Simplified Methods for Quantification of ^{18}F-Fluoromethylcholine Uptake: Is $SUV_{AUC,PP}$ Actually an SUV?

TO THE EDITOR: Verwer et al. (*1*) recently presented a study aimed at validating the use of simplified methods for quantification of ^{18}F-fluoromethylcholine uptake in a routine clinical setting of prostate cancer patients. The authors nicely demonstrated that ^{18}F-fluoromethylcholine uptake should be quantified using full kinetic modeling involving a single-tissue-compartment model with irreversible trapping and a blood volume parameter, in combination with a metabolite-corrected plasma input function based on invasive arterial blood sampling. The authors proposed—as a noninvasive simplified method based on 2 consecutive static PET scans—the use of the ratio ($SUV_{AUC,PP}$) of lesion activity concentrations ($A_L(t)$, assessed 30–40 min after injection) normalized to the area under the curve of the metabolite-corrected plasma input function (AUC_{PP}, computed over 0–30 min after injection). This ratio provided an excellent correlation to the uptake rate constant of the full kinetic modeling (Fig. 6C; $SUV_{AUC,PP} = 14.54 \times K_1 + 0.02$; $R^2 = 0.91$) (*1*).

We would like to point out that the slope of the fit reveals a discrepancy of 14.54 between $SUV_{AUC,PP}$ and K_1, whereas $SUV_{AUC,PP}$ should be considered as a noninvasive surrogate for K_1 and a slope around 1 should be expected. Indeed, as previously shown by Patlak (*2*), $K_1 = A_L(t)/AUC_{PP}$, which is actually the $SUV_{AUC,PP}$ definition. Therefore, corrections to the $SUV_{AUC,PP}$ outcomes reported by Verwer et al. may be proposed for a better comparison with K_1. For this comparison, an analytic expression for AUC_{PP} and hence for $SUV_{AUC,PP}$, as simple as possible, is needed to clarify the unit of each parameter. Let us assume that the metabolite-corrected plasma input function monoexponentially decays with a (decay-corrected) time constant α: then $AUC_{PP} = A_0/\alpha \times [1 - \exp(-\alpha T)]$, with T = 30 min and A_0 the initial (virtual) metabolite-corrected plasma activity concentration (*3*). AUC_{PP} is the total number of disintegrations per milliliter (of blood) that have occurred over the time range 0–T; A_0 is expressed in Bq/mL, that is, number of disintegrations per second and per milliliter; $[1 - \exp(-\alpha T)]$ has no dimension; α is expressed in s^{-1} because A_0 involves becquerels (i.e., equivalent to s^{-1}). Finally, $SUV_{AUC,PP}$ is expressed in s^{-1} because of the $A_L(t)$ unit, which is Bq/mL. To consistently compare $SUV_{AUC,PP}$ and K_1, we suggest that 2 corrective factors should be applied. First, because in current practice $A_L(t)$ is usually expressed in kBq/mL rather than in Bq/mL, A_0 should then be expressed in kBq/mL instead of in MBq/mL, as indicated in Figure 6C (and in Supplemental Fig. 2C) (*1*): the corrective factor is 1/1,000. Second, because K_1 is usually expressed in min^{-1} rather than in s^{-1} (the axis units in Fig. 6C and supplemental Fig. 2C are not clearly indicated), the corrective factor is 60. As a result, we suggest that the $SUV_{AUC,PP}$ outcomes reported by Verwer et al. should be multiplied by a corrective factor of 60/1,000, leading to a further slope of 0.87 instead of 14.54 in Figure 6C.

In conclusion, Verwer et al. convincingly demonstrated that, instead of SUV, $SUV_{AUC,PP}$ could be used in current clinical practice to noninvasively quantify ^{18}F-fluoromethylcholine uptake in prostate cancer patients. We further suggest that $SUV_{AUC,PP}$ is actually an uptake rate constant rather than an SUV (usually expressed in min^{-1} and g/mL, respectively) and that the above-proposed correction strengthens its relevance.

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REPLY: We would like to thank Laffon and coworkers for their interest in our paper (*1*), as well as for their valuable comments and for giving us the opportunity to further clarify our results.

In our paper we aimed to find a simplified method for quantification of ^{18}F-fluoromethylcholine uptake. The most common simplified metric to quantify tracer uptake is the standardized uptake value (SUV), which represents tracer concentration at a certain time normalized to injected activity and a factor representing distribution volume (e.g., weight, lean body mass, or body surface area). This normalization is used as a surrogate for the integrated availability of the radiotracer to the tumor.

One of the aims of full kinetic analysis is to identify and validate these simplified methods or normalization factors. In our study, we found that commonly used normalization factors such as injected activity per weight, lean body mass, or body surface area were not appropriate surrogates for the integrated availability of the radiotracer to the tumor, that is, the integral of the input function. Therefore, we proposed a dual-scan procedure in which the first scan is used to directly measure this integral, which is then used to normalize tracer uptake measured in the second scan. We would argue that the unit of the normalization factor does not qualify or disqualify the simplified measure from being termed an SUV, since commonly used normalization factors such as body weight or body surface area also yield SUV in different units.

Nevertheless, the authors are correct in their observation that we have not consistently used the same units in nominators and denominators of the relevant equations and we could have been