Original Article

Evaluation of Radiation Workers' Occupational Doses Working at NIMRA Jamshoro

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ABSTRACT

OBJECTIVES: The purpose of the current study was to evaluate the occupational radiation doses received by the workers of NIMRA Jamshoro.

METHODS: To detect occupational radiation doses, the radiation workers of NIMRA have been issued film badges with unique identification number for the particular worker. In this study, the radiation dose received in 2011 and total dose received in last five years (2007-2011) by 35 radiation workers was evaluated.

RESULTS: The results show that annual doses of workers were ranging from 0.1 mSv to 3.60 mSv (0.5% ~ 18.0%) of annual dose for the year 2011, whereas the summed up the total dose for the last five years (2007-2011) ranging from 2.57 mSv to 22.04 mSv out of 100 mSv (total dose for 05 years) were recorded.

CONCLUSION: The annual and last five years data of radiation doses to all the workers was in the acceptable range of National and International regulatory bodies.

KEYWORDS: Occupational dose, Film badge, Radiation source, Personal monitoring, Shielding.

INTRODUCTION

The general population is exposed regularly to natural low level background radiation, while exposure to man made sources is mosltly from radiation generating medical devices, particularly nuclear medicines and x rays (both diagnostic & industrial) estimated to be 4% and 11% [1] respectively, as shown in figure I.

The damage to living organism is known from early days of experiments with x rays and radium, when many of founders of these scientific areas suffered severly due to exposure[2]. To protect the radiation worker, comforters/ volunteers and the general public from man-made sources, the golden principle of radiation protection (Time-Distance-Shielding abbreviated as T-D-S) is employed as shown in figure II. TDS describes that spent less time near the source, if spending less time is not possible due to the work nature then appropriate distance between the source and subject should be maintained to reduce radiation exposure. In case, when spending less time near the source and maintaining distance from the sources is not possible, the goal of dose reduction can be achieved by placing proper shielding between the source and subject. For shielding purpose different gadgets are being used. Shielded container is used to store the radiation sources. Protective lead glass is installed / mounted as a wall between the radiation generating equipment/source and subject. Lead bricks are placed around the source to stop unwanted radiation. Sliding lead shields are placed between the radiation generating equipment/source and subject. Thick concrete wall construction can prevent undue exposure from radiation. Lead doors are being fixed in the passages of rooms where radiation generating equipments/sources are used to stop the primary and scattered radiation [3-6].

Nuclear Institute of Medicine and Radiotherapy (NIMRA) Jamshoro, Pakistan uses man made radiation generating devices, sealed and unsealed radiation sources for diagnostic and therapeutic purposes. In radiology section x-ray and mammography units are used, whereas in nuclear medicine department Tc-99m and I-131 are used for routine diagnostic procedures and treating thyroid disorders. The radiotherapy section uses Co-60 and Sr-90 for treating various types of cancer and eye disorders (pterygium etc.) respectively.

For proper radiation protection, the detection and measurement of radiation is necessary.The monitoring of workers working in radiation area by using film badge is one of the vital gadgets to measure the radiation dose for personal dosimetry. The film badge consists of a photographic film in a plastic holder. The holder has open windows and fitted with a range of filters, which allows us to distinguish between beta, x-ray, gamma and neutron radiations and also allows determination of the personal dose [7, 8]. The film from film badge when developed, allow us to determine from degree of optical density, the total dose received and contribution of each type of radiation received during handling of sourse[9]. Figure III and IV show typical film badge and the dose measuring device (densitometer).

Based upon standard and guidelines presecribed/

approved by International commission on Radiological Protection (ICRP) and International Atomic Energry Agency (IAEA), the Pakistan Nuclear Regualtory Authority (PNRA) has approved a permissible dose limit of 20 mSv as an occupational dose for radiation workers in Pakistan[10], as summarized in table I.

This study was conducted to evaluate the radiation doses received by radiation workers of NIMRA according to permissible limits as define by National [10] and International [11] regulatory bodies.

MATERIAL AND METHODS

This observation study was carried out at NIMRA, Jamshoro to detect occupational radiation doses, each worker of NIMRA who handle the radioactive material have been issued film badge with unique identification number for the particular that worker. The service of film badge is being provided by Pakistan Institute of Nuclear Science and Technology (PINSTECH) Islamabad on monthly basis. For the radiation workers' personnel monitoring, film badge is one of the recommended device for the measurement of occupational radiation dose of the workers [12].

In this study, the radiation dose received in the year 2011 (January-December 2011) and total dose received in last five years (January 2007- December 2011) by 35 radiation workers of NIMRA Jamshoro was evaluated. Out of 35 radiation workers 13 (37.14%) and 04 (11.43%) workers engaged in Nuclear Medicine and Radio Immune Assay sections respectively whereas 04 (11.43%) and 14 (40%) workers offered their services at Radiology and Radiotherapy sections respectively. The readings of film badges provided by PINSTECH were kept as records for the purpose of evaluating the radiation dose history of the workers [13].

Microsoft Office Excel 2007 was used to analyze the results.

RESULTS

Personnel radiation monitoring is essential to ensure that dose limits for staff do not exceed as recommended by the International Commission on Radiological Protection (ICRP) in modified form in 1991 [11]. The annual doses for the year 2011, summed up the total dose for the last five years (2007-2011) of radiation workers and their percentages with respect to anuual dose limit & total limit for five years are presented in Table II. The data of annual doses for radiation workers were ranging from 0.1 mSv to 3.60 mSv (0.5% ~ 18.0% of annual dose) for the year 2011. Two workers (05.71%) who served in Hot Lab of Nuclear Medicine section received some higher doses 2.54 mSv and 3.60 mSv (12.7% ~ 18.0% of of annual dose) respectively than other radiation workers due to their nature of duties but they were in the range of annual dose of 20 mSv as recommended by the National (PNRA) [10] and International (ICRP/IAEA) [11] organizations. The summed up total dose for the last five years (2007-2011) received by radiation workers ranging from 2.57 mSv to 22.04 mSv out of 100 mSv (total dose for 05 years), which was also in satisfactory range as adopted by PNRA [10] on the recommendations of ICRP [11].

TABLE I: ANNUAL DOSE LIMITS AS RECOMMENDED BY ICRP IN 1991 AND ADOPTED BY PNRA

	Occupational Exposure (mSv)	Exposure to Students/ Patients Volunteers (16-18 years of age) (mSv)	Public Exposure (mSv)
Dose to Whole body	20	06	01
Dose to Lens of Eye	150	50	15
Extremities Dose (hands, feet)	500	150	50

FIGURE I: RADIATION FROM NATURAL BACKGROUND AND MAN-MADE SOURCES AS DESCRIBED BY NCRP

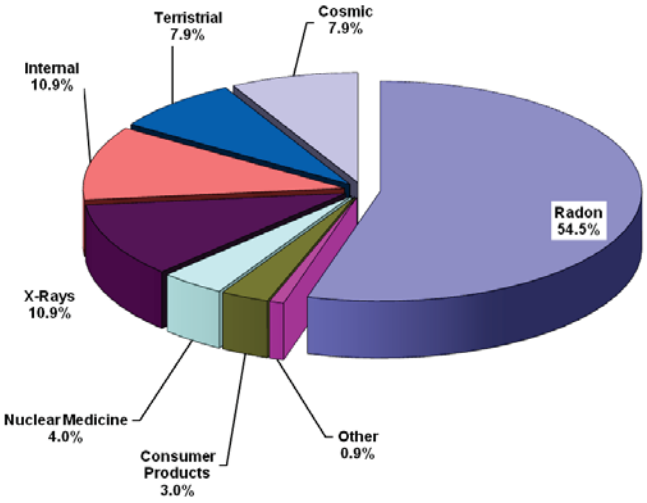

FIGURE II: T-D-S, THE GOLDEN PRINCIPLE OF RADIATION PROTECTION

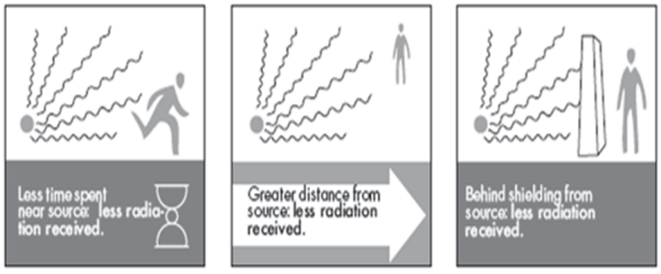

TABLE II: THE RADIATION WORKERS' ANNUAL DOSES OF NIMRA AND THEIR PERCENTAGES ACCORDING TO LIMITS FOR THE 2011 AND SUMMED UP TOTAL DOSE FOR THE LAST FIVE YEARS (2007-2011)

Section	Machine/Unit	Worker #	Annual Dose (2011)	%age from Annual limit of 20mSv	05 Years Dose (2007-2011)	%age from total dose (100 mSv) for 05 years
Radiology	Mammography	1	0.81	4.1	5.94	5.94
	Simulator	2	0.96	4.8	4.98	4.98
		3	1.12	5.6	5.7	5.7
	X-rays Unit	4	0.72	3.6	13.2	13.2
Nuclear Medicine	*General	5	0.76	3.8	5.02	5.02
		6	0.85	4.3	5.09	5.09
		7	0.77	3.9	5.16	5.16
		8	0.8	4.0	5.68	5.68
		9	0.78	3.9	2.57	2.57
	Gamma Camera	10	0.83	4.2	5.2	5.2
		11	0.99	5.0	5.97	5.97
		12	0.81	4.1	6.05	6.05
	Hot Lab	13	1.37	6.9	5.79	5.79
		14	1.02	5.1	10.41	10.41
		15	2.54	12.7	12.69	12.69
		16	1.77	8.9	18.22	18.22
		17	3.6	18.0	22.04	22.04
Radio Immune Assay	RIA Lab	18	0.77	3.9	4.84	4.84
		19	0.85	4.3	2.62	2.62
		20	0.74	3.7	4.74	4.74
		21	0.77	3.9	5.13	5.13
Radiotherapy	*General	22	0.79	4.0	3.31	3.31
		23	0.3	1.5	4.15	4.15
		24	0.7	3.5	5.76	5.76
		25	0.76	3.8	5.83	5.83
	Health Physics	26	1.19	6.0	6.26	6.26
		27	1.3	6.5	6.43	6.43
		28	0.7	3.5	7.23	7.23
	Teletherapy Units	29	0.43	2.2	3.43	3.43
		30	0.1	0.5	4.28	4.28
		31	0.7	3.5	4.67	4.67
		32	0.78	3.9	5.69	5.69
		33	0.53	2.7	5.9	5.9
		34	0.82	4.1	7.72	7.72
		35	0.78	3.9	10.13	10.13

*General means officers and workers who are not deputed on any machines/units.

FIGURE III: TYPICAL FILM BADGE

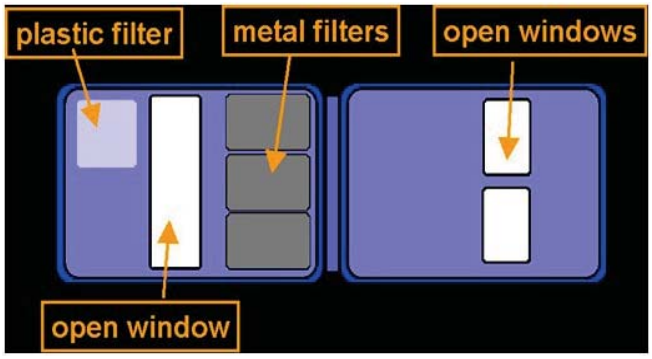

FIGURE IV: FILM READER (DENSITOMETER)

DISCUSSION

The majority of radiation workers of NIMRA (77.14%) received the annual doses less than 1 mSv (5% of annual dose), 17.14% workers' doses were above 1 mSv and below 2 mSv and only two workers (5.71%) received more than 2 mSv i.e. 2.54 mSv (12.7% of annual dose) and 3.6 mSv (18% of annual dose) respectively. Jabeen A et, al. [14] reported average occupational exposure data of workers due to external sources of radiation in nuclear medicine, radiotherapy and diagnostic radiology in Pakistan during 2003-2007 in the ranges from 1.39 mSv to 1.80 mSv, 1.05 mSv to 1.45 mSv and 1.22 mSv to 1.71 mSv respectively where as Weizhang W et, al. [15] presented the annual doses of radiation workers of diagnostic radiology, nuclear medicine and radiotherapy sections which were within the ranges of 1.5-2.2, 1.2-1.6 and 1.0-1.5 mSv, respectively . Korir GK et, al. [16] studied that 17% of radiation workers' annual doses were less than 1 mSv and 81% received the doses in a year ranging from 1 mSv to 5 mSv. Careiro JV and Avelar R [17] showed that the yearly occupational doses of 97.8% workers were under the array of 5 mSv. The results of our study are quite lower than the recommended international annual limit for one year (20 mSv) as recommended by ICRP [11] and for a period of 5 consecutive years which were also mentioned by Jabeen A et, al. [14, 18].

CONCLUSIONS

The main purpose of this study was the evaluation of radiation doses received by radiation personnel according to permissible limits [10, 11]. It is concluded from the dose data of annual and last five years of all radiation workers of NIMRA Jamshoro, the radiation doses of all radiation workers were in the acceptable range of National [10] and International [11] organizations which verifies that the facilities for radiation protection are satisfactory and show that radiation protection techniques are reasonable [13, 18].

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