Standardization in PET/CT Imaging Using EARL FDG-PET/CT Accreditation

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In pharmaceutical clinical trials, quantitative imaging with PET is typically used to evaluate and compare the effects of two therapies. In multi-center clinical trials, standardization is critical to ensure that all the centers involved apply the same parameters in PET imaging, in order to accurately compare the images and the quantitative values derived from those images.

Examining quantitative imaging as a biomarker for oncology multi-center clinical trials with different study designs clearly shows the need for standardization. When quantitative imaging with FDG-PET is used to evaluate response treatment, the parameters applied in image post processing can vary between imaging centers. The same challenge may be present when quantitative imaging is used to assess the staging of patient follow-up or to evaluate the response to neo-adjuvant chemotherapy.

Development of the PET Response Criteria in Solid Tumors (PERCIST) in 2009 to evaluate metabolic response was really the first step towards standardization in the interpretation of PET imaging. In a 2011 published paper, Professor Ronald Boellaard, PhD, showed that there are many methods to assess quantitative values in images, from simple to complex, and that there is a large variability in the applied PET processes and methodologies across institutions.[1] Boellaard also demonstrated the need for harmonization in the execution of PET exams, especially in terms of FDG activity and glucose status assessment, and in the actual start of the PET scan. There is also a need for harmonization in PET imaging quality control in regard to parameters such as scanner calibration, clock synchronization, and residual activities in the syringe and lines.

EANM (European Association of Nuclear Medicine) procedural guidelines, published in 2010, detailed how to proceed with an FDG acquisition from the injected dose to the reconstruction settings. This was the starting point for the EARL FDG-PET/CT accreditation program. Initiated in 2010, this program supports imaging sites that perform FDG-PET/CT oncology examinations in meeting the requirements indicated in the EANM guideline. The goal was to enhance the quality standard in PET/CT investigations for both data use and multi-center studies, and also to ensure similar performance of PET/CT systems within a multi-center setting by harmonizing acquisition and processing of PET/CT scans.

With EARL accreditation, a PET/CT center is able to compare, exchange, and combine FDG-PET/CT findings, including the SUVs in images, since data are collected and processed in a standardized manner.

In the first test—the calibration quality control test—reconstructed images of a phantom provide information about any possible calibration discrepancies between your site's PET camera and dose calibrator. You are required to use a cylindrical calibration phantom with the following characteristics: diameter of about 20 cm (17 to 22 cm) and length sufficient to cover the entire axial field of view (FOV). Furthermore the exact volume of the calibration phantom must be known and recorded in the calibration QC scan report form.

In our center we use the 1994 NEMA NU2 cylindrical PET phantom, which is prepared according to the EARL specified guidelines. Using your center's standard whole-body protocol, one acquisition of at least two PET bed positions is performed to cover the entire length of the phantom. EARL recommends at least a five-minute acquisition; we typically do a 10-minute acquisition to ensure good quality images.
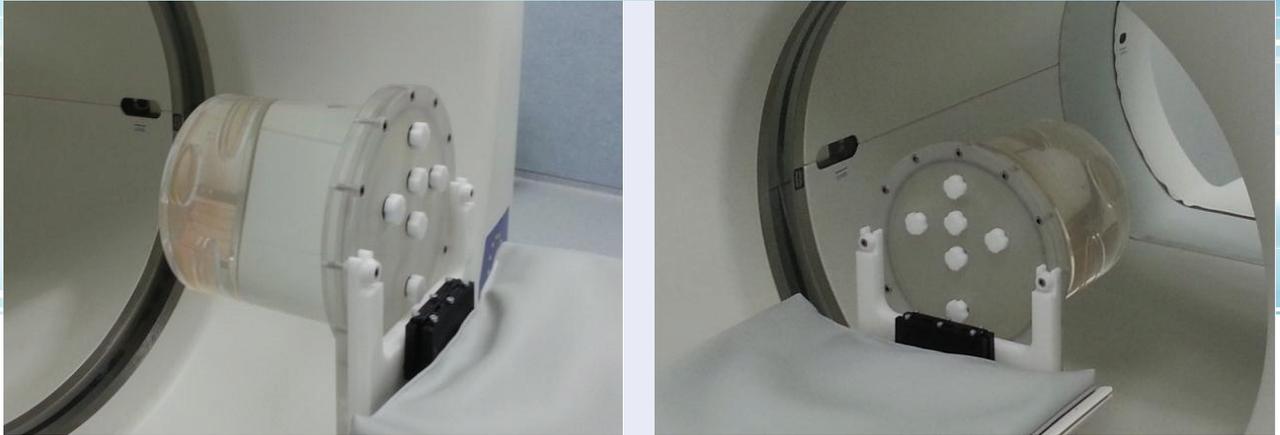
Figure 1. NEMA PET phantom.
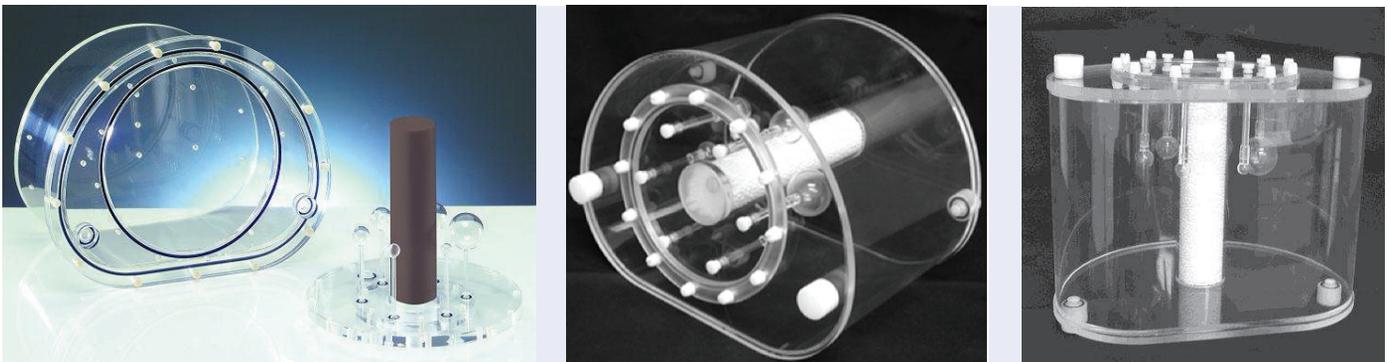
Figure 2. NEMA-NU2-2001/2007 image quality phantom.

Image reconstruction is then done with attenuation, scatter, normalization, decay, and all other corrections required for quantification.

When you submit the images, EARL will check the cross calibration factor between your PET camera and your dose calibrator, which should be equal to one. It is advisable to perform this verification before you submit the images to EARL to ensure there was no problem with your acquisition. This calibration quality control measurement will need to be repeated every three months.

Differences in SUV quantification may still occur between multiple centers in a clinical trial due to differences in the reconstruction parameters and the data analysis methodology used. For this reason, EARL requires a second test designed to check the correctness of the calibration and quantification, and to measure the activity concentration recovery coefficient as a function of sphere size.

For this test, you must use the NEMA NU2-2001/2007 image quality phantom with six different-sized spheres. The phantom is prepared according to very specific guidelines indicated by EARL and using two different solutions: one for filling the spheres and one for the background compartment. These solutions are prepared such that the sphere to background ratio equals about 10.

A routine quantitative whole body FDG-PET scan of at least two PET bed positions of at least five minutes each must be acquired. Furthermore a (low-dose) CT for attenuation correction purposes needs to be included. Image reconstruction settings are the same as those used for the first test.

From your images, EARL will determine the background calibration factor and also, for each sphere, the SUV recovery coefficient as a function of sphere size. This test must be repeated every year.

For both tests, it is critical that the same settings are used to reconstruct the images, since EARL will grant accreditation only for those reconstruction settings.

Three DICOM images must be reconstructed for submission: a non-attenuation-corrected PET image, an attenuation-corrected PET image, and a CT image. If the quality control documents you submit meet the standard requirements, your site is granted accreditation. If your documents do not meet the requirements, EARL will propose ways you can comply with the requirements—by using different reconstruction settings for example—or by performing the acquisition again, if necessary.

The criteria EARL uses to assess images submitted for accreditation were updated once after a first pilot phase of the program to account for new PET/CT camera developments. Nonetheless, there remain some limitations in PET acquisitions for multi-center clinical trials. For example, some centers are capable of performing some respiratory motion correction, while others aren't. Likewise some centers can do point spread function (PSF) modeling within the reconstruction, while others can't. These differences in data collection and processing can affect the SUVs and may cause problems in exchanging SUV between centers.

By ensuring cross calibration of your dose calibrator and your PET/CT camera as well as guaranteeing SUV recoveries within a certain bandwidth of performance, EARL FDG-PET/CT accreditation enables your imaging center to compare, exchange, and combine results consistently and confidently with other sites, and participate fully in multi-center clinical studies.

For more information on EARL, visit **http://earl.eanm.org/** ∎

References

1. Boellaard R. Need for Standardization of 18F-FDG PET/CT for Treatment Response Assessments. J Nucl Med 2011; 52:93S-100S.

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The Centre Hospitalier Universitaire de Bordeaux is a medical and academic institution that serves the south west region of France. It ranks in the top three of France's reference hospitals for surgical and medical practices. The hospital complex has 3,107 beds and 1,421 beds at the affiliated Pellegrin hospital group.