

## SUGGESTION FOR IMPROVEMENT OF PET QUALITY CONTROL TESTS IN BRAZIL

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### ABSTRACT

Nowadays nuclear medicine has a considerable importance among the other medical specialties. This medical specialty utilizes high-tech equipment for imaging in the diagnosis, obtaining information on the clinical functionality of organs and systems of the human body through the use of radioisotopes. In view of the importance of guaranteeing the image quality in SPECT and PET systems, enabling patients not repeat exams due to lack of quality control of equipment used in nuclear medicine, this paper aims to present a possible suggestion to update the quality control tests needed for quality assurance of nuclear medicine services. They were considered the requirements of the National Commission of Nuclear Energy (CNEN) and the National Health Surveillance Agency (ANVISA) in Brazil. The minimum requirements to be defined for inclusion of quality control tests on PET in the standard CNEN are extremely important because they will guide the evaluation of PET systems, determining the quality control tests to be performed. And those tests for PET will be a regulatory requirement by the CNEN and ANVISA. As the National Health Surveillance Agency has already publication of RDC 38 with recommendations for services of nuclear medicine. This study will continue with evaluation of PET systems and presenting the tests of quality control with additional objects and simulators to ensure safety in PET systems have not standardized in nuclear medicine services in Brazil.

### 1. INTRODUCTION

Nowadays nuclear medicine has a considerable importance among the other medical specialties. This medical specialty utilizes high-tech equipment for imaging in the diagnosis, obtaining information on the clinical functionality of organs and systems of the human body through the use of radioisotopes [1].

The handling of radioactive materials is required in the preparation of radioisotopes for use in patients who are submitted diagnostic procedures and therapeutic, such manipulation occurs of way routine in nuclear medicine service. There are various procedures in nuclear medicine for diagnostic purposes using specific radionuclides in the study of the physiology of organ systems the body, the Technetium ( $^{99m}\text{Tc}$ ) that has a physical half-life of 6.02 hours and is obtained by elution from molybdenum ( $^{99}\text{Mo}$ ) generators, and fluorine ( $^{18}\text{F}$ ) which is produced in cyclotron and has a physical half-life of 110 minutes are examples of radionuclides more currently used in single photon emission computed tomography (SPECT) and  $^{18}\text{F}$  in emission tomography by positrons (PET), respectively [2, 3].

The SPECT technique is used to obtain tomographic images that allow the study of organs and of some abnormalities in the human body. To This examination are administrated drugs

to the patient marked by radionuclides emitting gamma radiation. The PET system has the same functionality of SPECT, however, this technique uses only positrons emitting radionuclides. PET is more often used in neurology, oncology and cardiology. In both techniques the diagnoses are made through qualitative and quantitative analysis of digital images of organs and systems [4].

In Brazil, the National Health Surveillance Agency (in Portuguese, Agência Nacional de Vigilância Sanitária, ANVISA) published in the Resolution of Collegiate Directors (RDC) of N° 38 on 24/07/2008 in the Brazilian Official Daily a regulation for nuclear medicine services, including testing of quality control for PET. Before that, the ANVISA convened several entities, including Brazilian Society of Biology and Nuclear Medicine (in Portuguese, Sociedade Brasileira de Biologia e Medicina Nuclear, SBBMN) has discussed the regulation of plant and operation of Nuclear Medicine "in vivo" [5].

Several authors have been searching methods to improve the quality control in nuclear medicine. MacFarlane and colleagues (2006) report that there is no quality control tests required for PET and consider the standard technique of nuclear medicine of American College of Radiology for performing tests. According to the authors, each nuclear medicine department should submit a summary of quality control, such as frequency of testing that is done in each asend PET, performance of equipment, qualification of personnel and image quality [6].

The tests suggested by the International Atomic Energy Agency (IAEA) and National Commission of Nuclear Energy (in Portuguese, Comissão Nacional de Energia Nuclear, CNEN) are for gamma camera for SPECT and planar imaging, as can be seen in TECDOC-317, TECDOC-602 and CNEN-NN-3.05 [7-9]. The National Electrical Manufacturer's Association (NEMA) has published criteria for PET and dedicated PET, as the standards NU2-1994 and NU2-1994-2001, these are useful for quality control tests. It should be noted that Brazil does not yet have specific regulations for PET [10-12].

In view of the importance of ensuring the image quality in SPECT and PET systems, this paper aims to discuss a possible suggestion to improve the quality control tests of nuclear medicine services in order to obtain most current quality standards to evaluation of SPECT and PET cameras.

## **2. METHODOLOGY**

Suggestions were made from the standard CNEN-NN-3.05. These suggestions are based on documents already published, such as: the 2003 Revision of the Society of Nuclear Medicine Performance and Responsibility Guidelines for NMT that presents the recommendations for quality control tests and frequency required for each test [8]; ANVISA in RDC 38, published in 2008 and NEMA (Standard NU2-2001) [5, 11]. In principle, the proposals aim to update the standard with the inclusion of specificities in CNEN-NN-3.05 about PET and PET/CT.

These minimum requirements to be defined for inclusion of quality control tests on PET in the standard CNEN are extremely important because they will guide the evaluation of PET systems, determining the quality control tests to be performed. It is expected that these tests

for PET will be the regulatory requirements of the CNEN or ANVISA. In order to evaluate the PET quality control the minimal tests are described below:

Quality control tests on positron emission tomography:

- uniformity;
- energy resolution;
- accuracy in the correction of random events ;
- sensitivity;
- transverse and axial spatial resolution;
- intrinsic scattering rate;
- count rate evaluation, equipment performance;
- correction of counting loss;
- correction for random events;
- use of simulator objects (phantom model PET/NEMA94/P) for tests of uniformity, assessment of counting rate, scattering rate and a ttenuation correction;
- image quality.

### **3. RESULTS AND DISCUSSIONS**

It is important to comment that in the regulation of RDC ANVISA 38 [5] the tests of quality control suggested are properly. Thus, we only suggest that the uniformity test will be performed more frequently, rather than annual that this test can be conducted monthly. More frequent tests can prevent persistent failures witch to leading to examinations repetition by the same patient because of inconclusive results caused by defects in equipment or in the image process. After all, as some authors describe, the parameters for acceptance tests are very necessary and must be conducted according to the manufacturer's manual and NEMA recommendations.

Another important factor to be considered in quality control of PET is related to use of phantom for the testing of quality control, such as uniformity, count rate evaluation, scattering rate and the correction of attenuation. Thus, it is considered that the care required for the proper use of equipment reduces the probability of error, avoiding the unnecessary repetition of tests. Furthermore, although the radionuclides used in PET have short mean life, energy released in disintegrations is high (511 keV) if compared to the radionuclides used in SPECT. The department of nuclear medicine that has PET equipment must perform the tests described in this paper with the following frequencies (Table 1), respecting the rules presented by ANVISA, IAEA and NEMA [5, 7-13].

**Table 1. Tip for the quality control tests in PET and their respective frequencies.**

Quality control tests in PET	Frequency
Uniformity	Weekly
Sensitivity	Semester
Spatial resolution	Weekly
Fraction of scattering	Monthly
Loss of accuracy in the correction of counting	Monthly and if necessary
Accuracy in the correction of random events	Monthly and if necessary
Accuracy in image quality	Monthly and if necessary

From the moment that the National Commission of Nuclear Energy standardizes the quality control tests to dedicated PET systems, these equipments become safer than now, enabling greater security for workers in nuclear medicine services, ensuring the quality of images and preventing future incidents that may occur in PET, reducing failure witch can impede the perfect operation of nuclear medicine service. Thus enhancement in the standard allows ensure that the PET system works with accuracy and precision.

#### **4. CONCLUSIONS**

Discussions for evaluating of a proposal for improvement of quality control tests in nuclear medicine in Brazil indicates that it is important to the National Commission of Nuclear Energy standardize the testing of quality control for PET, considering their frequencies. A significant step in this improvement was given by the National Sanitary Surveillance Agency with the publication of RDC 38 (2008) that presents recommendations for services of nuclear medicine. Our study will continue with evaluation of PET systems and presenting the quality control tests with additional phantoms to ensure safety of other equipment which has not yet regulated in nuclear medicine services in Brazil.

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