Journal of Nuclear Medicine, published on January 19, 2017 as doi:10.2967/jnumed.116.187757

Variation in maximum count rates during myocardial blood flow quantification using Rubidium-82 PET

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Funding: None
Manuscript type: Letter to the Editor
Potential conflicts of interest: None (all authors)

Author contributions

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TO THE EDITOR:

With great interest we read the recent article by Renaud et al. entitled: *'Characterization of 3D PET systems for accurate quantification of myocardial blood flow'* published online on Augustus 18 2016 (1). The authors describe a method to obtain the maximum injected activity for which accurate quantification of myocardial blood flow (MBF) can be achieved. We think that this method majorly contributes to the existing knowledge. It shows that accurate dynamic PET imaging is possible for a range of 3D-PET systems if maximum injected activities are respected to limit peak dead-time losses during the bolus first-pass transit.

The authors translated the maximum activities for accurate MBF as determined by phantom studies to maximum patient-specific tracer-activities (in MBq/kg). However, to our opinion, this translation might be an oversimplified approach, as the activity distribution and photon attenuation in patients during the first-pass transit do not solely depend on body weight. We think that application of the presented method may lead to higher count rates in some patients than the maximum count rates as derived from the phantom study. These higher count rates may subsequently hamper accurate MBF quantification.

To ground our viewpoint, we obtained the maximum prompt coincidence count rate on our PET system (Ingenuity TF, Philips Healthcare) using the same phantom as described by Renaud et al. (1). Next, we retrospectively obtained the maximum accepted count rates during myocardial perfusion imaging in rest, with Rb-82 PET in 72 consecutive patients. All patients provided written informed consent for the use of their data for research purposes. An activity of 740 MBq was injected at a flow of 50 ml/min (CardioGen-82, Bracco Diagnostics Inc.) in the phantom and in patients. Next, we studied the effect of using the recommended injected activity/body-weight as proposed by Renaud et al. (1). Therefore, we multiplied the measured maximum count-rate, normalized to the injected activity, with body weight and 4.6 MBq/kg for each patient. This way we obtained a simulated maximum count-rate when using 4.6 MBq/kg. We chose 4.6 MBq/kg as this is the maximum activity/body-weight ensuring accurate quantification for a comparable PET system (Gemini, Philips Healthcare) (1). The body-weight equivalent of the phantom was set at 50 kg (1).

The maximum simulated count rate for the phantom was 2,001 kcps. The mean body-weight of the included patients was 86 ± 17 kg and the BMI 28.6 ± 5.4 kg/m^2. We found a mean simulated maximum count rate of 2,975 ± 681 kcps, with a large range of 909 to 4,431 kcps (see also Appendix 1). In 66 patients (92%) we found a maximum count rate that was higher than 2,001 kcps, the value that we derived from our phantom study. This implies that the suggested translation to 4.6 MBq/kg may result in count rates exceeding the 10% activity bias criteria (1) in 92% of the patients, possibly leading to biased MBF measurements. Nevertheless, our results support the use of a weight-based activity, as this resulted in simulated maximum count rates that were independent of body weight.

Applying a lower maximum injected weight-based activity than as suggested by Renaud et al. (1) can account for the large variation in maximum count rates encountered in patients and may prevent biased MBF measurements. To ensure accurate MBF quantification with Rb-82 PET across all patients, we therefore suggest to include a correction in the translation of phantom results to the maximum weight-based activity in patients.

REFERENCES

1. Renaud JM, Yip K, Guimond J, et al. Characterization of 3D PET systems for accurate quantification of myocardial blood flow. *J Nucl Med*. 2016:Aug 18, Epub ahead of print.

Appendix:

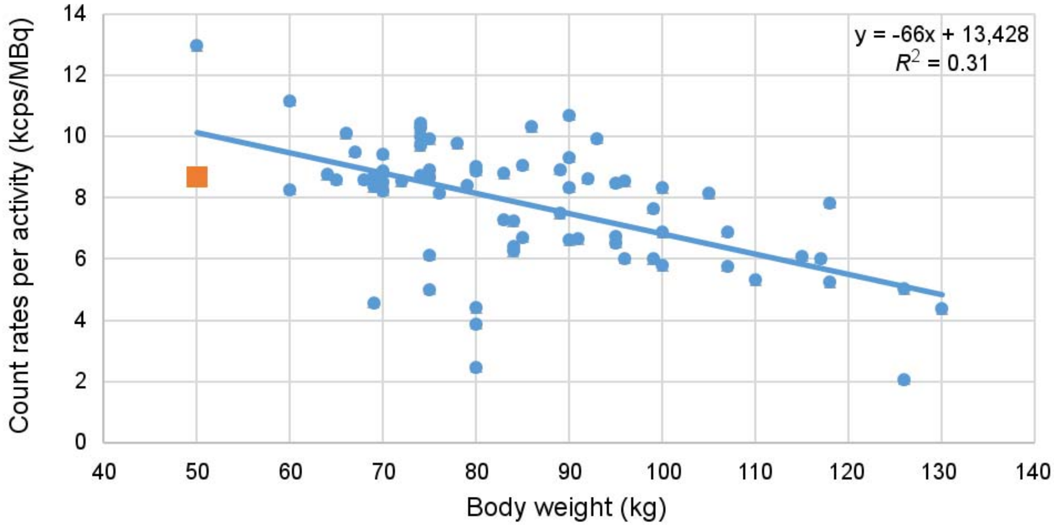

Figure 1. Maximum count rates as encountered in patients (dots) and in the phantom (square), normalized to the Rb-82 tracer activity, as a function of body weight. The line represents a linear fit. The fit result and coefficient of determination are included in the top right corner.

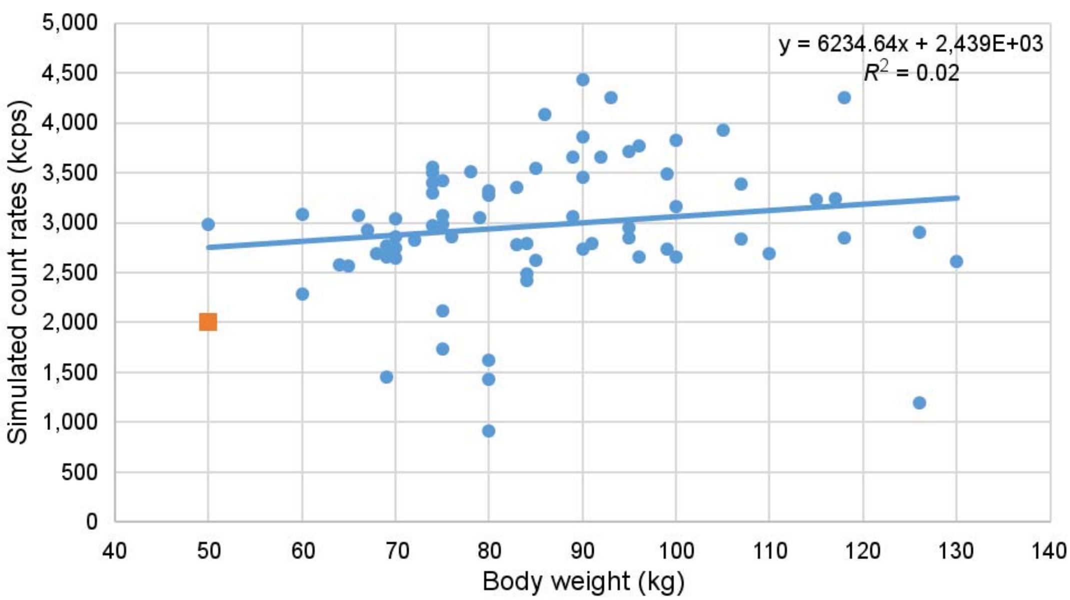

Figure 2. Simulated maximum count rates in patients (dots) and in the phantom (square) when applying 4.6 MBq/kg Rb-82 as a function of body weight. The dashed line represents a linear fit. The fit result and coefficient of determination are included in the top right corner. The maximum simulated count rate was higher in 92% of the patients compared to the phantom result. Furthermore, there was no significant correlation between maximum count rate and body weight when applying 4.6 MBq/kg.