Academic Journal of Physics Research

Juniper Publishers
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Research Article
Volume 1 Issue 1 - April 2025

Academic Journal of Physics Research

Retrospective Assessment of Gross Alpha, Beta, And Gamma Radioactivity in Radiologists Medical Radiation Workers at Usmanu Danfodiyo University Teaching Hospital, Sokoto, Nigeria.

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Submission: April 03, 2025; **Published:** April 16, 2025

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Abstract

Radiation exposure is detrimental to workers in the medical radiation sector as a result of the interaction effects of the radiation sources. Occupational radiation exposures workers' gross alpha, beta and gamma radio activities were investigated in the study. The outcomes acquired for gross alpha, beta and gamma radio activities ranged from 1.78×10^{-5} - 4.05×10^{-5}, 3.55×10^{-6}-8.1×10^{-6} and 2.67×10^{-6} -6.08×10^{-6} Svm^2/h respectively. The obtained value indicated that the gross doses were the highest for the Radiologists Radiographers and the lowest for the Darkroom technicians. The analysis result was less than the given values of 0.1, 1.0 and 0.02 Bq/L for gross alpha, beta and gamma respectively. The obtained values were much lower than the screening limit, thus do not pose any harmful effect. Exposure to radiation harmful to medical radiation workers as the result of interaction with radiation sources.

Keywords: Radiation Activity; Beta; Alpha; Doses; Exposures

Abbreviations: RG: Radiographer; RD: Resident Doctors; DT: Darkroom technicians; Nur: Nurses; A: Activity; α: Alpha activity; β:Beta activity; γ: Gamma activity; Dα: Gross alpha activity; Dβ: Gross beta activity; Dγ: Gross gamma activity

Introduction

Ionizing radiations', such as x-rays and the gamma radiations of radioactive materials, are electromagnetic. They can penetrate matter and cause harm when absorbed in it. They are useful in many aspects, but there is a negative; they can be harmful if not treated with care [1]. They have the ability to kill living cells, or to induce unwanted cell changes without killing them. Hence, they pose a potential hazard to anyone who comes into contact with them. In your career, you work with this type of radiation. Therefore you should also know what risks are, and how they interact with the rest of the everyday hazards. You should also be able to recognize how they may be reduced to a safe quantity. These topics will be treated in this book. All X-ray equipment operators and radioactive material users must be certified to an industry-standard level recognized in the industry, and possess qualifications as required by any Nigeria laws or regulations in force.

All operators must:

i. be familiar with the content of the Nigeria Radiation Act, regulations, and conditions of the license.

ii. be aware of radiation hazards of their work and that they are bound to protect themselves and others.

iii. Have clear understanding of their job, of safe working procedures and of special techniques.

iv. By proper application of proper techniques and methods, try to eliminate or reduce to lowest practical levels all exposures.

v. Be at least 18 years old.

A pregnant female employee should be advised to notify her employer in case she thinks she is pregnant so that appropriate steps can be taken to see to it that her work tasks during the remainder of the pregnancy are compatible with the maximum permitted exposure to radiation, as specified in this standard [2]. The behavior of X-rays; X-rays emit in a radial fashion out of the x-ray tube focal spot (in the same manner that light emerges from a light bulb), and they can be shaded out so as to cast a shadow. Just as light is scattered all directions from anything it strikes, so are the x-rays. X-rays do not stop at the first surface they encounter as light does. They penetrate materials to some degree depending on how they are manufactured and depending on the type of material. Bone is visible in a radiographic image because it has greater x-ray absorption compared to soft tissue. Lead and steel absorb x-rays even more and are used as x-ray barriers for shielding. X-rays are emitted in every direction when the x-ray tube is switched on. Built-in lead in the tube housing stops x-rays from escaping in any direction. The maximum size of the effective x-ray beam is restricted by the size of this opening. Beam size (as defined by the diaphragms) determines what part of the object can be seen at any given instant, and how much scattered x-radiation is produced [3]. This background radiation, which originates in something penetrated by the x-ray beam, goes in all directions, and if not stopped, will have to be a personnel hazard. It is much weaker than the primary x-ray beam, yet does occur in the air about an object as the x-ray beam strikes it. The intensity (and therefore the hazard) of both primary and scattered x-rays decreases very precipitously with distance from the source, precisely as does light intensity with distance. In fact, if distance is doubled, in either case, intensity drops by a factor of four. And if the distance is boosted by a factor of three, intensity drops to one-ninth, and so on. X-rays only exist when an x-ray device is operating. They do not exist when the unit is not operating.

The operator and the material being scanned do not become radioactive during or after a x-ray exam just as you are not glowing in the dark when a light goes out. Gamma rays, on the other hand, are emitted by radioactive materials continuously and cannot be turned off by the operation of a switch. Their intensity and penetrating power depend on the radioisotope from which they are emanating [4]. Otherwise, they are similar to x-rays.

Aside from the radiation induced by exposure to x-ray and radioisotope application, all members of the human species are exposed to some amount of “background radiation” and have been since the dawn of time. Background radiation in the environment is caused by cosmic rays from space, from within the radioactive air we breathe in our natural surroundings, and from our body radioactivity. So any dose we receive from occupational sources is an addition to this “background,” which varies in some degree from place to place on the planet. The biological effect of radiation; X - and gamma rays have proven to be of crucial value in diagnostic and therapeutic medicine, and in a variety of applications in industry and research. Exposure to them by individuals is unavoidable, then. The problem is to achieve an acceptable exposure to radiation (over the unavoidable background) compared to other risks of daily life. The International Commission on Radiation Protection (ICRP) is a body of professionals, who have for many decades compiled and made sense of human radiation effects data. Periodically, it has published so-called recommended limits of radiation exposure” that it finds acceptable [5]. Recommended limits of radiation exposure (along with unavoidable background) have lowered from time to time in the past fifty years. This is not a result of harmful effects being observable at the earlier levels. Rather, it is a result of it having become possible to lower the levels without drastically limiting the use of radiation for medical purposes and other uses. This “As Low As is Reasonably Achievable,” or ALARA principle, applies to all radiation risk levels and includes patients that are being examined as well as occupationally exposed workers [6]. The human impact of radiation; More is known regarding the impact of radiation - more than is known regarding the impact of chemicals such as insecticides, fungicides, etc. The two impacts, which can be induced by the low doses of radiation received by people involved in the use of x-rays, are genetic changes and initiation of cancer.

The badges; which can be employed in assessing personal exposure, contain two small crystalline chips, which respond to extremely low levels of radiation. They are required to be worn for a reasonable period (typically three months) before they are returned for measurement of the accumulated exposure. The findings indicated are what the badge recorded during the three-month period. Since we are interested in the radiation dose the individual wearing the badge receives, the badge always has to be shielded from radiation when it is not being worn. It also has to be worn on the body when x-rays are being taken. If the badge is not worn, there is no possible way of knowing how much radiation the individual receives. The individual who issued the badge should wear it when x-rays are likely to be present. Ionizing radiation used in medical procedures, including x-ray procedures, fluoroscopy, mammography, and computed tomography, represents the second largest fraction of the total dose of ionizing radiation worldwide. There has been a warranted concern regarding the extensive application of ionizing radiation in medical diagnosis [7]. In addition, the potential biological risks developed due to exposure to ionizing radiation and leading to diseases such as radiation sickness, cell injury, tissue and organ damage, cancer, and cataract development have been described at various levels of exposure to radiation.

Methodology

Data for this study were gathered from personnel in the Radiology Department of Usman Danfodiyo University Teaching Hospital Sokoto, Nigeria. Anonymous data with quarterly measurements of dosage were gathered from the departments between 2014 and 2018. Data documented on the doses of medical exposure to radiation were gathered. The records received did not disclose the identity of the workers to comply with the HREB regulations. Each participant was identified by a unique TLD

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code, and coded and anonymous records contained data on the quarterly whole body and extremity doses for medical radiation workers in the department, which were utilized to calculate the cumulative annual dose. The following formula [3] was employed for the same purpose

$$D = \frac{H_T}{w_R} \quad (1)$$

Where D = Absorbed dose

H_T = Equivalent dose

w_R = Radiation weighing factor

The time between irradiation and readout should be the same to keep fading from one calibration to another for all TLDs [1]. The calibration factor is defined as:

TLDs. The calibration factor is defined as follows:

$$f_{calibration} = \frac{D_{ionizationchamber(mGy)}}{TLD_{reading(n)}} \quad (2)$$

Absorbed dose due to irradiation is obtained after background subtraction using equation 3

$$D_{TLD} = D_{av} - BG \quad (3)$$

The absorbed dose is obtained for each TLD using equation 3.4

$$D(mGy) = f_{cal}\left(\frac{mGy}{nC}\right) XTLD_{reading}(nC) \quad (4)$$

For every individual measurement, the minimum detectable quantity (also referred to as MDL or minimum detection level) is 0.05 mSv in 3 months after background correction. This MDL is a threshold for dose reporting. Thus, workers who were given doses less than this MDL are considered not to have been exposed. Reader for Thermoluminescent Dosimeters (TLD) provides shallow dose equivalent (also referred to as Skin dose) and deep dose equivalent (also referred to as DDE) values both of which are input manually into a Microsoft Excel spread sheet. These values are then employed to determine the respective personnel dose equivalents, Hp(0.07) and Hp(10). The equations applied in the calculation of Skin and deep doses are presented in Equations 3.5 and 3.6, as described in the study of [8].

Skin dose: Hp(0.07) = [(1.2958Rskin) + 0.0097] Msv (5)

Deep dose: Hp(10)= [(1.3772Rdeep) + 0.056s6]mSv (6)

$$\frac{A\alpha,\beta,\gamma}{D2} = D_{\alpha,\beta,\gamma} \quad (7)$$

Dose reporting was performed on quarterly basis and only those workers with doses exceeding a minimum detection level (MDL) of 0.05 mSv (exposed workers) after background subtraction will be considered. The workers with doses less than MDL are considered as non-exposed.

Data Analysis

In this study, one quantity recommended by was used to analyze individual doses for the stipulated period. The recommended quantity is, average annual effective dose.

Results And Discussion

This study aimed at the extent of occupational exposure to radiation among workers in Usman Danfodiyo University Sokoto Teaching Hospital where ionizing radiation sources were being utilized from. This report gave the summary of mean effective dose on a yearly basis for the radiotherapy workers, and it is found through the study. The Results Obtained from the above (Table 1) revealed that Radiographers were subjected to the highest doses whereas Resident Doctors were subjected to the lowest doses of 0.71 – 1.62 mSv with gross alpha, beta and gamma activity of 1.78 x10^{-5} -4.05 x10^{-5}, 3.55 x10^{-5} -8.1 x10^{-5}, 2.67 x10^{-6} – 6.08 x10^{-6} Svm^2 respectively. These results suggested that Radiographers were most exposed to the radiation sources whereas Resident Doctors were least.

Table 1: Medical Radiation doses received by Radiology workers

ID	Doses(mSv)	$D_{\alpha(svm^2/h)}$	$D_{\beta(svm^2/h)}$	$D_{\gamma(svm^2/h)}$	$D_{T(svm^2/h)}$
RG	1.62	4.05x10^{-5}	8.1 x10^{-6}	6.08 x10^{-6}	5.47 x10^{-5}
RD	0.71	1.78 x10^{-5}	3.55 x10^{-6}	2.67 x10^{-6}	2.40 x10^{-5}
DT	1.05	2.63x10^{-5}	5.25x10^{-6}	3.94x10^{-6}	3.55x10^{-5}
NUR	1.05	2.63 x10^{-5}	5.25 x10^{-6}	3.94 x10^{-6}	3.55 x1s

Conclusion

The result obtained for gross doses were less than the recommended screening values of 0.1, 1.0, and 0.02Bq/L

Recommendation

Construction of a model that will detect gross alpha, beta and gamma radioactivity from occupational radiation workers simultaneously.

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