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Study of wrist, finger and crystalline dosimetry in radiopharmacists and nursing assistants to adjust a percentage factor between the extremities

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Abstract:

This work finds a correlation factor setting a percentage of the difference between the values obtained at the body extremities. The data was obtained from 4 workers who inject and dispose radiopharmaceuticals. The workers handling radioactive material worn both ring and wrist dosimeters, with the exception of the radiopharmacist who worn one dosimeter on each wrist and a ring on his right hand. The dosimeters were TLD. To measure the crystalline, dosimeters were placed in each rod of workers' safety goggles. The results show that for the radioisotope ^{99m}Tc were carried out a total of 20 elutions; 49 markings and 199 fractioning. Fourteen fractioning to ^{18}F, 4 ^{131}I, ^{67}Ga with 3 and 1 to ^{111}In. The radiopharmacist's ring showed dose of 11 mSv, while the wrist dosimeter marked 7.78 mSv on the right and 5.40 mSv on the left. The goggles showed 0.43 mSv on the left side and 0.52 mSv on right side. The nurse's results were: Nurse A: 1.13 mSv in ring and 0.23 in wrist; Nurse B: 1.11 mSv in ring and 0.90 mSv in wrist; Nurse C: 0.73 mSv in ring and 0.56 mSv in wrist. The goggles worn by Nurse B recorded 0.19 mSv on the right side and BG on the left side. The difference between the dose received by wrists and rings was between 20% and 30%. This factor obtained in these data encourages continuing research and shows that wrist dosimetry is feasible, respecting the proportionality.

Keywords: Dosimetry, OEI, Crystalline, Wrist, Fingers.

1. INTRODUCTION

For workers in Nuclear Medicine, especially radiopharmacists and nursing technicians who apply medication to patients, the doses they receive in the extremities is a factor of concern. Although the annual equivalent dose limit for these regions is high (500 mSv /year), these doses have to be controlled and linked to good work practices1.

Currently in Brazil there are 11 laboratories certified to provide external individual monitoring services, but not all of them offer finger dosimetry. This type of dosimetry is also not well accepted by most workers, who claim to experience great difficulty in adapting to the ring while wearing the gloves. In addition, many fear forgetting to remove it before disposing the gloves, throwing it in the garbage or contaminating it.

Wrist dosimetry is an alternative, but many radioprotection organizations, find that this evaluation not sufficient to verify the dose in the final extremities. Those competent studies report potential difference between the equivalent dose received by the worker in fingers when used wrist dosimeters.

In this scenario, this work was developed to improve the quality of the dosimetry implemented in nuclear medicine services and to obtain a percentage difference between these measurements. The study's goal is to obtain the dosimetry of the extremities (fingers and wrists), and of the crystalline of workers, who inject and dispose, mark and distribute radiopharmaceuticals. Those observations may allow finding a correlation factor that adjusts a percentage between the differences measured in these extremities. With these data, it may be possible to choose between the use of ring dosimetry or the wrist dosimetry continuity.

The knowledge of the percentage of this difference will allow optimizing the dosimetry and thus improve the quality of dosimetric measurements in the services.

2. METHODS

Four workers who directly handle with radioactive material participated in this study, which had duration of one month. Three nursing assistants worn one ring and one wrist type dosimeters; the radiopharmacist worn a dosimeter on each wrist and a ring type one on his right hand. The dosimeters were TLD and have been adapted for use on finger. Since the workers are Occupationally Exposed Individuals (OEI's), they also used the TLD chest dosimeter, in addition to the extremities ones. Nevertheless, the chest dosimeter was not accounted in this study. Two workers were wearing safety goggles: the radiopharmacist and one nursing assistant. On both safety goggles, a dosimeter in each rod was installed in order to measure the radiation that can reach the crystalline.

The radionuclides used in the period were: ^{99m}Tc, ^{67}Ga, ^{18}F, ^{131}I and ^{111}I.

3. RESULTS

The radiopharmacist accounted for a total of 20 elutions, in relation to the ^{99m}Tc radioisotope (504,384 MBq or 13,632 mCi); 49 markings (258,075 MBq or 6,975 mCi) and 199 fractionations (143,346.51 MBq). Fourteen fractionations were performed for the ^{18}F radioisotope (3,774.74 MBq or 105.02 mCi;), 4 procedures with ^{131}I (266.4 MBq or 7.2 mCi), 3 fractionations of the ^{67}Ga radioisotope (886.89 MBq or 23, 97mCi) and 1 for ^{111}In (185 MBq or 5mCi). The ring dosimeter used by the worker had a dose of 11 mSv, while the wrist on the right had a dose of 7.78 mSv and the one on the left, 5.40 mSv. The radiopharmacist is right-handed. The safety goggles presented a dose of 0.43 mSv on the left side and 0.52 mSv on the right side. The recorded time of work performed by the professional was between 30 seconds in the removal of the material and 1 minute in the elutions.

The nursing assistants, for the same amounts of activity, except for marking and elutions, presented the following results: Nurse A: 1.13 mSv in the ring and 0.23 in the wrist; Nurse B: 1.11 mSv ring and 0.90 mSv wrist; Nurse C: 0.73 mSv on the ring and 0.56 mSv on the wrist. The safety goggles were worn only by Nurse B and recorded 0.19 mSv on the right side and BG on the left side. The distance between the position of the OEI eyes and the radioactive material to be applied to the patient's arm was approximately between 30 and 40 cm. The application duration was of approximately 1 minute.

Table 1: Doses obtained for wrist, ring and crystalline measured during one month, for Occupationally Exposed Individuals (OEI's) in Nuclear Medicine

OEI	RIGHT WRIST (mSv)	LEFT WRIST (mSv)	RING (mSv)	GOGGLES RIGHT (mSv)	GOGGLES LEFT (mSv)
RADIOPHARMACIST	7,78	5,40	11	0,52	0,43
NURSE A	0,23	-	1,13	-	-
NURSE B	0,90	-	1,11	0,19	BG
NURSE C	0,56	-	0,73	-	-

The measured difference between the doses received by workers on wrists and rings was between 20% and 30%. This already shows a good pattern for using wrist dosimetry using this correction factor.

The dosimetry of crystalline remained low and without problems with the dose limit adopted in Brazil, which is 20 mSv/year [Standart CNEN-NN-3.05, 2013, Standart CNEN-3.01, 2014].

CONCLUSION

The data show that there is a good technical efficiency of workers [EUROPEAN COMMISSION, 2013]. The doses obtained are within the standards established by the standards in place in Brazil and by the recommendations presented by the radioprotection organizations worldwide.

To have a reliable factor between wrist and finger dosimetry facilitates the optimization of this dosimetry. This will help workers and services that find it difficult to adopt ring type dosimeters to have greater control over their exposures.

It is essential that there is good dosimetry in the service to guarantee the safety and reliability of the OEI's in their Radiation Protection supervisors and immediate superiors. This way, they can convey calm and tranquility to the patients.

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