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Assessing the occupational radiation doses for medical workers at Cairo university hospital based on job categories

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Abstract

The objective of this study is to assess the occupational ionizing radiation doses in medical uses based on job categories and level of radiation doses exposure. Radiation survey has been carried out in Cairo University hospital in 3 main places that use radionuclide for various diagnostic and therapeutic purposes, nuclear medicine department (Exposed to high doses of Tc^{99m} and I^{131}), Cardiology center (Exposed to medium doses of Tc^{99m}) and gamma camera center in King Fahd unit and radiotherapy center (Exposed to low doses of Tc^{99m}). Each level of exposure is divided into three subgroups according to job category, Physicians, Physicists and Technologists (Technicians and Nurses) groups. Equivalent dose of hand per year "msv" was measured for radiation workers in nuclear medicine only, while the equivalent dose per year "msv" and the accumulated doses over ten years "msv" (2002-2012) of whole body were measured for the all groups. The results revealed that the Physicists in nuclear medicine were the highest equivalent dose of hand (36.5±1.86) mSv followed by Physicians (21.7±1.96) mSv and Technologists (6.23±1.72) mSv. The statistical analysis of these results showed a considerable significant difference among each group. The maximum expected annual dose of fingers appeared to be less than the annual limit (500 mSv/y). For whole body, the results of equivalent and accumulated doses indicated that, there was no significant difference among each group in each level of radiation also revealed that these doses were lower than the international recommended dose limits (20 mSv/ year) [1,2].

Key words: Equivalent dose of hand, accumulated doses, Occupational radiation doses, Medical workers, Radiation protection.

1. Introduction

Radiology was introduced as part of medicine in Egypt since about 86 years but unfortunately, studies were not enough to estimate radiation doses that medical workers were exposed. Nuclear medicine and radiation therapy are essential in the management of a wide variety of tumors for various diagnostic and therapeutic purposes, but the immediate and delayed side effects of ionizing radiation on the normal tissues limit the effectiveness of the diagnosis and therapy. Fortunately, most radiation exposures involve low doses (<1 Gy) and as such do not have immediate life threatening effects. However, long-term effects of low-dose exposures may be real and should be given serious consideration [3]. As a result of the gamma radiation emitted by radioactive elements (Tc^{99m} and I^{131}) used in nuclear medicine laboratories for diagnostic and therapeutic purposes, nuclear medicine workers are exposed to

whole-body doses "the total energy deposited in the body divided by the mass of the body". These doses are usually measured by using individual film dose meters. Lead or lead glass shields used during the handling of radioisotope minimize the whole-body dose received. Nevertheless, part of the job has to be performed manually hence the hands are more exposed to radiation. The measurement of radiation doses to the fingers of staff involved in handling large quantities of radioactivity not only indicates the level of radiation safety standards maintained at a given centers but also can act as a guide for safe work practice. The specific nature of work performed with isotopes contributes to the considerable differences in the value of an equivalent dose received by the metacarpus, wrist and fingertips [4]. In the study of W. Chruscielewski, et al [5], on the medical workers, the study indicated that, in some instances, the danger of radiation dose to the hand may be significant. Monthly doses exceeded 50 mSv, which may suggest that an annual dose may be higher than 500 mSv. J. Jankowski et al, [4] found the thumb and index finger tips are the parts most exposed to ionizing radiation .The average value of equivalent dose to the thumb and index finger received during one shift is about 6 mSv. This means that during one year (200 shifts) the dose may reach 1.2 Sv. The medical workers are exposed to higher doses of ionizing radiation during their occupation as compared to environmental radiation exposure therefore, it is important to provide data on the actual absorbed dose and effect of occupational exposure to ionizing radiation.

The objective of this study is an assessing the occupational ionizing radiation (equivalent and accumulated) doses in medical uses based on job categories and the level exposure doses of radiation in addition to assessment the equivalent dose to the hands of workers in nuclear medicine with respect to whole body exposure.

2. Materials and methods

2.1 workers studies

Our investigation comprised 27 healthy medical workers all of them gave written informed consent to participate in this study. The work has been carried out in Cairo University hospital in three main places that use radionuclides for various diagnostic and therapeutic purposes:

1- Nuclear medicine unit (workers were exposed to high dose of Tc^{99m} and I^{131}).
2- Cardiology center (workers were exposed to medium dose of T^{c99m}).
3- Gamma camera center (King Fahd unit) and radiotherapy center (workers were exposed to low dose of Tc^{99m}).

Radiation dose accumulated by occupationally exposed over ten years (2002-2012) was calculated based on the individual thermoluminescence dosimeter (TLD) records and multiplied with exposure time. The medical workers are classified according to radiation level of exposure into three levels, high, moderate and low. Each level of exposure is divided into three subgroups according to job category, Physicians, physicists and Technologists groups.

2.2 Dosimetry reading

Each medical radiation worker received an individual dosimeter with a personal number. All workers were instructed to wear the dosimeter during working hours only. Workers in nuclear medicine (9 workers) have two TLD, one for measuring equivalent dose of whole body and the other was worn in the index finger for measuring equivalent dose of hand. The rest workers have only one TLD for measuring equivalent dose of whole body. Irradiated TLD

disks with different doses of gamma rays from Tc^{99m} and I^{131} were placed in the TLD reader (measured each three months at NEMROCK EGYPT) to obtain their response in relation to radiation dose. The radiation weighting factor for the γ-photons from annually; Irradiated both I^{131} and Tc^{99m} was taken as 1.

2.3 Statistical Analysis:

The data were collected, categorized and processed by using Statistical Package for Social Sciences (SPSS), version 15 software package. The quantitative variables were expressed as mean ± standard deviation (SD) and comparison was done using paired students t-test. P-value levels of <0.05 was considered statistically significant.

3. Results and Discussion:

The results in table 1 revealed that the Physicists in nuclear medicine were the highest equivalent dose to the fingers (36.5±1.86) mSv followed by Physicians then by Technologists (6.23±1.72) mSv. These values could be related to the nature of the corresponding jobs for each group. Physicists were involved in the elution of Tc^{99m} from the M^{99m} -Tc^{99m} generator, handling Tc^{99m} labeled compounds and handled large quantities of I^{131} for diagnostic and therapeutic procedures. Physicians were involved in injecting the patient intravenously with radio pharmaceuticals for ϒ-camera imaging. Technologists were involved in positioning the patients for imaging and occasionally in assisting Physicians in dose administrations. These results are in agreement with Gauri S et al [6] and W. Chruscielewski, et al [5]. The maximum expected annual dose to the fingers appeared to be less than the annual limit (500 mSv/y) [6] because all of workers are on rotation and do not constantly handle radioactivity throughout the year.

Dosimetry measurements of whole body exposure to medical radiation workers exposed to high, medium and low doses of ionizing radiation are shown in tables 2, the results showed all exposure levels are lower than the international recommended dose limits because all of workers are on rotation and do not constantly handle radioactivity throughout the year. In addition to the M^{99m} -Tc^{99m} generators used have law energies. The statistical analysis of the equivalent dose of hand revealed extremely significant difference (table 3). As shown in table 3, no significant difference among all groups. In medium and low level of radiation, doses to the fingers could not be calculated per unit of activity because they did not handle the radiopharmaceuticals directly. On other hand, as depicted from (table 2) the equivalent doses of whole body for high and medium doses slightly greater than that for low dose. All exposure levels are lower than the international recommended dose limits, these results are in agreement with Young-Woo Jin [7], G K Korir [8], Piwowarska-Bilska, H.et al [9] ALMasri, H.Y.et al [10] and Jabeen, A. et al. [11]. No significant difference among each group in each level of radiation (table 3). Accumulated dose of whole body was calculated during ten years for all medical workers. The results also showed that there is no significant difference among each group in each level of radiation (table 3).

It should be noted that the Egyptian law follow The system of protection recommended by the International Commission on Radiological Protection (ICRP) regarding the occupational exposure to ionizing radiation based on the principles that the practice must be justified, that

all exposures should be as low as reasonably achievable (ALARA principle), and that individual exposures are subject to dose limits. Dose quantity limits were defined as in International Commission on Radiological Protection (ICRP) Publication 60: an occupational dose limit of an average of 0.02 Sv per year averaged over a 5-year period, the dose should not exceed 0.05 Sv in any single year.

Table 1: Equivalent Dose to fingers (nuclear medicine workers)

	Equivalent dose to fingers (mSv)
Physicists	36.5 ± 1.86
Physicians	21.7 ± 1.96
Technologists	6.23 ± 1.72

Quantitative variables are expressed as mean ± standard deviation.

Table 2: Dosimetry measurements of medical workers exposed to high, moderate and low doses of radiation.

		Physicists	Physicians	Technologists
Equivalent dose/ year (mSv)	High doses	13.08 ± 3.13	12.31 ± 3.45	11.14 ± 2.98
	Moderate doses	11.86 ± 2.03	10.63± 1.83	10.71 ± 2.84
	Low doses	6.92 ± 2.47	6.51 ± 2.01	7.28 ± 1.13
Accumulated dose/ 10 year (mSv)	High doses	133.36 ± 8.88	124.4 ± 12.96	125.52 ± 11.86
	Moderate doses	114.48 ± 7.12	116.4± 4.76	108.4 ± 2.95
	Low doses	68.96 ± 7.35	57.23 ± 17.87	67.28 ± 2.22

Quantitative variables are expressed as mean ± standard deviation.

Table 3: p value among all groups

Equivalent dose		Physicians	Physicists	Physicians	Technologists	Physicists	Technologists
P value	high doses	0.690		0.545		0.296	
	moderate doses	0.297		0.955		0.438	
	low doses	0.759		0.431		0.750	
Equivalent dose of fingers		0.000**		0.000**		0.000**	

Data expressed as mean ± SD, n = 54, $p < 0.05$ *significant difference, **extremely significant.

List of tables:

Table 1	Equivalent Dose to fingers (nuclear medicine workers)
Table 2	Dosimetry measurements of medical workers exposed to high, moderate and low doses of radiation.
Table 3	p value among all groups

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