Available online at www.elixirpublishers.com (Elixir International Journal)

Radiological Physics

Elixir Radiological Physics 169 (2022) 56410 - 56413

ISSN: 2229-712X

Evaluation of Radiation Exposure to Radiation Workers in Different Departments of SKIMS Hospital

Sajad Ahmad Rather

Department of Radiological Physics and Bio-Engineering, Sher-i-Kashmir Institute of Medical Sciences, Srinagar 190011, India

ARTICLE INFO

Article history:
Received: 17 May 2022;
Received in revised form: 10 June 2022;
Accepted: 20 June 2022;

Keywords
Radiation workers,
Thermoluminiscent Dosimeter (TLD),
Radiation,
Radiation Protection,
Occupational exposure.

ABSTRACT

The occupational radiation doses for medical staff at the Sheri Kashmir Institute of Medical Sciences (SKIMS) Hospital's departments of diagnostic radiology, nuclear medicine, radiotherapy, cardiology, gastroenterology, radiological physics, and bioengineering were monitored and evaluated.

To ascertain the status of their average yearly effective dosage and average cumulative lifetime exposure, 250 medical radiation employees were observed. The Radiation Safety Lab of the Department of Radiological Physics and Bioengineering at SKIMS was where the analysis for this study was completed. Based on their clinical responsibilities and expertise, the observed personnel were divided into two subgroups: technical professionals and physicians. Thermo luminescent dosimeters (TLD-BARC ($CaSo_4$:Dy)) were used to measure the whole body doses in all categories of workers, with the exception of those in the cardiology lab and gastroenterology, for whom the TLD was worn under the lead apron (0.5millimeter lead thickness).

Additionally, an extremities dosimeter was given to each of the three departments—nuclear medicine, cardiology, and gastroenterology. Radiological physics, nuclear medicine, radiation, cardiology, gastroenterology, BE, and SKIMS Medical College employees' annual average effective doses were found to be 0.26, 0.60, 0.18, 0.35, 1.37, 0.17, and 0.25 mSv, respectively. The average hand/extremity dose recorded by the department of nuclear medicine utilising the unsealed radioisotopes was 1.06mSv. Cardiology and gastroenterology, two departments that use fluoroscopic guidance for a variety of procedures, were also given an extra extremity dosimeter, and the average dosages were discovered to be 0.42 and 5.57 mSv, respectively. The measured annual dosage resulted in levels that were significantly lower than the international recommended occupational dose limit.

Introduction

The radioactive sources used in many applications for a wide verity of beneficial purposes such as in medicine, research, education, industry, and in an agriculture field. The combination of improved health services and an ageing population has resulted in an increased use of radionuclide's and radiation in diagnosis and treatment [1]. All medical and occupational exposure to ionizing radiation, represent the major part of exposure to low radiation dose. The researchers estimated that, the cancer risk incidence directly increases with the absorbed dose. It is important, for this low radiation dose to establish a model to determine the carcinogenic effects for that dose [2].

The goal and purpose of various international regulatory bodies is to control and provide a system with useful standards for radiation protection, including medical, occupational, environmental, and exposure controls against radiological accidents without unduly restricting the advantageous practises that lead to radiation exposure. The important one being the International Commission on Radiological Protection (ICRP) [3,4]. It defines the term "occupational exposures" which refers to the exposure of people at work to ionizing radiation from natural and man-made sources as a result of operations within a workplace [5-12]. It is recommended for workers exposed to medical radiation sources to strictly follow and practice all the regulatory requirements established in the International Basic Safety Standards for Protection against Ionizing Radiation and the Safety of Radiation Sources, here in India to follow the Atomic Energy Act of 1962 (33 of 1962) and Atomic Energy Radiation Protection Rules-2004. Dose estimation for radiation workers is an important factor for government and Atomic Energy Regulatory Board (AERB) to evaluate radiation risks and establish protective measures strictly to be followed in medical use of Ionizing radiation [13]. All occupational workers must be consequently subjected to routine monitoring of the radiation exposures they receive during their work practices [14, 15].

The radiation dose to workers is expressed in terms of effective dose for whole body and equivalent dose for extremities and eye lens as stated by the International Commission on Radiological Protection (ICRP) report number 60 and recent report number 103 [3]. The International Commission on Radiological Protection (ICRP) recommends the personal dose equivalent Hp (10) as universal operational quantity in the field of radiation protection by individual monitoring. It is the dose received by tissue (effective dose) at a 10-mm depth from the skin surface and is considered to be the dose to the whole body recorded by the personnel dosimeter worn at the chest level by the radiation professional. From the basic safety standards (BSS) recommendation, the equivalent doses limits should apply i) to the whole body, as represented by the operational quantity Hp (10); and ii) to the extremities, via the operational quantity Hp (0.07). The BSS defines the Hp (0.07) dose as the dose at a depth of 0.07 mm and is considered to be the dose received by the skin of the workers. The dose limit for workers proposed by the ICRP was established as an annual effective dose. An effective dose limit of 20 mSv each year has been set for persons employed in radiation work [16–18]. It is important to measure the radiation doses received by personnel and evaluate the parameters concerning total radiation burden. Thermo luminescent dosimetry is the easiest method to carry out measurements on personal dosimeters [19,20]. The main objective of this study was to investigate and evaluate the annual occupational radiation dose history among the workers of Sher-I-Kashmir Institute of Medical Sciences Hospital and Medical College (SKIMS H&MC) so as to increase the confidence of radiation safety strategy used and followed. The study concentrated on seven medical departments of SKIMS H&MC — Radiodiagnosis, Nuclear medicine, Radiotherapy, Cardiology, Gastroenterology, Radiological physics & BE and Sheri Kashmir Institute of Medical Sciences Medical College (SKIMS Medical college) -during a ten year period from 2010 to 2020 to track these departments for the occupational radiation dose to determine the highest exposure area and to check the radiation protection standards met out at these departments.

Materials and Methods

In this study, thermo luminescent dosimeters (TLD) were used. The TLDs consist of cards with appropriate filter holders containing a detector crystal of Calcium sulphate doped with dysprosium -$CaSO_4$:Dy to provide measurements of skin and deep doses. Of the thermo luminescence phosphors, dysprosium doped calcium sulphate is one of the most efficient and cheap phosphors for the use in radiation dosimetry . It was made sure that the workers wore the badge in proper places during their work. The upper side of the chest is the most important area to wear the dosimeter as recommended by ICRP. The calibration process was totally automated from Ultratech Lab Pvt Ltd. Both the whole-body dose (effective dose in milli Sievert-mSv) Hp (10) and the skin dose-extremity (equivalent dose in milli Sievert-mSv) Hp (0.07) for the period from 2010 to 2020 were taken from the radiation safety labs data base from SKIMS. The International Commission on Radiological Units and Measurements recommends whole-body doses in terms of the personal dose equivalent, Hp (10). TLDs worn by occupational medical personnel's were evaluated by the company itself for personnel dose equivalents. It is important to mention that a single TLD badge was recommended for occupational workers in radiodiagnosis, radiotherapy, radiological physics and BE & Sheri Kashmir Institute of Medical Sciences Medical College (SKIMS Medical college) and two TLD dosimeters for nuclear medicine, cardiology and gastroenterology-one for whole body and another for extremity to measure dose to skin Hp(0.07).

Results and Discussion

Distribution of medical radiation workers

The dose distributions of radiation workers are used to determine the minimum level of exposure in the medical field according to as low as reasonably achievable -ALARA principles. In the SKIMS H&MC, approximately 250 occupational radiation workers were monitored. The percentage distribution of the occupational medical radiation personnel's in the seven medical departments of SKIMS Hospital & MC were Radio-diagnosis (42%), Nuclear Medicine (8%), Radiotherapy (21%), Cardiology (8%), Gastroenterology (7%), Radiological Physics and BE (7%), & SKIMS Medical college (7%), during the period from 2010 to 2020. Table 1 shows the number of radiation workers monitored (male and female) in all occupational categories of medical departments and their position during 2010-2020.

Occupational Doses at the Department of Radio diagnosis

The measured occupational doses for radiology workers are presented in Table 2 for different types of radiation workers. For a radiologist, which represents the greatest number of radiation workers, 101 Table 2 shows that the average annual effective dose ranged from 0.01 mSv to 0.86 mSv, with an average value of 0.27 mSv for technical professionals and 0.01 mSv to 1.60 mSv, with an average value of 0.20 mSv for doctors in the department of radio diagnosis. All these values are well below the international recommended dose limit (20 mSv). The highest recorded dose (0.87 mSv) is well below the recommended dose limit (20 mSv) as adopted from the ICRP recommendations. As seen in Table 2, the highest annual dose value recorded was 1.60 mSv, recorded by the chest TLD worn by one of the radiologists in the department, which represents 8% of the annual recommended dose limit.

Occupational doses at the Department of Nuclear Medicine

Again from Table 2 the average annual effective dose for the department of nuclear medicine ranged from 0.19 mSv to 2.11mSv, with an average value of 0.57 mSv for technical professionals and 0.2 mSv to 1.94 mSv, with an average value of 0.65 mSv for doctors in the department. An additional wrist TLD Badge was provided to the staff in the nuclear medicine due to the use of unsealed radioisotopes. The average wrist dose was found to be ranging between 0.6 to 1.70mSv with an average of 1.06mSv. From these values it can be concluded that the measured doses were well below the dose limit. In general, it was noted that the nuclear medicine technicians received relatively higher values for their chest absorbed dose (>2 mSv) than did the nuclear medicine doctors due to their main job and responsibilities to carry out the examinations using unsealed radioisotopes for diagnostic and therapeutic applications according to the set protocol of the department.

Occupational doses at the Department of Radiotherapy

Table 2 shows that the average annual effective dose ranged from 0.06 mSv to 0.33mSv, with an average value of 0.18 mSv for technical professionals and 0.03mSv to 1.27 mSv, with an average value of 0.20 mSv for doctors in the department of radiotherapy. These values were well below the recommended dose limit.

Occupational doses at the Department of Cardiology

The occupational radiation doses for medical staff using fluoroscopic procedures are usually on a higher side [3]. Cardiology is the most dynamic field in terms of medical exposure due to the application of diagnostic X-rays. Workers in the cardiology field have a high effective dose, and in addition, the extremity and eye lens dose can reach the recommended regulatory limit [5]. Table 2 shows that while the annual occupational dose to a technical professional ranged from 0.03 mSv to 1.42 mSv with an average value of 0.44 mSv, the corresponding value for a cardiology laboratory doctors ranged from 0.00 mSv to 1.04 mSv with an average value of 0.26 mSv. An additional wrist TLD Badge was provided to the staff in this department as the use of fluoroscope predominates here too. We can conclude that the workers in a cardiology laboratory are exposed to a relatively higher amount of radiation than those doing CT scans radiology dept. This received dose still remains well below the recommended dose limit.

Occupational doses at the Department of Endoscopy-Gastroenterology

Table 2 shows the distribution of the annual dose for different specialists among the workers in the endoscopy department. The highest recorded doses were among this community as the use of fluoroscopy predominates here as well. The average annual effective dose ranged between 0.15 and 2.33 mSv, with an average value of 1.28 mSv for technical professionals and 0.08 mSv to 3.98mSv, with an average value of 1.84 mSv for the doctors. These values were well within the recommended dose limit (20mSv).

An additional wrist TLD Badge was provided to the staff in this department as the use of fluoroscope predominates here too. The average wrist dose was found to be ranging between 0.09 to 11.54mSv with an average of 5.57mSv. Based on the results of the annual dose in every department, a close correlation between the received doses and the job position was observed.

Occupational doses at the Department of Radiological Physics and Bio-Engineering

Table 2 shows the distribution of the annual dose for different specialists among the workers in the RPBE department. This department has the responsibility of maintaining the radiation safety at the hospital level. The Radiation Safety Officer along with the Qualified Medical Physicists ensure the radiation safety in all dimensions with regard to the safety of occupational workers, patient and general public, these act like a mini competent authority at a hospital level. The average annual effective dose ranged between 0.1 and 0.43 mSv, with an average value of 0.19 mSv for technical professionals and 0.0mSv to 0.28mSv, with an average value of 0.01 mSv for the doctors.

Occupational doses at the Department of SKIMS MC

Table 2 shows the distribution of the annual dose for different specialists among the workers in the Dept of SKMC, i.e. Radiology and Orthopedics.

Table 1. Number of radiation workers monitored in all occupational categories of medical departments

Occupational category	Radiation workers	Number of monitored	workers	
		Males	Females	Total
Dept. of Radiodiagnosis	Technical professionals(T)	90	11	80
	Doctors(D)			21
Dept. of Nuclear Medicine	Technical professionals(T)	13	7	14
	Doctors(D			6
Dept. of Radiotherapy	Technical professionals(T)	35	20	45
	Doctors(D)			10
Dept. of Cardiology	Technical professionals(T)	21	0	17
	Doctors(D)			4
Dept. of Gastroenterology	Technical professionals(T)	18	0	15
	Doctors(D)			3
Dept Radiological Physics & BE	Technical professionals(T)	16	2	15
	Doctors(D)			3
SKIMS-MC	Technical professionals(T)	6	11	15
	Doctors(D)			2
Total number of workers		199	51	250

Table 2. Departmental distribution of average annual dose

Department	Total number of workers	Working group	Dose range mSv	10 years Average Annual dose (mSv)
Dept. of Radiodiagnosis	101	Technical professionals(T)	(0.01-0.86)	0.27
		Doctors(D)	(0.01-1.60)	0.2
Dept. of Nuclear Medicine	20	Technical professionals(T)	(0.19-2.11)	0.57
		Doctors(D)	(0.2-1.94)	0.65
Dept. of Radiotherapy	55	Technical professionals(T)	(0.06-0.33)	0.18
		Doctors(D)	(0.03-1.27)	0.2
Dept. of Cardiology	21	Technical professionals(T)	(0.03-1.42)	0.44
		Doctors(D)	(0.00-1.04)	0.26
Dept. of Gastroenterology	18	Technical professionals(T)	(0.15-2.33)	1.28
		Doctors(D)	(0.08-3.98)	1.84
Dept. of Radiological Physics & BE	18	Technical professionals(T)	(0.1-0.43)	0.19
		Doctors(D)	(0.01-0.28)	0.1
Dept. of SKIMS-MC	17	Technical professionals(T)	(0.00-0.19)	0.15
		Doctors(D)	(0.00-1.43)	0.25

These departments used CT Scanners, X-Rays and Fluoroscopes, therefore the doses here too are little on a higher side. The average annual effective dose ranged between 0.0 and 0.19 mSv, with an average value of 0.15 mSv for technical professionals and 0.0mSv to 1.43mSv, with an average value of 0.25 mSv for the doctors.

The highest doses were received by the doctors/technical professionals in gastroenterology dept, followed by dept of nuclear medicine which directly correlates these values with the nature of their clinical responsibilities. Approximately 90% of all monitored radiation workers at SKIMS H &MC had annual dose values below or equal to the average level of global occupational exposure associated with the medical field (0.5mSv/year). From all the results it is clear that the department of gastroenterology and nuclear medicine had a relatively higher occupational dose, but that dose is still below the recommended dose limit (20 mSv/year).

Conclusion

The measured annual effective doses for occupational radiation workers at seven different medical departments received was well below the recommended dose limit (20 mSv). The doses to the workers of radio diagnosis, nuclear medicine, radiotherapy, cardiology lab, gastroenterology, radiological physics & BE & SKIMS Medical college, workers was 0.26, 0.60, 0.18, 0.35, 1.37, 0.17 and 0.25 mSv, respectively which is many times (93%) lesser than the stipulated limits set by the national and international regulatory authorities. Thus the radiation protection programme to limit the low dose radiation exposure carried out at SKIMS Hospital & Medical College is much effective and is a direct outcome of the strict adherence to these national and international protocols.

References

1. S. Balwinder, S. Jaspreet, K. Amritpa, Applications of Radioiso- topes in Agriculture, Int J Biotechnology and Bioengineering Research 4 (3) (2013) 167–174.
2. Effect of ionizing radiation. United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), United Nations, New York, 2006 (1).
3. Report 60 Recommendations of the International Commission on Radiological Protection. International Commission on Radiological Protection (ICRP), 1990, Publ 60, Ann ICRP 21 (1-3).
4. L. Dariusz, The Grand Challenge: use of a new approach in devel- oping policies in the area of radiation and health, Frontiers in Public Health: Radiation & Health journal 2 (50) (2014) 1–4.
5. W. Weizhang, W. Zhang, R. Cheng, L. Zhang, Occupational Exposures of Chinese Medical Radiation Workers in 1986-2000, Radiation Protection Dosimetry 117 (4) (2005) 440–443. T. Yuan, Z. Liang, J. Yongjian, Dose level of occupational expo- sure in China, Radiation Protection Dosimetry 128 (4) (2008) 491–495.
6. M. Chales, Sources and effects of ionizing adiation, J. Radiol. Prot; 21 (1) (2001) 83– 86.
7. International basic safety standards for protection against ioniz- ing radiation and for the safety of radiation source, International Atomic Energy Agency (IAEA), 1996, Safety Series No 115.
8. Radiation, sources and effects of ionizing. United Nations Scien- tific Committee on the Effect of Atomic Radiation (UNSCEAR), Volume I, United Nations Sales Publication, New York, 2000.
9. M. Khalid, A. Munir, Z. Junaid, H. Mumtaz, A. Afshan, Z. Haroon, Assessment of Occupational Exposure Among Pakistani Medical Staff During 2007-2011, Australas Phys. Eng. Sci. Med 35 (2012) 297–300.
10. A. Jabeen, M. Munir, A. Khalil, M. Masood, P. Akhter, Occu- pational Exposure from External Radiation used in Medical Practices in Pakistan by Film Badge Dosimetry, Radiation Pro- tection Dosimetry 140 (4) (2010) 396–401.
11. Occupational radiation protection: protecting workers against exposure to ionizing radiation. International Atomic Energy Agency (IAEA), in: Proceedings of an International Conference, Geneva, 26-30 August, 2002.
12. P. Mora, M. Acuna, Assessment of Medical Occupational Radi- ation Doses in Costa Rica, Radiation Protection Dosimetry 147 (1-2) (2011) 230–232.
13. P. Mora, M. Acuna, Assessment of Medical Occupational Radi- ation Doses in Costa Rica, Radiation Protection Dosimetry 147 (1-2) (2011) 230–232.
14. R. Hendee, Estimation of radiation risks: BEIR V and its signifi- cance for medicine, J Am. Med. Assoc. 268 (1992) 620–624.
15. P. Covens, D. Berus, N. Buls, P. Clerinx, F. Vanhavere, Personal dose monitoring in hospitals: Global assessment, critical applica- tions and future needs, Radiation Prot. Dosimetry 124 (3) (2007) 250–259.
16. M. AleksanDa, I. Sonja, S. Vesna, J. Slobodan, A dose estima- tion for persons occupationally exposed to ionizing radiation in Montenegro 2008. (1-2) (2008) www.onk.ns.ac.yu/Archive.
17.R.Kopec, M.Budzanowski, A.Budzyniska, R. Czepczynski, M. Dziuk, J.Sowinski, A. Wyszomirska, On the relationship between whole body, extremity and eye lens doses for medical staff in the preparation and application of radiopharmaceuticals in nuclear medicine, Radiation measurements 46 (2011) 1295–1298.
18. H. WY, K. Wong, Y. Leung, K. Cheng, H. FTH, Radiation Doses to Staff in a Nuclear Medicine Department. Radiation Doses to Nuclear Medicine Staff J HK, Coll Radiol 5 (2002) 24–28.
19. R. Janssen, R. Hadders, M. Henkelman, A. Bosli, Exposure to operating staff during cardiac cardio catheritization measured by thermo luminescence dosimetry, RadiatProt.Dosim 43 (1992) 175–177.
20. L. Niklason, M. Marx, H. Chan, The estimation of occupational effective dose in diagnostic radiology with two dosimeters, Health Phys 67 (6) (1994) 611–615.