Evaluation of the errors obtained in a radiopharmaceutical activity measurement using a switch pre-set for another radioisotope

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ABSTRACT

To ensure the radiation dose applied to the patient is adequate, in nuclear medicine procedures, the radiopharmaceutical activity must be adequately measured. In order to obtain assurance in activity measurement the activity meter must be calibrated in the same energy as it is used. The goal of this study is to verify the errors obtained when a radiopharmaceutical activity is measured using a radioisotope key pre-set for another radioisotope. Results show a variation from 6.1 % to 75.7 % when the correct key is not used for the measurement, which indicates the calibration must be made for each radioisotope used.

INTRODUCTION

Nuclear medicine is a medical specialty involving the application of radioactive isotopes in diseases diagnostic and/or treatment [1]. In order to ensure the radiation dose applied to the patient is adequate, the radiopharmaceutical activity must be adequately measured.

In Brazil, the activity meter calibration is not an obligation, which leads to unreliable results, generating many measurement differences [2]. Brazilian regulations only recommend periodic quality control tests [3].

The lack of traceability in activity meter measurements affects the radiopharmaceutical activity assurance, weaken image quality and/or exposing patients to higher dose levels. Studies that showed the need to develop an activity meter calibration methodology are important to highlight. [4,5]

An important activity meter characteristic must be considered before the calibration methodology establishment: these equipments have several isotopes keys, which are used to insert different radioisotopes in its memory. The calibration must be made for each radiopharmaceutical in order to avoid measurement errors.

The goal of this study is to verify the errors obtained when a radiopharmaceutical activity is measured using a radioisotope key pre-set for another radioisotope (here called *radioisotope-key combination*) and show that the calibration procedure must be made for each radiopharmaceutical used in nuclear medicine services.

MATERIALS AND METHODS

In this study a Capintec CRC-15R activity meter was used (figure 1), which has been tested using reference sources[6]. In this equipment are 13 configurable keys, which can be used to insert different radioisotope.

CRC-15R keyboard. It is possible to note some pre-set keys for some specific radioisotopes

The activities of the most used radioisotopes in Brazilian nuclear medicine services, ^{99m}Tc, ^{131}I and ^{67}Ga[7], were verified. Gamma energy and the half-life of these radioisotopes are shown in table 1.[8]

Radioisotope	**γ energy (MeV)**	**Half-life**
Tc-99m	0.143	6.01 h
Ga-67	1.000	3.26 d
I-131	0.971	8.02 d

Table 1. Gamma energy and the half-life of the most used radioisotopes in nuclear medicine in Brazil.

Each source was placed inside the well chamber. Measurements were made using four pre-set keys: the specific key for the radioisotope inserted (reference measurement) and the keys for the quality control tests sources (^{57}Co, ^{133}Ba and ^{137}Cs). A summary for this test is presented in table 2.

Radioisotope	**Pre-set key**					
	^{99m}Tc	**^{131}I**	**^{67}Ga**	**^{57}Co**	**^{133}Ba**	**^{137}Cs**
^{99m}Tc	X			X	X	X
^{131}I		X		X	X	X
^{67}Ga			X	X	X	X

Table 2. Radioisotope-key combinations used in this study

The ^{99m}Tc, ^{67}Ga and ^{131}I reference activities were taken in the activity meter using the pre-set key for each radioisotope. Ten measurements for each combination radioisotope-key were made and the mean values were compared.

RESULTS AND DISCUSSION

The results for this test are presented in table 3.

Radioisotope	Activity variation (%)		
	^{57}Co	^{137}Cs	^{133}Ba
Tc-99m	29.4 ± 0.9	63.8 ± 1.8	75.7 ± 2.2
Ga-67	6.1 ± 0.2	39.5 ± 1.1	72.9 ± 2.1
I-131	-20.1 ± 0.7	22.6 ± 0.8	65.4 ± 2.0

Table 3. Variation between the reference measurement and the value obtained using other radioisotopes keys.

A variation from 6.1 %, when the ^{67}Ga activity is measured using the ^{57}Co key, to 75.7 %, when the ^{99m}Tc activity is measured using ^{133}Ba key, was obtained. In general the activity measured using a key pre-set for another radioisotope is smaller than using the correct key. Although, when ^{131}I activity is measured using ^{57}Co pre-set key the variation is about -20.1 %, which means the activity obtained in these conditions was higher than the activity measured using the ^{131}I key.

The differences obtained in these tests show that this equipment applies some correction to the measurement, and this correction varies for each radioisotope. This is the reason why setting each key for a specific radioactive source is necessary. Results show the need for a specific calibration methodology establishment, which should be made using samples for each one of the radioisotopes used in nuclear medicine.

CONCLUSIONS

Results show that the calibration for each one of all the radioisotopes being measured in specific equipment is necessary to be made, and calibration using only one reference source does not guarantee other sources measurement quality.

This test was made using the three most used radioisotopes in nuclear medicine in Brazil. The samples activity was measured using the key for each one of them. These activities were compared with the values obtained when they are measured using switch pre-set for a different radioisotope.

A variation of up to 75.7 % between the activities obtained in both situations was obtained, what show the importance of developing a calibration methodology that could be applied for each radioisotope, individually.

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