British Journal of Medicine & Medical Research
19(9): 1-9, 2017; Article no.BJMMR.31226
ISSN: 2231-0614, NLM ID: 101570965

SCIENCEDOMAIN *international*
www.sciencedomain.org

Monitoring and Evaluation of Radiation Dose Level at Institute of Nuclear Medicine and Allied Sciences, Khulna

M. R. Islam[1,2*], M. S. Parvez[1,2*], M. R. Hasan[1,2], M. B. Hossain[1], H. R. Khan[1] and A. K. Paul[2]

[1]Physics Discipline, Khulna University, Khulna-9208, Bangladesh.
[2]Institute of Nuclear Medicine and Allied Sciences, Khulna-9000, Bangladesh.

Authors' contributions

This work was carried out in collaboration between all authors. Author MRI performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author MSP designed the study and managed the analyses of the study. Authors MRH and MBH managed the literature searches. Authors HRK and AKP supervised this analysis. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/BJMMR/2017/31226
Editor(s):
(1) Rodrigo Crespo Mosca, Department of Biotechnology, Institute of Energetic and Nuclear Research (IPEN-CNEN), University of Sao Paulo (USP), Brazil.
Reviewers:
(1) A. Ayeshamariam, Khadir Mohideen College, Adirampattinam, India.
(2) Chinyere P. Ononugbo, University of Portharcourt, Portharcourt, Rivers State, Nigeria.
Complete Peer review History: http://www.sciencedomain.org/review-history/17749

Original Research Article

Received 27th December 2016
Accepted 25th January 2017
Published 8th February 2017

ABSTRACT

Every type of radiation is harmful for the occupational workers, patients and also for the environment. Among of these, ionizing radiation is more mischievous. So it is essential to monitor the radiation level to ensure the health and safety of the occupational workers, general public and also to protect the environment from the harmful effect of ionizing radiation. In medical sector, ionizing radiation is used for diagnosing and treating various diseases. For this purpose, a radiation survey has been performed during a period of eight months with a view to establishing the ambient radiation level in the area of Institute of Nuclear Medicine & Allied sciences (INMAS) at Khulna Medical College Hospital, Khulna. Survey meter is used for monitoring the radiation level at different location in INMAS, Khulna. We have obtained the result 0.8 mSv in many locations and 8 mSv in one location not crossing 20 mSv which is within the acceptable limit. It is concluded that there is no (or less) possibility of radiation hazard in the INMAS, Khulna.

**Corresponding author: E-mail: rakibulislamjiko@gmail.com, shohel.ku.phy@gmail.com;*

Keywords: Radiation monitoring; radiation hazard; radiation safety; survey meter.

1. INTRODUCTION

We live with radiation and it has become a part of our life. From the creation of human beings, animals and plants are exposed by the natural radiation. Many radiation isotopes contained when the earth formed about billion years ago. Though it is harmful for some instance, radiation is useful in some purposes. It can induce cancer and also cure from many serious diseases. The effect of radiation on tissues first came to light after discovery of X-rays by Wilhelm Conrad Röntgen in 1895 [1-4]. For this reason, the ionizing radiation is used in medical departments. But all the technological procedures have associated with risks. When the use of radioactive materials or the mechanics producing ionizing radiation is uncontrolled, it may cause harm to the occupational workers, patients, general public and also environment. Every country has many INMAS centers where ionizing radiation is used for diagnosing and treating various diseases. Since ionizing radiations are injurious for health, it is essential to take proper steps to control the radiation level. There is no alternative of monitoring radiation level to protect technicians and public who are involved in radiation works. But all the instruments are used in testing the radiation level should not exceed the period of fourteen months [5]. For this purpose an investigation has been performed to monitor the radiation at different location in INMAS, Khulna.

On the other hand, it may produce the internal exposure during the handling of damaged sealed or opened sources of radioactive materials. To ensure the safety of the workers, general public and the environment, we performed monitoring at Institute of Nuclear Medicine & Allied Sciences (INMAS). The International Commission on Radiation units and Measurements (ICRU) and the International Commission on Radiological Protection (ICRP) are the key organizations in this field since 1991 [6]. The concept for radiation protection quantities and the operational quantities introduced by ICRU for monitoring of external expose described in 2003 [7]. Various kinds of radiation monitoring instruments such as survey meters, pocket dosimeter, TLD, area monitors and environmental monitors are used in radiation facilities to measure or to observe radiation level and personal exposure. In this work, we only used the survey meters for the area monitoring. To understand the radiational condition of the examine place is the main objective of the present work. The area is classified in (a) Uncontrolled area (dose rate ≤2.5 µSv per hours) (b) Supervised area (dose rate ≤7.5 µSv per hours) (c) Controlled area (dose rate ≥7.5 µSv per hours) and (d) Restricted area (dose rate ≈25 µSv per hours) [8]. Finally we will discuss our result in the chapter result and discussion and also ensure the health of the occupational workers.

2. MATERIALS AND METHODS

The continuous radiation survey data and the estimation of radiation doses were done during the period of eight months. The survey meter technique has been used in the estimation of radiation doses. We monitored the radiation dose in three times per day. Firstly we took the data before working period 8 am, secondly the data during working time and finally the data after working time 2.30 pm. The random radiation doses were received by the survey meters in the time of processing the radioisotopes, dispensing of radioisotopes and scanning the patients. The Health Physics Division, Bangladesh Atomic Energy Commission (BAEC) was sent the survey meter in every year to monitor the radiation doses in every INMAS center. Ionization chamber is an instrument to detect the ionizing radiation by using the ionizing properties of radiation. It consists of one central electrode, i.e. anode, one cathode outside the anode and buildup cap. The cavity of the chamber filled with air/gas. The shape, size, volume of chambers, materials of electrodes and buildup cap etc. are well recognized. Ion chambers, in principle are the simplest of all gas-filled detectors. Its normal operations are based on collection of all charges created by direct ionization within the gas through the application of an electric field. As with other detectors, ions chambers can be operated in current or pulse mode. In most common applications, ion chambers are used in current mode as dc devices. The term ionization chamber has conventionally come to be used exclusively for the type of detector in which ion pairs are collected from gases.

One of the most important applications of ion chambers is in the measurement of gamma ray exposure. An air filled ion chamber is particularly well suited for this application because exposure is defined in terms of the amount of ionization charge created in air. Under the proper

Fig. 1. Cylindrical ionization chamber used in Dosimetry

conditions, the determination of the ionization charge in an air filled ionization chamber can give an accurate measure of the exposure and a measurement of the ionization current will indicate the exposure rate.

The ionization chamber NE 2575 has been designed to achieve a high degree of stability, combined with uniform X-ray energy dependence characteristics over wide range of energies. The basic features are:

- The energy response characteristic is effectively flat i.e., within ± 1%.
- Ion collection efficiency is better than 99.99%.
- Thimble is made by high purity, high density extruded graphite.

We used the survey meter (Model 2# 069-702, serial no 851887, New York, USA & Model: Mini-rad series 1000, serial no 1781, British) for continuous radiation surveys with the units µSv/h. Some places like hot laboratory, dispensing room, gamma camera room (where the patients were scan) and other places (patient waiting room, corridor) were routinely monitored the radiation dose level by the help of survey meters. Ambient dose equivalent is therefore an isotopic measure [9]. In INMAS, generally the radio-pharmaceuticals I^{131}, Tc^{99m} (for the diagnostic and therapeutic studies), sources of the radiation doses have been used. The equivalent doses due to the different type of incidences in the body or emitted by the radionuclide within the body are monitored [10].

3. RESULTS AND DISCUSSION

To calculate the doses, radionuclides are deposited to the patient from internally is much more difficult because the activity will be distributed and cleared from the various organs in the body [11]. The gamma camera detects photons escaping from the organs and then the radio-pharmaceutical is monitored. In the case of Gamma camera, the photons create a defined image of tissues by distributing radionuclides [12]. The residual doses which are administered to patients with radio-pharmaceuticals for diagnostic and therapeutic studies with the view of assessing, a survey was carried out by using of I^{131}, Tc^{99m} radioisotopes. A brief description of some of the case studies is given below:

Table 1. Radiation level in hot laboratory

Time	Location	Dose rates (µSv/h) for several days											
		22-4-14	24-4-14	25-4-14	26-4-14	27-4-14	28-4-14	23-7-14	24-7-14	25-7-14	23-8-14	24-8-14	25-8-14
8 AM	Fume hood	1.4	2.0	1.8	1.4	1.8	2.0	1.4	2.0	1.2	1.5	1.6	2.0
	Background	0.8	0.7	0.4	0.7	0.4	0.5	0.6	0.7	0.4	0.8	0.5	0.7
10 AM	Fume hood	4	4	6	5	6	6	4	3	4	5	4	4
	Background	1	1	0.5	0.7	0.6	0.5	0.6	0.7	0.4	0.8	0.5	0.7
2.30 PM	Fume hood	3.5	4	4	4	4	5	4	3	4	2	4	4
	Background	0.8	0.8	0.3	0.4	0.4	0.5	0.4	0.7	0.4	0.8	0.5	0.7

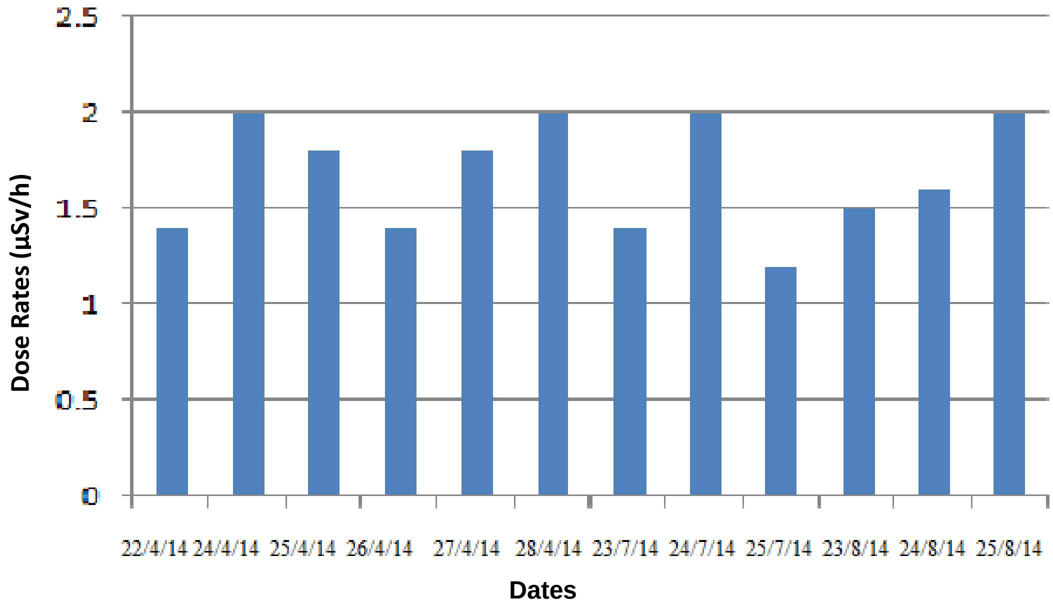

Fig. 2. Radiation dose level in hot laboratory at 8 am

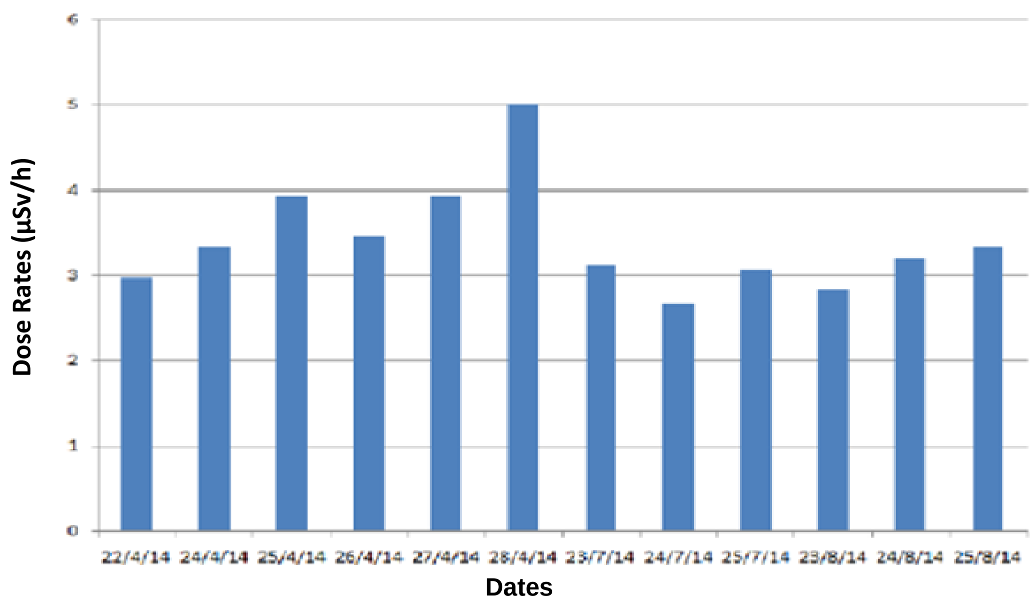

Fig. 3. Radiation level in hot laboratory at 10 am

When radioisotopes are used for diagnosis, the result of higher radiation level around the patients may cause harm to the technicians, practitioners, and some extents to the family members of the patient [13]. The continuous radiation survey data over a period of eight months is shown in the above Tables 1 to 4 and the radiation dose level are shown in the graph 1 to 9. From above table and graph it is seen that the radiation level in some places is different from others. We have seen that radiation level in corridor which is generally used as patient waiting room after pushing the dose for diagnosing disease is higher than all other places. In this place, maximum radiation level is 15 µSv/h, which is far below the maximum permissible level 25 µSv/h. In other places such as hot laboratory, dispensing room, SPECT (gamma camera) room and outside the INMAS center the radiation level are far below the maximum permissible level 25 µSv/h. Among these places maximum radiation level is found in top of the bench in dispensing room and fume hood in hot laboratory. In hot laboratory, the radiation level is high at 10 am and 2 pm because radiation source such as radionuclide generator is present there but at 8 am radiation level is very low due to the absence of radiation source. In dispensing room, radiation level is high all time at basin and top of the bench due to presence of instrument but low at floor. Minimum radiation is found in SPECT room and outside the SPECT room. In corridor, the radiation level is higher because after receiving the dose the patient waits here for some time and radiate γ ray. Most of the cases we get background radiation which is far below the maximum permissible level 25 µSv/h and it are not the significant radiation hazard.

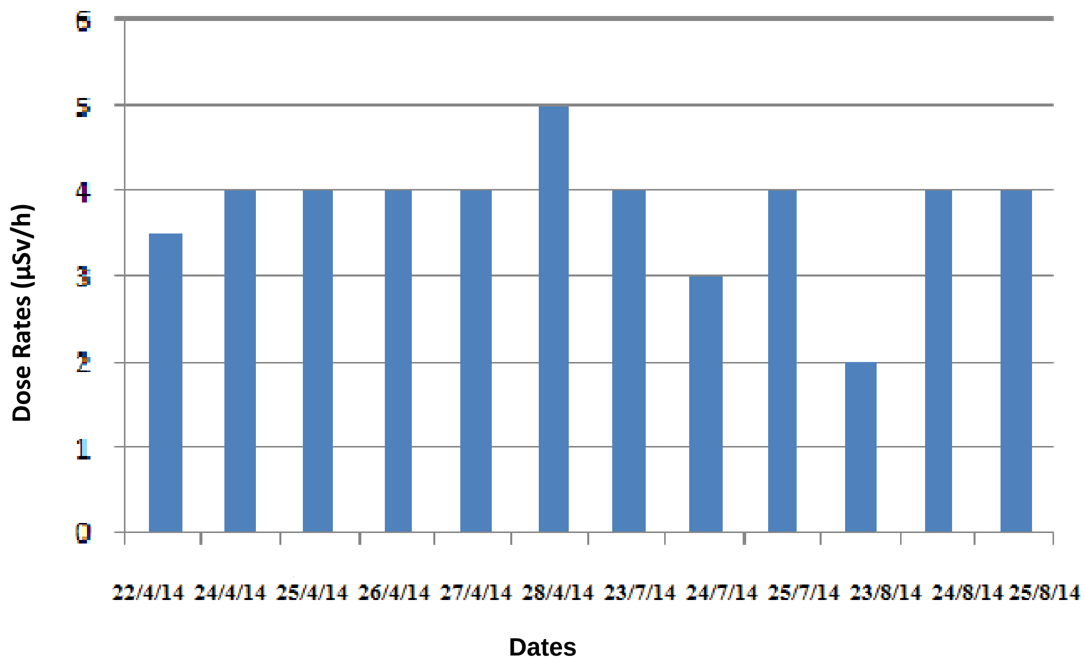

Fig. 4. Radiation level in hot laboratory at 12.30 pm

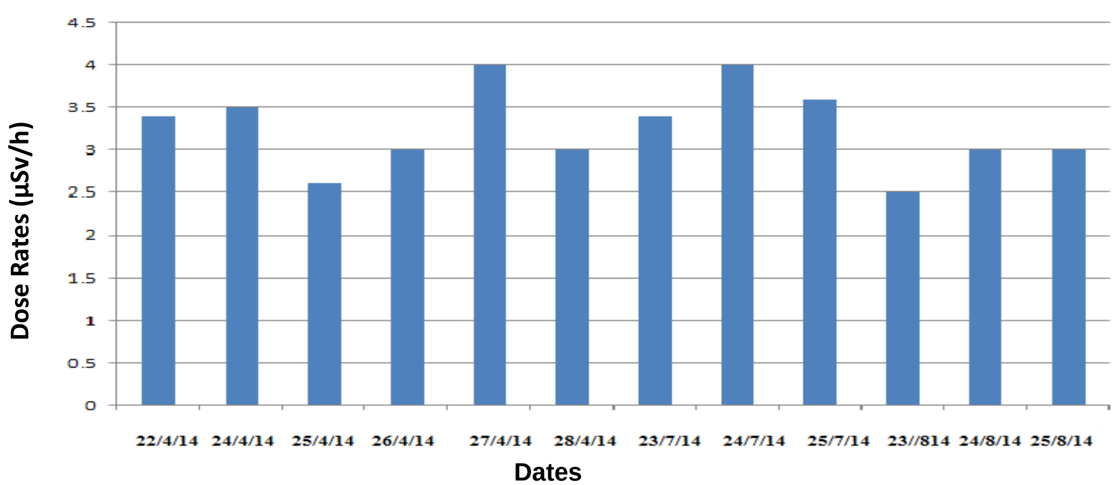

Fig. 5. Radiation level in dispensing room at 8 am

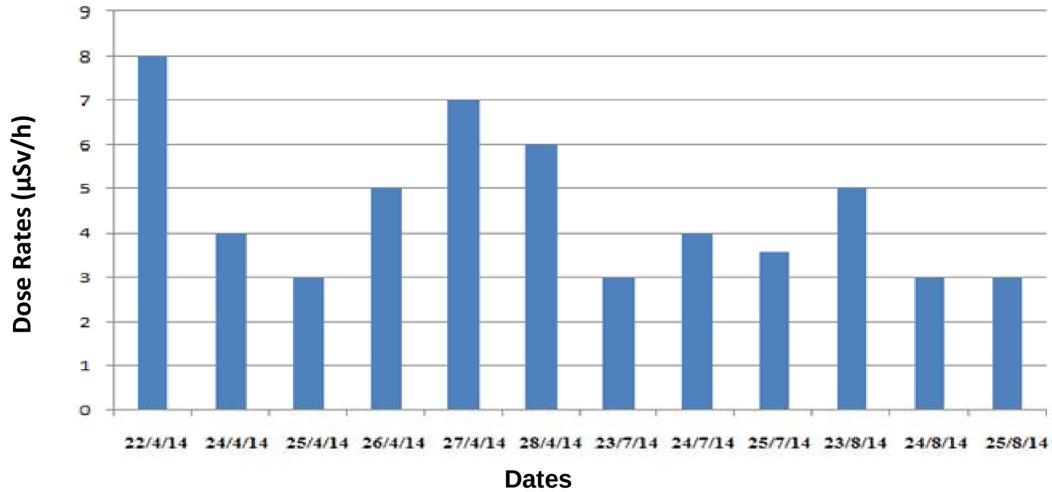

Fig. 6. Radiation level in dispensing room at 10 am

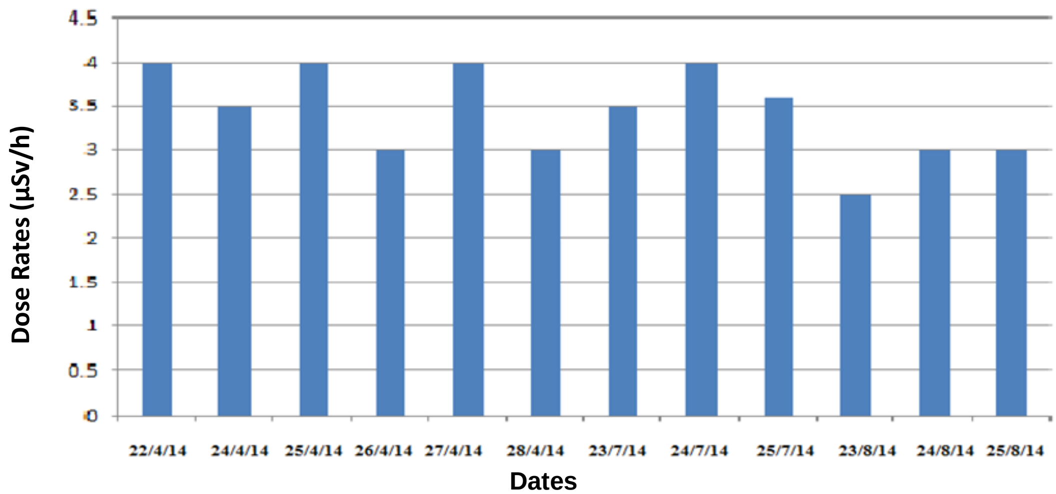

Fig. 7. Radiation level in dispensing room at 12.30 pm

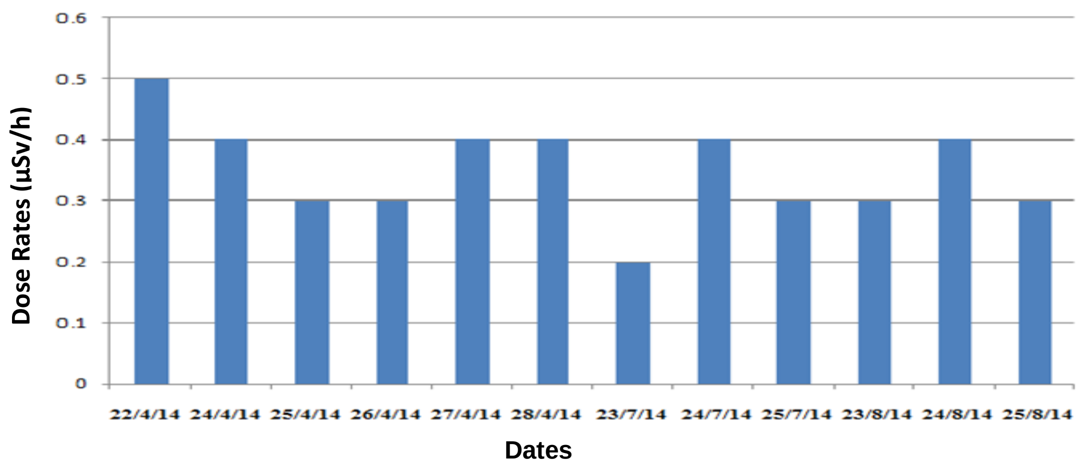

Fig. 8. Radiation level in gamma camera room at 8 am

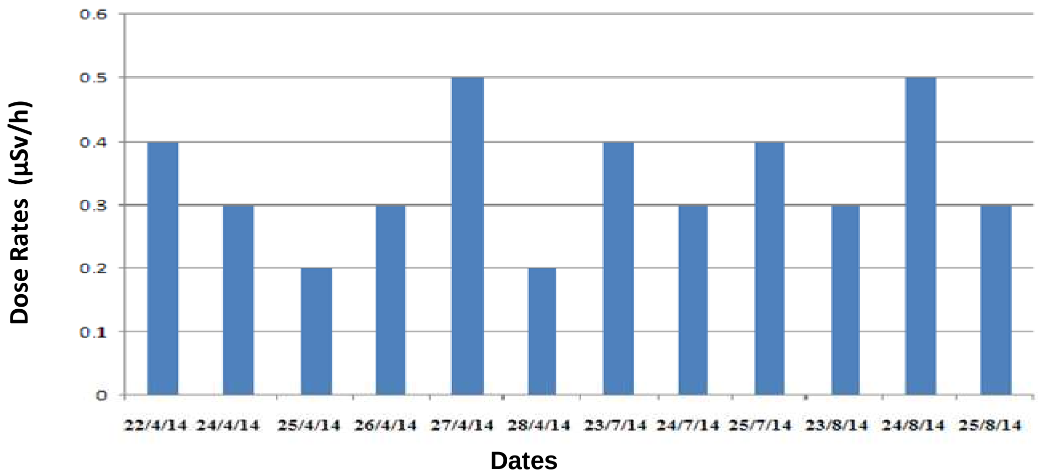

Fig. 9. Radiation level in gamma camera room at 10 am

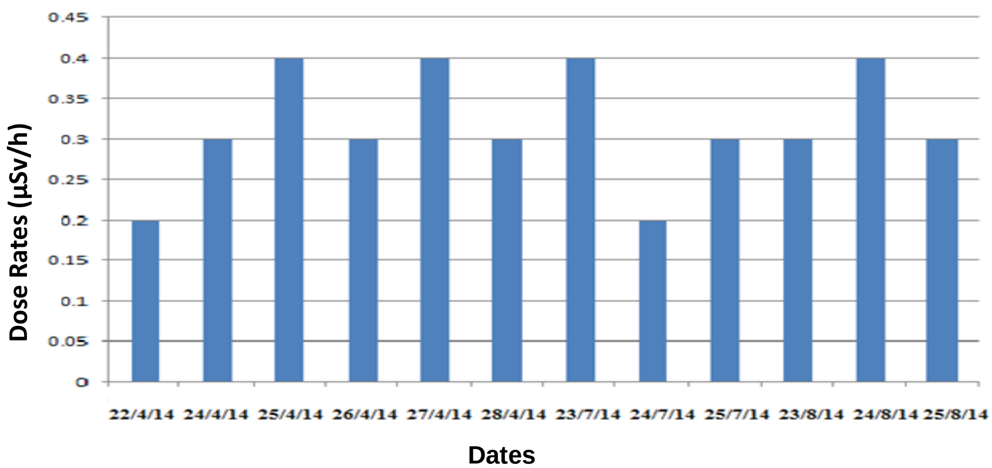

Fig. 10. Radiation level in gamma camera room at 12.30 pm

Table 2. Radiation level in dispensing room

Time	Location	Dose rates (µSv/h) for several dates											
		22-4-14	24-4-14	25-4-14	26-4-14	27-4-14	28-4-14	23-7-14	24-7-14	25-7-14	23-8-14	24-8-14	25-8-14
8 AM	Basin	2.0	3.0	3.0	2.0	3.0	2.0	2.0	3.0	3.0	3.0	3.0	2.0
	Top of the bench	3.4	3.5	2.6	3.0	4.0	3.0	3.4	4.0	3.6	2.5	3.0	3.0
	Floor	1.0	1.0	0.5	1.0	0.2	0.4	0.5	0.6	0.3	0.6	0.5	0.7
10 AM	Basin	4.0	3.0	2.2	1.7	4.0	6.0	1.0	2.0	2.0	3.0	4.0	2.0
	Top of the bench	8.0	4.0	3.0	5.0	7.0	6.0	3.0	4.0	3.6	5.0	3.0	3.0
	Floor	2.0	1.0	0.8	0.5	1.0	2.2	0.4	0.5	0.6	0.3	0.6	0.7
2.30 PM	Basin	3.0	3.0	2.5	1.8	3.0	2.0	2.0	3.0	3.0	2.0	2.0	2.0
	Top of the bench	4.0	3.5	4.0	3.0	4.0	3.0	3.5	4.0	3.6	2.5	3.0	3.0
	Floor	0.6	0.5	0.6	0.8	0.4	0.5	0.4	0.6	0.3	0.6	0.7	1.0

Table 3. Radiation level in SPECT (gamma camera) room

Time	Location	Dose rates (µSv/h) for several days											
		22-4-14	24-4-14	25-4-14	26-4-14	27-4-14	28-4-14	23-7-14	24-7-14	25-7-14	23-8-14	24-8-14	25-8-14
8 AM	1 meter from patient	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4
	Behind lead shield	0.5	0.4	0.5	0.4	0.4	0.3	0.4	0.4	0.4	0.4	0.3	0.3
	Processing place	0.5	0.4	0.3	0.3	0.4	0.4	0.2	0.4	0.3	0.3	0.4	0.3
10 AM	1 meter from patient	4.0	3.0	2.0	4.0	4.0	3.0	3.0	4.0	4.0	4.0	3.0	3.0
	Behind lead shield	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.4	0.3	0.3	0.3
	Processing place	0.4	0.3	0.2	0.3	0.3	0.2	0.4	0.3	0.4	0.3	0.4	0.3
2.30 PM	1 meter from patient	0.5	0.4	0.4	0.4	0.3	0.4	0.4	0.4	0.3	0.3	0.4	0.3
	Behind lead shield	0.3	0.3	0.2	0.3	0.3	0.3	0.4	0.4	0.3	0.3	0.3	0.4
	Processing place	0.2	0.3	0.4	0.3	0.4	0.3	0.4	0.2	0.3	0.3	0.4	0.3

Table 4. Radiation level in other place

Location	Dose rates µSv/h for several days											
	22-4-14	24-4-14	25-4-14	26-4-14	27-4-14	28-4-14	23-7-14	24-7-14	25-4-14	23-8-14	24-8-14	25-8-14
Outside the SPECT	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.4	0.4	0.3
Under the stair	0.7	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Corridor (patient waiting room)	15	10	14	13	12	14	15	13	15	12	12	10

4. CONCLUSIONS

The radiation level in the hot laboratory was never found exceeding maximum of the permissible limit, it was significantly below 25 µSv/h and maximum value was found in the corridor is 15 µSv/h, hot laboratory is 6 µSv/h and dispensing room is 8 µSv/h. From the above results, it can be said that hot laboratory area and dispensing room are supervised area. But the corridor is called controlled area. All other places are uncontrolled area. Due to the case of preparation of different types of activity of isotope in the dispensing room, higher fluctuation background radiation are shown but it is also below the permissible limit. The ambient radiation level was never found exceeding the maximum permissible limit 25 µSv/h in the scanning rooms including the adjacent supervised areas. To eliminate of public exposure arising from practicing nuclear medicine is possible by good security and overall by controlling access to the areas where such radioactive materials used. So according to the results INMAS, Khulna center is safe and radiation hazardless. It should be borne in mind that surveys are only supplementary forms of radiation control in nuclear medicine. But to follow the code of practice and insists other to comply with the rules and standards is the basic method of control.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

DISCLAIMER

Some part of this manuscript was previously presented in the following conference.
Conference name: International Conference on Advances in Physics 2015. 18-19 April, 2015. Department of Physics, University of Rajshahi.
Web Link of the proceeding:
https://www.researchgate.net/profile/Mdabdullah-Al-Mashud/publication/280022985_The_Gynaecological_Dose_Calculations_at_Risk_Organs_using_AAPM_HEBD_Report-229_and_IAEA_Protocols/links/55a4047108ae00cf99c8f227.pdf.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Biswal BM. Introduction to clinical radiotherapy. Universiti Sains Malaysia, Malaysia.
2. Fang YZ, Yang S, Wu G. Free radicals, antioxidants, and nutrition. Nutrition. 2002; 18:872.
3. Brooker RJ. Genetics: Analysis and principles, 4th Ed, McGraw-Hill Higher Education; 2011.
4. © 2015 American Cancer Society, 15 Nov 2014, Inc, Evolution of Cancer Treatments: Radiation. Available:http://www.cancer.org/cancer/cancerbasics/thehistoryofcancer/the-history-of-cancer-cancer-treatment-radiation
5. Alan Martin, Samuel A. Harbison. An introduction to radiation protection. Chapman and Hall Ltd., London, 1st Edition; 1972.
6. ICRP. Recommendation of the International Commission on Radiological Protection, ICRP 21; 1991.
7. ICRP. Recommendations of the International Commission on Radiological Protection, ICRP Publication 26, Annals of 1; 1977.
8. Abdul Jalil. An introduction to health physics, Publication June; 1995.
9. Kramer R, Ermittlung von Konversions-faktorenzwischen Korperdosen and Relevanten Strahlungskenngrossenbei. External Rontgen-und Gamma-Bremsstrahlung; 1979.
10. Annals of the ICRP. International Commission on Radiological Protection (ICRP), ICRP-60), Recommendations of the International Commission on Radiological Protection, Pergamon Press, Oxford. 1990;21.
11. Sharp PF, et al. Practical nuclear medicine. IRL Press.
12. Gopal B. Shaha. Physics and radiobiology of nuclear medicine. Second Edition; 2001.
13. John R. Cameron, James G. Skofnick. Medical Physics. John Wiley & Sons; 1978.

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/17749