Author’s response to reviews

Title: Assessing and Reducing PET Radiotracer Infiltration Rates: A Single Center Experience in Injection Quality Monitoring Methods and Quality Improvement

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Response to Reviewers

The authors appreciate the reviewers comments and believe the feedback received and implemented has helped our work be more impactful. The manuscript has been updated in a number of areas, with specific reviewer comments addressed as follows:

Reviewer 1

The instrument seems to be an useful object; can quantify the injection and infiltration processes and help the medical physicist and nuc med practitioners to be more accurate in analyses; but few points:

1. There was no significant correlation between reference SUVs and injection score? Which the authors should explain more?

   a. Additional information was added to the abstract and to the manuscript that further describes the reference SUV and injection score comparison. In this work, our reference region of interest used was the liver, as that is a standard baseline region for diagnostic PET imaging assessment. In this study, we assessed whether or not any correlation existed between SUVs calculated from regions drawn in the liver and injection score, and we found no such correlation. Since the injection score is associated with the injection quality, the fact that liver SUVs do not track with those values helps show that the liver SUV alone cannot be used to determine whether a patient injection has been compromised.
2. Is there any difference between putting instruments in lower limbs instead of upper limbs in such analyses?
   
a. Although this is not part of this work, we have placed control detectors on other limbs. One detector must be placed near the injection site, while placing the control detector on either the arm or other limbs does not make a significant difference in the assessment of whether the bolus returns to baseline quickly.

Reviewer 2

GENERAL COMMENTS: The manuscript describes the results of a single institutional study measuring the infiltration rates in radiotracer injections for PET/CT imaging. The authors aimed to develop an actionable quality improvement plan to reduce infiltrations and to compare injection scoring to PET/CT imaging results. REQUESTED REVISIONS:

1. I would suggest the authors providing more information regarding the scoring system about the quality of injection in the abstract for the abstract readers.
   
a. The abstract has been updated to include information about the scoring system and more details have been added to the manuscript. A brief description of the system is below for the reviewers.
   
b. In this study, we use a device that is FDA listed for the purposes of monitoring injection quality. This system enables us to collect the time activity curves associated with the injection and then upload those curves to a web-based platform that also provides a score that is related to the quality of the injection. A detector is placed on each arm and time activity curves collected. The quality of the injection is assessed by the web-based system based on the shape of the bolus and how quickly it returns to a baseline value after injection.

2. "value being too low anecdotally being associated with possible infiltration". I understand that there is no discrete value, but it would be very interesting for the readers to know what approximate SUV value you usually consider as the threshold to call suspect subcutaneous infiltration of radiotracer.
   
a. A statement on an SUV of approximately 1 being anecdotally associated with potential infiltration was added to the manuscript. An additional statement was added indicating that this was based on a survey of local radiologists that felt like they had seen a pattern of infiltrated injections associated with low SUVs in the liver.

3. "Methods", you may use "Patients and Methods". " This is true for the average PET scan, however, the authors note that severe infiltrations may result in visual changes to the data that make it evident something is wrong with a particular dataset". This statement is
not supported by your data. Your explanation needs to be supported by some evidence. At least you may consider adding a sample case. Otherwise, this statement is under question.

a. The Methods section was renamed to Patients and Methods

b. Two sample images were added to the manuscript as Figure 4 to illustrate some examples of potential visual changes that can occur with compromised injections. An additional reference was also added relating to infiltration impact on diagnostic images.

4. "information about the quality of the injection should be consistently placed into the official radiology report to provide treating physicians with key information regarding potential quality issues related to a metabolic study". This is a very good idea. I would like to invite the authors to further develop this idea. For example, in CT angiography coronary arteries, there is a scoring system for the quality of imaging. This usually comes in the very first parts of the report. You may also consider suggesting a kind of scoring system about the quality of injection to be included in the radiology reports of PET/CT exams.

a. Information has been added to the manuscript that adds additional information on the language we use in our standardized reporting of infiltrations

5. Please consider comparing and contrasting your methods and findings with those of the previous studies to allow you to interpret your data within the context of the field and highlight the new information derived from your research.

a. Significant information was adding comparing and contrasting our work with previous research and adding key statements about what is specifically novel regarding our work

6. You mentioned "non-significant correlation between the injection score and SUV". So what is the clinical significance of this finding? I mean why it should be important for the radiologist reader or examiner to know if the radiotracer has been infiltrated or not. You mentioned "The misadministration or infiltration of the dose can negatively affect cancer patient staging, therapy assessment, treatment planning, and can lead to unnecessary invasive procedures and patient radiation exposure". It seems that your study findings does not support this statement.

a. A description of clinical significance has been added to the manuscript

b. Additional analysis has also been added to the manuscript to highlight the lack of correlation between standard PET/CT image values and injection quality

7. Please make sure that your text is not redundant with your tables/figures.

a. Text has been updated to be less redundant