer injection, respectively. The study revealed—besides a slightly, but not significantly, higher accuracy of ECD for the detection of the infarct—a higher washout of ECD from ischemic parietal zones than from normal pari-