

Evaluation of radiation workers occupational doses for newly established medical center NORIN Nawabshah in Pakistan

Abdul Razaq, Muhammad Waqar, Quratulain Soomro, Muhammad A. Javed

Nuclear Medicine Oncology and Radiotherapy Institute Nawabshah (NORIN)

E-mail: norin.nawabshah@paec.gov.pk

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Abstract: The purpose of this study is the evaluation of radiation doses received by radiation personnel in newly established medical Centre, Nuclear Medicine Oncology and Radiotherapy Institute Nawabshah (NORIN) Pakistan. In this study the annual dose data of workers for the year 2013 and 2014 in different sections will be analyzed using different statistical methods and results. It will be discussed that how we careful in occupational radiation dose and comparison with national and international organization will be done to know that the facility in NORIN for radiation protection is reasonable and satisfactory.

Keywords: occupational dose, TLD

1. Introduction

The general population is exposed regularly to natural low level background radiation, while exposure to man-made sources is mostly from radiation generating medical devices, particularly nuclear medicines and x rays (both diagnostic and industrial) estimated to be 4% and 11% respectively.¹ 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 severely due to exposure. 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. 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 used in the passages of rooms to stop the primary and scattered radiation, where radiations generating equipment's / sources are placed.²

Nuclear medicine oncology and radiotherapy institute Nawabshah (NORIN), Pakistan uses radiation generating devices and manmade radio-isotopes 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 radioisotopes are used for routine diagnostic procedures and treating thyroid disorders. The radiotherapy section uses Co-60 for treating various types of cancer. For proper radiation protection, the detection and measurement of radiation is necessary. The monitoring of workers working in radiation area by using TLD's is one of the vital sources to measure the radiation dose for personal dosimetry. The TLD badge consists of two lithium fluoride chips in a plastic holder. Based upon standard and guidelines prescribed/ approved by international commission on radiological protection (ICRP) and international Atomic Energy Agency (IAEA), the Pakistan Nuclear Regulatory Authority (PNRA) has approved a permissible dose limit of 20 mSv as an occupational dose for radiation workers in Pakistan, as

summarized. This study was conducted to evaluate the radiation doses received by radiation workers of NORIN referring to permissible limits as defined by National and International Regulatory bodies.³

2. Materials and methods

This study was carried out at NORIN, Nawabshah to detect occupational radiation doses, each radiation worker of NORIN have been issued TLD personal dosimeter badge with unique identification number for the particular worker. The service of annealing and readout is being provided by Karachi Institute of Radiotherapy and Nuclear Medicine (KIRAN) on regular intervals. For the radiation worker's personnel monitoring, TLD badge is one of the recommended devices for the measurement of occupational radiation dose of the workers accuracy & energy independent 0.1 mGy to 100 Gy. In this study, the radiation dose received by 23 workers in the years 2013 (January – December 2013) and by 28 workers in 2014 (January – December 2014) of NORIN Nawabshah was evaluated. Statistical analysis applied to the individual worker dose and compare with annual limits (20 mSv). Data is also analyzed in section basis in which workers offered their services at Radiology, Nuclear Medicine and Radiotherapy departments respectively. The readings of TLD's badges provided by KIRAN were kept as records for the purpose of evaluating dose history to the workers.

Table 1. Departmental average dose distribution.

Department	Year	Total Workers	Total Dose (mSv)	Average Dose of Worker (mSv)	% of Permissible Limit i.e. 20mSv
Nuclear Medicine	2013	7	12.63	1.80	9.02
	2014	8	17.16	2.14	10.72
Radiology	2013	9	15.00	1.67	8.33
	2014	12	22.96	1.91	9.56
Radiotherapy	2013	7	10.38	1.48	7.41
	2014	9	16.80	1.87	9.33

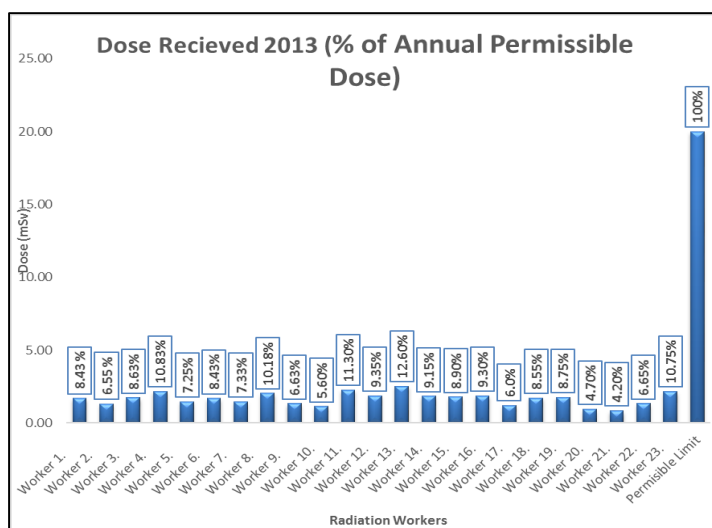


Figure 1. Individual radiation worker dose for the year of 2013

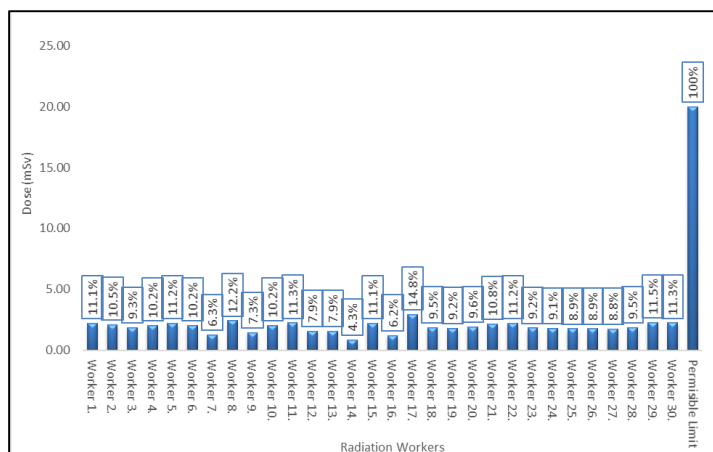


Figure 2. Individual radiation worker dose for the year of 2014

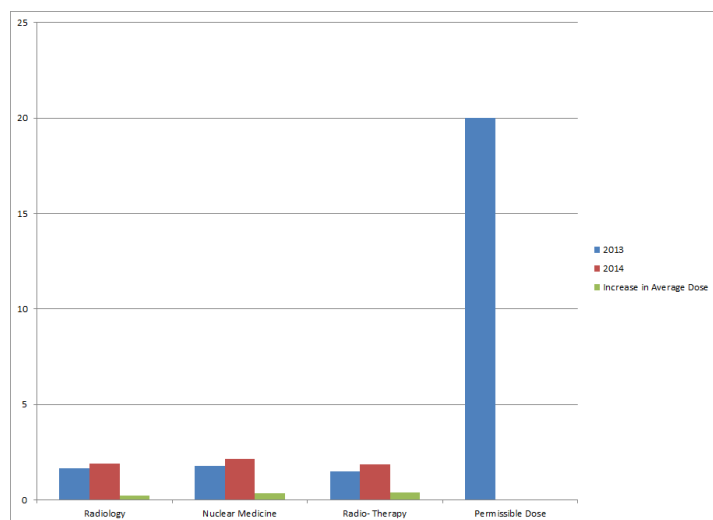


Figure 3. Department wise average annual dose for the year of 2013 & 2014

3. Results and discussion

Fig 1 indicates the distribution of percentage annual occupational dose for different groups of medical radiation workers in NORIN in 2013. The measured range for annual absorbed dose was 0.84 mSv to 2.52 mSv received 4.20% and 12.60% by worker no. 21 and worker no. 13 respectively. Permissible limit which is 20mSv is also shown, for comparison with other worker data. Fig 2 shows the distribution of percentage annual occupational dose for radiation workers 2014. In this graph the measured range for annual absorbed dose was 0.86 mSv to 2.95 mSv received 4.30% and 14.80% by worker no. 14 and worker no. 18 respectively. Between the years of 2013 and 2014, the maximum increment of average dose of workers was observed in radiotherapy department was 0.39 mSv (1.87 – 1.48 mSv), whereas in nuclear medicine the increment is 0.34 mSv (2.14 mSv – 1.8 mSv) and in radiology department the increment was just 0.24 mSv (1.91 – 1.67 mSv). In both years 2013 and 2014 it was also observed that the workers of

Nuclear medicine have received the maximum radiation dose and minimum dose was received by the workers of radiotherapy department. The limit of annual collective effective dose from occupational exposure in the medical sector was 20mSv per person. For all the subjects monitored, the doses were below the 15% of prescribed limit of 20 mSv per year.⁴ Only 5 workers among 23 and 14 workers among 30 in the years 2013 and 2014 respectively was received effective dose more than 10% (2 mSv), of the annual occupational dose limits.

Table 1 shows the departmental wise total dose received by all workers (column 04), average dose to the radiation worker and dose in comparison of limit i.e. % of permissible limit, for the year of 2013 and 2014. Different departments having variable number of workers received different effective doses. Comparison for the both years 2013 and 2014 in all three departments are shown in Figure 3. In nuclear medicine department 9.0% and 11% of permissible dose limit, in radiology 8.3% and 10% and in Radiotherapy received 7.4% and 9% for the year of 2013 and 2014 respectively.

Percentage increment in annual dose of 2014 in comparison of 2013 is 15.89%, 12.57% and 20.86% respectively. In the year 2014 the percentage increment exhibited the larger amount of radiation exposure owing to increased patient workload as well as increase in time to spend in the radiation area.

The majority of radiation workers of NORIN received the annual doses less than 2 mSv (10% of annual dose). Jabeen A et al.⁵ 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.⁶ 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.⁷ 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 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.⁸

4. Conclusion

The main purpose of this study was the evaluation of radiation doses received by radiation personnel in a newly establish medical centre is according to permissible limits. It is concluded from the dose data of annual of all radiation workers of NORIN Nawabshah, the radiation doses of all radiation workers were in the acceptable range of National and International organizations which verifies that the facilities for radiation protection are satisfactory and show that radiation protection techniques are reasonable. This study also showed that providing each worker with the measured monthly dose can have a positive influence on improving radiation safety measures. Radiation workers, who, like physicists, have fundamental understanding and knowledge of radiation safety, can derive the most benefit from these studies because their measured monthly dose showed the largest spread in distribution. The trend also indicates that working behaviour changed when radiation workers realised that they would be subjected to detailed analysis of their annually exposure.

References

- ¹ National Council on Radiation Protection and Measurements. NCRP Publication No. 93: Ionizing radiation exposure of the population of the United States: Recommendations of National Council on Radiation Protection and Measurements.
- ² Martin A & Harbison SA. Natural and Man-made radiation: Man made sources of radiation. In: A Martian editors. An introduction to radiation protection, Champ & Hall Medical, London, pp. 45-47 (1996)
- ³ Memon, Sajjad Ahmed, Naeem Ahmed Laghari, and Asrar Ahmad Cheema. Evaluation of radiation workers' occupational doses working at NIMRA Jamshoro. JLUMHS, **11.03**, pp. 190 (2012)
- ⁴ Korir, Geoffrey K., Jeska S. Wambani, and Ian K. Korir. Estimation of annual occupational effective doses from external ionising radiation at medical institutions in Kenya, SA Journal of Radiology, **15.4** (2011).
- ⁵ Jabeen A, Munir M, Khalil A, et al. Occupational exposure from external radiation used in medical practices in Pakistan by Film badge dosimeter.
- ⁶ Weizhang W, Wenyi Z, Ronglin C et al. Weizhang W, Wenyi Z, Ronglin C, Liang'an Z. Occupational exposures of Chinese medical radiation workers in 1986-2000, Radiat Prot Dosimetry, pp. 117 (2005)

- ⁷ Korir GK, Wambani JS, Korir IK. Estimation of annual occupational effective doses from external poisoning radiation at medical institutions in kenya, SA Journal of Radiology, December, pp. 116-169 (2011)
- ⁸ International Commission on Radiological Protection. ICRP Publication 60: Annals of ICRP 21(1-3), New York. International Commission on Radiological Protection; 1991.M. (2011).