Data-Driven Respiratory Motion Correction in Clinical PET - A Turning Point

Matthew D Walker[1], Kevin M Bradley[2,3], Daniel R McGowan[1,4]

[1]Radiation Physics and Protection, Oxford University Hospitals NHS FT, Oxford, UK.

[2]Department of Radiology, Oxford University Hospitals NHS FT, Oxford, UK.

[3]Wales Research & Diagnostic PET Imaging Centre, Cardiff University, Cardiff, UK

[4]Department of Oncology, University of Oxford, Oxford, UK.

First and Corresponding Author:

Dr Matthew D Walker, Radiation Physics and Protection, Churchill Hospital, Oxford, OX3 7LE, UK. Telephone: + 44(0)1865 226718. Email: matthew.walker@ouh.nhs.uk ORCID 0000-0003-0829-0869

Disclosure: OUH has a research contract with GE Healthcare covering loan of equipment, but without financial support. No other potential conflicts of interest relevant to this article exist.

Short title: Data-Driven Respiratory Gating for PET

Word Count: 795

Dear Dr. Czernin,

Dr. Kesner's letter regarding our recent publication *(1)* raises several useful points. We wholeheartedly agree that data-driven gating is an important innovation. Indeed, the launch of a commercial implementation provides opportunity for celebration of this success and for reflection on the journey. The many teams involved in both academic institutions and industry should be rightly satisfied by this achievement, and it should spur them and others to continue pushing for further improvements and innovations for the benefit of the many patients whom we humbly serve.

We are grateful to Dr. Kesner for raising the awareness of some current and past developments relating to data-driven gating in PET, including the valuable contributions of him and his co-workers. He has championed this field for many years *(2–4)*. We do however note that while commercial developments often take inspiration from academic publications, such developments can also include specific innovations or implementation details that are kept outside the public domain. We hence take this opportunity to also acknowledge the contributions of the many exceptional scientists and developers that rarely publish in the academic literature.

In our recent work we cited the work of Dr. Kesner in both the introduction and discussion, but made a conscious decision not to include an overview of the general development of data-driven gating techniques. Instead, we provided the key references that relate to the specific commercially developed solution to which our manuscript was concerned. Likewise, and as noted in our discussion, we chose not to include an extensive comparison to different algorithms. Rather, we chose to keep our discussion focused on aspects of the commercial solution and to keep our manuscript within the journal's word limit. We considered that the main interest in our work would come from that part of the JNM readership directly employed as

healthcare professionals. For this subset of the readership, the performance of the clinically available software and the limitations of our testing were considered the most important topics for discussion, and these were prioritised over a comparison of the performance of different algorithms or software that is currently absent from the clinic. While an extended discussion of the many non-approved DDG algorithms (and their differences) had interest and value, it did not make the final cut. To give some justification, consider the length of the letter from Dr. Kesner which covers just some of these points: it is 1/3rd of the word limit for our entire manuscript. We also feel that a comparison of the commercial solution with other algorithms is best achieved via a dedicated study on a common dataset. We hence respectfully disagree with the assertion that we did not "properly" reference his work, or that his works have not been acknowledged. In fact they are acknowledged through various citations and discussions in each of our recent publications on this topic *(1,5,6)*. We are happy to acknowledge them once again.

As the translation of this technology into a clinical product is an exciting landmark, we suggest that now may be an appropriate moment for others to provide an objective review of this technology and the potential for further development.

Sincerely,

Drs. Matthew D Walker, Kevin M Bradley, Daniel R McGowan

REFERENCES

[1] Walker MD, Morgan AJ, Bradley KM, McGowan DR. Data Driven Respiratory Gating Outperforms Device-Based Gating for Clinical FDG PET/CT. *J Nucl Med*. Apr 3, 2020 [Epub ahead of print].

[2] Kesner AL, Koo PJ. On noting the achievements and future potential of data-driven gating for respiratory motion correction in PET imaging. *Nucl Med Commun*. 2014;35:893.

[3] Kesner AL. The relevance of data driven motion correction in diagnostic PET. *Eur J Nucl Med Mol Imaging*. 2017;44:2326-2327.

[4] Kesner A, Schmidtlein CR, Kuntner C. Real-time data-driven motion correction in PET. *EJNMMI Phys*. 2019;6:3.

[5] Walker MD, Bradley KM, McGowan DR. Evaluation of principal component analysis-based data-driven respiratory gating for positron emission tomography. *Br J Radiol*. 2018;91:20170793.

[6] Walker MD, Morgan AJ, Bradley KM, McGowan DR. Evaluation of data-driven respiratory gating waveforms for clinical PET imaging. *EJNMMI Res*. 2019;9:1.