Article published online: 2022-07-04

Assessment of Knowledge of Radiography Students about Personnel Radiation Monitoring Devices and Their Use

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Indian J Radiol Imaging 2022;32:191–196.

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Abstract

Background Personnel radiation monitoring equipment monitors the level of exposure to radiation and personnel will have to wear a personnel device for radiation detection while working. Personnel monitoring equipment is usually worn by a worker for 3 months.

Aim This study aims to evaluate the knowledge of radiology students about personnel radiation monitoring devices and their use.

Materials and Methods A questionnaire-based cross-sectional study was performed in the College of Paramedical Sciences, Teerthanker Mahaveer University, Delhi–Road Moradabad, Uttar Pradesh, India. This questionnaire-based study was performed for the period time of 1 year from June 2020 to May 2021. A validated questionnaire was circulated among undergraduate and postgraduate radiology students.

Result In this study the questionnaire was filled by a total of 140 students who were pursuing bachelor's and master's degree programs, including 61% (86) males and 39% (54) females from the radiology department. According to the data master's knowledge levels are greater than the bachelor's level. The level of knowledge of monitoring devices among MRIT (M.Sc. in Radiology and Imaging Technology) second year (81%) is more than those of MRIT first year (80%), BRIT (B.Sc. in Radiology and Imaging Technology) third year (65%), and BRIT second year (66%).

Conclusion It is concluded that there is a lack of awareness about personnel radiation monitoring systems. The level of knowledge of personnel radiation monitoring devices among students remains at a medium level from the results of our students as it has been concluded that master's knowledge level is greater than the bachelor's level. The level of knowledge of monitoring devices increases with the age of the students and the year completed.

Keywords
- OSL
- TLD
- lithium fluoride

published online
July 4, 2022

DOI https://doi.org/10.1055/s-0042-1744521.
ISSN 0971-3026.

Thieme Medical and Scientific Publishers Pvt. Ltd., A-12, 2nd Floor, Sector 2, Noida-201301 UP, India

Introduction

Radiation was discovered by Wilhelm Conrad Roentgen on November 8, 1895. It is possible to say today that radiation is one of the causes of illnesses. Radiation is more damaging on the molecular, cellular, and organ systems, which are known health stress agents.[1] Personnel radiation monitoring equipment monitors the level of exposure to radiation and personnel will have to wear a personnel radiation detection device while dealing with radiation. A personnel monitoring equipment detects and records a radiation dose over a set period of time. The personnel monitoring equipment is usually worn by a worker for 3 months. The measured dosage by the personnel monitoring equipment is registered to the employer and then it is sent to the dosimetry service provider for review.[2] According to AERB (Atomic Energy Regulatory Board) guidelines, the occupational exposure of any worker will be so controlled that the effective dose of the whole body is 20 mSv/year on average for 5 years, 30 mSv in any 1 year or public performance for 1 mSv/year dose equal to the eye lens is 20 mSv in 1 year, spread over a given 5 year period; or public exposure 15 mSv a year; 500 mSv a year or an equivalent dose of skin 50 mSv/year in public exposure; equal dose of hands and feet at per year 500 mSv. The fetus should not be exposed to greater than 1 mSv for pregnant radiation workers following pregnancy declarations. AERB's mission consists of ensuring the use of radioactive and ionizing radiation in India does not pose a health and environmental danger.[3] The purpose of the measurement is to identify undesirable practices and unexpected sources of high risk to provide information about occupational exposure, directing long-term controls necessary to limit exposure and reduce exposure.[4] A variety of personnel radiation monitoring devices are used to measure radiation exposure dose rates of radiation workers, such as film badge, thermoluminescent dosimeter (TLD), pocket dosimeter, and optionally stimulated luminescence (OSL) dosimeters.[5]

Film Badge

Personnel dosimeter film badges are widely used for X-rays, gamma-rays, and β particles for measuring and recording radiation exposure. The detector is a photographic film, as the name implies, which is sensitive and must be produced on a monthly basis. The film is sealed in a light- and vapor-resistant envelope to avoid any effects of illumination, moisture, or chemical vapor on the film. The higher the radiation exposure, the darker the film becomes. The film's blackness is linearly proportional to the dosage and doses can be tested up to around 10 Gy. Dosimeters for film badges are used once only and cannot be reused. A dosimeter is a film tag, which is worn by a person for monitoring the surface of the body, and it records the received exposure dose. Film dosimeters, aluminum oxide-based dosimeters, and electronic personal dosimeters are commonly replaced by TLDs.[6,7]

Thermoluminescent Dosimeter

TLD is an inert radiation detector device for monitoring personal exposures and for measurement of patient exposure. The dosage can be as low as 1 millirem for a long duration (normally 3 months or less), but the low dose capacity is almost identical to that of a film badge under daily conditions. TLD badge parts are fitted with plastic, nickel-plated TLD aluminum cards, discs of thermoluminescent content, and normally doped with dysprosium-activated calcium sulfide ($CaSO4:Dy$) or lithium fluoride (LiF). The discs are 0.8 mm in thickness and 1.35 cm in diameter. Each disc has three filters; top: copper and aluminum, center: perspex, bottom: free. Electrons are excited as radiation enters into the TLD and store energy. If you have a lead apron, you should wear the TLD badge inside the apron (to reflect body supplements). TLD can measure doses from 0.01 mGy to 10 Gy.[8,9]

Pocket Dosimeters

These are used to protect the wearer from X-rays andgamma rays. They are normally worn in the pocket as the name indicates. There are mainly two types, direct read pocket dosimeters and digital electronic dosimeters, widely used in industrial radiography.[10]

- Direct read pocket dosimeter: It is usually of the size and shape of a fountain pen. This dosimeter has a small ionization chamber with a volume of about two cubic milliliters. There is a central wire anode inside the ionization chamber, and a metal connected to this wire anode is the quartz fiber. When the anode is charged to a positive potential, the charge is stocked between the anode and the quartz fiber.[10]
- Digital electronic dosimeter: This wireless electronic dosimeter is another kind of pocket dosimeter. This dosimeter records the dosage and dose information. The radiation detector output is collected and the recovered charge is unloaded to activate the electronic counter when there is a predetermined danger. The counter then shows the risk and dosage rate accrued in the digital form. An audible warning, which releases an audible signal or chirp each time the emission is increased, is used in some wireless electronic dosimeters.[10] The advantage of a pocket dosimeter is to permit the staff to check his and her risk, a significant benefit to high-radiation workers at all times.[11]

Optically Stimulated Luminescence Dosimeters

OSL dosimeters are designed to provide a very high level of sensitivity to X-rays or gamma-ray photon energy from 5 kV to greater than 40 MeV, giving accurate readings as low as 1 millirem. OSL technologies are mainly using for x-ray, gamma-ray, β-ray, neutron and radiation detections are planned to be supplied by OSL dosimeters. The dynamic component of the OSL locator is a meager shot in a lace containing carbondoped aluminum oxide powder. This powder is then covered with a fastener between two portions of a polyester film, then combined consequently framing a lace. OSL dosimeters have properties that clarify why they are generally utilized: nondamaging perusing; an expansive estimating range from 0.01 mSv to 10 Sv; and preferred affectability to all energies over photographic film and TLDs.[12]

Materials and Methods

This study was a prospective, comparative, questionnaire-based study and designed and performed among paramedical students of College of Paramedical Sciences, Teerthanker Mahaveer University, Delhi–Moradabad Road, Uttar Pradesh. Knowledge about personnel monitoring devices and their use by postgraduate and undergraduate students, from the Department of Radiological Imaging Techniques, was compared. A total of 140 paramedical radiology students pursuing both bachelor's and master's degree programs were selected. The study was composed of a self-structured survey partitioned into two segments. The first section of the questionnaire consisted of demographic data including name, age, gender, program, department, and year. The second section of the questionnaire consisted of 20 basic questions regarding assessing adequate theoretical and practical knowledge of the participants for personnel radiation monitoring devices based on AERB 2017 guidelines. The randomized study control consisted of all students including both males and females of College of Paramedical Sciences who were physically and mentally sound and aged between 17 and 30 years, excluding the candidates who fell under the exclusion criteria.

Inclusion Criteria

Radiology students pursuing bachelor's (second year and third year) and master's degree programs (first year and second year).

Exclusion Criteria

Students of B.Sc. in Radiology and Imaging Technology (BRIT) first year, all except radiology students and diploma holders.

Procedure

For this study 140 participants who were willing to participate were taken from the College of Paramedical Sciences, Teerthanker Mahaveer University, Moradabad as per the inclusion and exclusion criteria. The questionnaire used in the study consists of 20 questions that comprise the knowledge of personnel monitoring devices and their use. The data collection was done by an online source (Google form) and the link of the form was shared in the classrooms under the inclusion criteria, by which all the responses were obtained in MS Office (2013) files and the data were subjected to mean value.

The project setting was done in the College of Paramedical Sciences, Teerthanker Mahaveer University, located in the area of Moradabad district of Uttar Pradesh, India. This University is well established with various paramedical courses with various programs required for this study including radiological imaging techniques.

Statistical Analysis

The data collected were compiled, tabulated, presented in graphs, and analyzed. Analysis was done using the mean value.

Result

This study questionnaire was filled by a total of 140 students who were students of bachelor's and master's programs, including 61% (86) males and 39% (54) females from the radiology department.

►**Fig. 1** shows a pie chart of the total number of students, males and females.

BRIT second year students comprised 41% (58), BRIT third year participants comprised 35% (49), M.Sc. in Radiology and Imaging Technology (MRIT) first year participants comprised 10% (14), and master's final year students comprised 14% (19) of the total participants.

►**Fig. 2** shows a pie chart of the total number of students.

►**Fig. 3** shows a graph of the overall average %.

The graph shows that from the students of the BRIT second year, 66% responded with the right answer and the rest 34% responded with the wrong answer. Among participants from BRIT third year, 65% responded with the right answer and the rest 35% with the wrong answer. Among participants from MRIT first year, 80% responded with the right answer and the rest 20% with the wrong answer, and among MRIT final year participants 81% responded with the right answer and the rest 19% with the wrong answer.

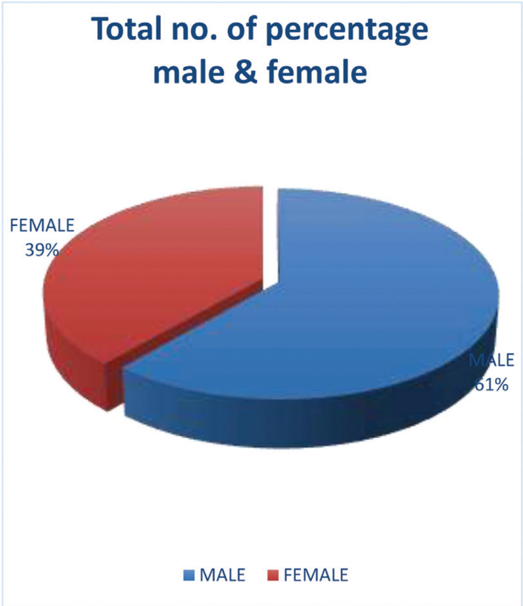

Fig. 1 A pie chart representing the total number of students, male and female.

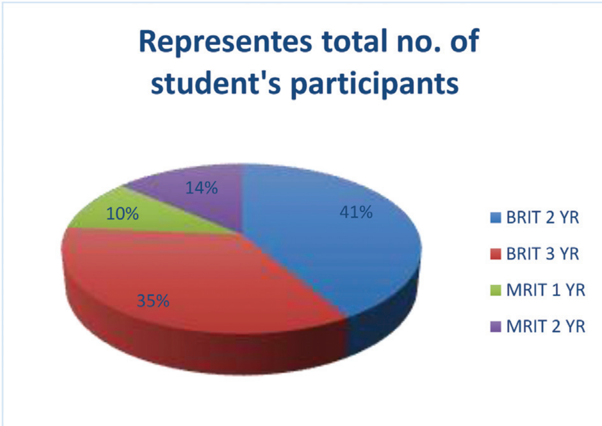

Fig. 2 A pie chart representing the total number of students.

Discussion

In this study to obtain the response of the first question about personnel monitoring device, 49 out of 58 (84%) responded with the right answer and the rest 9 (16%) with the wrong answer from BRIT second year; from BRIT third year 45 out of 49 (92%) responded with the right answer and the rest 4 (8%) with the wrong answer; from MRIT first year 13 out of 14 (93%) responded with the right answer and the rest 1 (7%) with the wrong answer; and from MRIT final year participants 19 out of 19 (100%) responded with the right answer.

For the second question about what type of material is used in the TLD badge, from BRIT second year participants, 40 out of 58 (69%) responded with the right answer and the rest 18 (31%) with the wrong answer; from BRIT third year participants, 28 out of 49 (57%) responded with the right answer and rest 21 (43%) with the wrong answer; from MRIT first year students, 11 out of 14 (79%) responded with the right answer and rest 13 (21%) with the wrong answer; and from MRIT final year participants, 15 out of 19 (79%) responded with the right answer and the rest 4 (21%) with the wrong answer.

For the third question about which type of monitoring device replaces the film badge, 53 out of 58 (91%) responded with the right answer and the rest 5 (7%) with the wrong answer from BRIT second year; from BRIT third year 43 out of 49 (88%) responded with the right answer and the rest 6 (12%) with the wrong answer; from MRIT first year 12 out of 14 (86%) responded with the right answer and the rest 2 (14%) with the wrong answer; and from MRIT final year participants 16 out of 19 (84%) responded with the right answer and the rest 3 (16%) with the wrong answer.

For the fourth question about whether TLD uses lithium fluoride, 41 out of 58 (71%) responded with the right answer and the rest 17 (29%) with the wrong answer from BRIT second year; from BRIT third year 44 out of 49 (90%) responded with the right answer and the rest 5 (10%) with the wrong answer; from MRIT first year 14 out of 14 (100%) responded with the right answer; and from MRIT final year participants 17 out of 19 (89%) responded with the right answer and the rest 2 (11%) with the wrong answer.

For the fifth question about which device gives instant reading when exposed to radiation, 38 out of 58 (66%) responded with the right answer and the rest 20 (34%) with the wrong answer from BRIT second year, from BRIT third year 35 out of 49 (71%) responded with the right answer and rest 14 (29%) with the wrong answer, from MRIT first

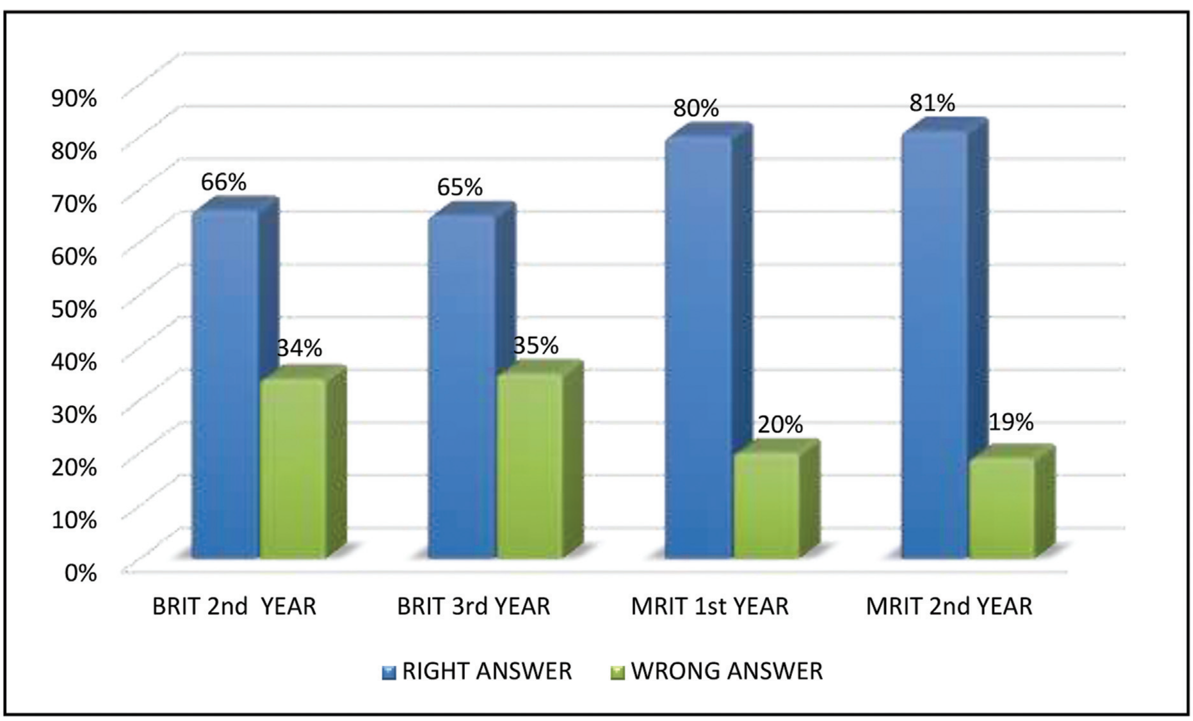

Fig. 3 A graph representing the overall average %.

year 13 out of 14 (93%) responded with the right answer and rest 1 (7%) with the wrong answer and from MRIT final year 15 out of 19 (79%) responded with the right answer and rest 4 (21%) with the wrong answer.

For the sixth question about which monitoring device was easily affected by heat, water, and humidity, 38 out of 58 (66%) responded with the right answer and the rest 20 (34%) with the wrong answer from BRIT second year; from BRIT third year 29 out of 49 (59%) responded with the right answer and the rest 20 (41%) with the wrong answer; from MRIT first year 10 out of 14 (71%) responded with the right answer and the rest 4 (29%) with the wrong answer; and from MRIT final year 13 out of 19 (68%) responded with the right answer and the rest 6 (32%) with the wrong answer.

For the seventh question about whether the statement was true that film badge records whole-body radiation over a long period the time, 38 out of 58 (66%) responded with the right answer and the rest 20 (34%) with the wrong answer from BRIT second year; from BRIT third year 5 out of 58 (10%) responded with the right answer and the rest 44 (90%) with the wrong answer; from MRIT first year 7 out of 14 (50%) responded with the right answer and the rest 7 (50%) with the wrong answer; and from MRIT final year 8 out of 19 (42%) responded with the right answer and the rest 11 (58%) with the wrong answer.

For the eighth question about the maximum period time TLD should be worn, 40 out of 58 (69%) responded with the right answer and the rest 18 (31%) with the wrong answer from BRIT second year, from BRIT third year 36 out of 49 (73%) responded with the right answer and the rest 13 (27%) with the wrong answer; from MRIT first year 11 out of 14 (79%) responded with the right answer and rest 3 (21%) with the wrong answer; and from MRIT final year 19 out 19 (100%) responded with the right answer.

For the ninth the question about the things film badge, OSL, a pocket dosimeter, and TLD have in common, 48 out of 58 (83%) responded with the right answer and the rest 10 (17%) with the wrong answer from BRIT second year; from BRIT third year 48 out of 49 (98%) responded with the right answer and the rest 1 (2%) with the wrong answer; from MRIT first year 14 out of 14 (100%) responded with the right answer; and from MRIT final year 19 out of 19 (100%) responded with the right answer.

For the 10th question about which device uses an aluminum oxide detector, 38 out of 58 (66%) responded with the right answer and the rest 20 (34%) with the wrong answer from BRIT second year; from BRIT third year 38 out of 49 (78%) responded with the right answer and the rest 11 (22%) with the wrong answer; from MRIT first year 12 out of 14 (86%) responded with the right answer and the rest 2 (14%) 38 with the wrong answer; and from MRIT final year 15 out of 19 (79%) responded with the right answer and the rest 4 (21%) with the wrong answer.

For the 11th question about which dose limit is specified for, 36 out of 58 (62%) responded with the right answer and the rest 22 (38%) with the wrong answer from BRIT second year; from BRIT third year 25 out of 49 (51%) responded with the right answer and the rest 24 (49%) with the wrong answer; from MRIT first year 12 out of 14 (86%) responded with the right answer and the rest 2 (14%) with the wrong answer; and from MRIT final year 18 out of 19 (95%) responded with the right answer and the rest 1 (5%) with the wrong answer.

For the 12th question about the annual effective dose limit of students which should not be exceeded, 36 out of 58 (62%) responded with the right answer and the rest 22 (38%) with the wrong answer from BRIT second year; from BRIT third year 25 out of 49 (51%) responded with the right answer and the rest 24 (49%) with the wrong answer; from MRIT first year 11 out of 14 (79%) responded with the right answer and the rest 3 (21%) with the wrong answer; and from MRIT final year 16 out of 19 (84%) responded with the right answer and the rest 3 (16%) with the wrong answer.

For the 13th question about which compound is used in OSL, 28 out of 58 (48%) responded with the right answer and the rest 30 (52%) with the wrong answer from BRIT second year; from BRIT third year 23 out of 49 (47%) responded with the right answer and the rest 26 (53%) with the wrong answer; from MRIT first year 10 out of 14 (71%) responded with the right answer and the rest 4 (29%) with the wrong answer; and from MRIT final year 13 out of 19 (68%) responded with the right answer and the rest 6 (32%) with the wrong answer.

For the 14th question about OSL stimulation, 32 out of 58 (55%) responded with the right answer and the rest 26 (45%) with the wrong answer from BRIT second year; from BRIT third year 28 out of 49 (57%) responded with the right answer and the rest 21 (43%) with the wrong answer; from MRIT first year 10 out of 14 (71%) responded with the right answer and the rest 4 (29%) with the wrong answer; and from MRIT final year 15 out of 19 (79%) responded with the right answer and the rest 4 (21%) with the wrong answer.

For the 15th question about in pocket dosimeter which unit is used to measure radiation, 16 out of 58 (28%) responded with the right answer and the rest 42 (72%) with the wrong answer from BRIT second year; from BRIT third year 16 out of 49 (33%) responded with the right answer and the rest 33 (67%) with the wrong answer; from MRIT first year 5 out of 14 (36%) responded with the right answer and the rest 9 (64%) with the wrong answer; and from MRIT final year 3 out of 19 (16%) responded with the right answer and the rest 16 (84%) with the wrong answer.

For the 16th question about the three filters used in TLD, 22 out of 58 (38%) responded with the right answer and the rest 36 (62%) with the wrong answer from BRIT second year; from BRIT third year 21 out of 49 (43%) responded with the right answer and the rest 28 (57%) with the wrong answer; from MRIT first year 10 out of 14 (71%) responded with the right answer and the rest 4 (29%) with the wrong answer; and from MRIT final year 18 out of 19 (95%) responded with the right answer and the rest 1 (5%) with the wrong answer.

For the 17th question about the type of radiation measured by TLD, 54 out of 58 (93%) responded with the right answer and the rest 4 (7%) with the wrong answer from BRIT second year; from BRIT third year 46 out of 49 (94%) responded with the right answer and the rest 3 (6%) with the wrong answer; from MRIT first year 14 out of 14 (100%) responded with the right answer; and from MRIT final year 19 out of 19 (100%) responded with the right answer.

For the 18th question about the level TLD should be worn at, 47 out of 58 (81%) responded with the right answer and the rest 11 (19%) with the wrong answer from BRIT second year; from BRIT third year 41 out of 49 (84%) responded with the right answer and the rest 8 (16%) with the wrong answer; from MRIT first year 13 out of 14 (93%) responded with the right answer and the rest 1 (7%) with the wrong answer; and from MRIT final year 19 out of 19 (100%) responded with the right answer.

For the 19th question about the location of TLD inside the lead apron, 40 out of 58 (69%) responded with the right answer and the rest 18 (31%) with the wrong answer from BRIT second year; from BRIT third year 36 out of 49 (73%) responded with the right answer and the rest 13 (27%) with the wrong answer; from MRIT first year 8 out of 14 (57%) responded with the right answer and the rest 6 (42%) with the wrong answer; and from MRIT final year 16 out of 19 (84%) responded with the right answer and the rest 3 (16%) with the wrong answer.

For the 20th question about whether technologists can use the same TLD, 33 out 58 (57%) responded with the right answer and the rest 25 (43%) from BRIT second year; from BRIT third year 26 out of 49 (53%) responded with the right answer and the rest 23 (47%) with the wrong answer; from MRIT first year 13 out of 14 (93%) responded with the right answer and the rest 1 (7%) with the wrong answer; and from MRIT final year 15 out of 19 (79%) responded with the right answer and the rest 4 (21%) with the wrong answer.

Conclusion

According to this study, it is concluded that there is good awareness about personnel radiation monitoring systems. The level of knowledge of personnel radiation monitoring devices among students remains at a medium level from the results of our students as it has been concluded that master's degree students' knowledge level is greater than that of bachelor's level. The level of knowledge of monitoring devices increases with the age of the students and the year completed. Personnel monitoring's purpose is to provide early notice if the exposure exceeds the thresholds and as low as reasonably achievable (ALARA). Furthermore, the tracking device maintains a permanent record of the radiation. For the knowledge about personnel radiation monitoring devices and their use for further improvement, regular seminars, workshops, continuing medical education should be organized. Enforcing personnel monitoring safety rules, as well as any level of safety education and instruction, is important for wellbeing.

Conflict of Interest
None.

References

1 Nde-ed.org. Nondestructive evaluation techniques. Radiography. 2021. Accessed February 15, 2022 at: https://www.nde-ed.-org/NDETechniques/Radiography/Introduction/history.xhtml
2 NSW Environment Protection Authority. Personal radiation monitoring. 2021. Accessed February 15, 2022 at: https://www.epa.nsw.gov.au/your-environment/radiation/management-licence/info-radiation-management/monitoring/pmd-monitoring
3 AERB. Radiation protection principle. Aerb.gov.in. 2021. Accessed February 15, 2022 at: https://www.aerb.gov.in/english/radiation-protection-principle
4 Nucmedtutorials.files.wordpress.com. 2021. Accessed February 15, 2022 at: https://nucmedtutorials.files.wordpress.com/2016/12/personnel-monitoring-devices.pdf
5 Iortile JT, Archibong BE, Chelen JT. Assessment of the levels of radiation absorbed by radiology personnel in some hospitals in Makurdi Metropolis. Int J Nat Sci Res 2013;1(04):26–29
6 Nde-ed.org. Nondestructive evaluation NDE engineering. Radiation safety. 2021. Accessed February 15, 2022 at: https://www.nde-ed.org/NDEEngineering/RadiationSafety/radiation_safety_-equipment/film_badges.xhtml
7 Radiation-dosimetry.org. 2021. Accessed February 15, 2022 at: https://www.radiation-dosimetry.org/what-is-film-badge-dosimeter-film-dosimeter-definition/
8 Goel A. 2021. Thermoluminescent dosimeter | Radiology Reference Article | Radiopaedia.org. *Radiopaedia*.org. 2021. Accessed February 15, 2022 at: https://radiopaedia.org/articles/thermoluminescent-dosimeter
9 Nde-ed.org. Nondestructive evaluation NDE engineering. Radiation safety. 2021. Accessed February 15, 2022 at: https://www.nde-ed.org/NDEEngineering/RadiationSafety/radiation_safety_equipment/thermoluminescent.xhtml
10 Nde-ed.org. Nondestructive evaluation NDE engineering. Radiation safety. 2021. Accessed February 15, 2022 at: https://www.nde-ed.org/NDEEngineering/RadiationSafety/radiation_safety_-equipment/pocket_dosimeter.xhtml
11 ORAU. General information about pocket chambers and pocket dosimeters. Orau.org. 2021. Accessed February 15, 2022 at: https://www.orau.org/PTP/collection/dosimeters/pocketchamdos.htm
12 Radioactivity: Dosimeters OSL. Radioactivity.eu.com. 2021. Accessed February 15, 2022 at: https://www.radioactivity.eu.com/site/pages/OSL_Dosimeters.htm

