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# MEASUREMENT OF RADIATION DOSE IN ONCOLOGY AND RADIOTHERAPY UNIT AT AHMADU BELLO UNIVERSITY TEACHING HOSPITAL, SHIKA, ZARIA

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## Abstract

Within the Ahmadu Bello University Teaching Hospital (ABUTH), is the Oncology and Radiotherapy unit accomplished with Cobalt-60 machine, Brachytherapy and Orthovoltage radiation facilities and Chemotherapy ward. Radiation dose survey was carried out in all the rooms in the unit and also background radiation measurement was carried out within the hospital premises. Atomtexdose rate meterand Thermo luminescencedetector (TLD) chips were used in the work with the results at error of 5%. Theradiation dose rate measured with the TLD chips was 13.17% higher than that of the Atomtex meter. This indicated a small difference which is due to the difference of the inbuilt radiation materials in each detector. A high absorbed dose rate0f 0.50µSv/h (meter) and 0.54µSv/h (TLD) were measured in the cobalt-60 machine room. The value is insignificant compared to recommended dose 1.0mSv/h at 1m distance from the source. The mean radiation level in all the rooms at the unit was 0.21±0.02µSv/h with meter and 0.23µSv/h with TLD while the background Radiation level within the hospital environment was 0.14±0.01µSv/h. The radiation dose rate at the unit was higher than the background radiation level within the hospital premises by 10%. This indicated an indoor/outdoor radiation level and of course the presence of radiation facilities in the unit. The radiation level measured around the radiation facilities and hospital premises were small and within radiation level standard of 5.0mSv/year for radiation workers and 1.0mSv/year for public as reported by UNSCEAR, 2000

**Keywords:** Background radiation, dose ratedose, Dose rate meter, TLD, Leakage radiation, Gamma ray, radiation Sources, ICRP.

## Introduction

The occurrence of radiation is either from naturally existing sources or artificial ones (MLA, 2009). The naturally occurring radiations are obtained from natural radioactive sources such as Potassium-40, Radon, Uranium in earth crust and cosmic rays whereas the artificial radiation sources comprise of various man-made radiation sources, or natural sources which are enhanced by technology. The largest man-made contributors to background radiation in the environment are the medical use of radiation in diagnostic and therapeutic radiology (MLA, 2009). The world-wide estimated average annual man-made background radiation is about 0.4mSv/y(MLA, 2009), (Cember, 1983). In developed industrialized nations, the average estimated value is much closer to 1.0mSv/y. Other man-made radiations include the use of radioisotopes in researches or in bodies, radioactive waste disposal, occupational exposure and fallout from nuclear weapons used in wars or in testing (Alan and Samuel, 1986). Nuclear power is estimated to contribute an average effective dose of 0.0002mSv/h to the population and 5.0mSv/y to the radiation workers (MLA, 2009)

The Average annual dose rate due to man-made radiation in the United Kingdom (UK) for diagnostic radiology, therapeutic radiology and use of Isotopes in Medicine are 220, 30 and 2µSv/y respectively, (Alan and Samuel 1986). All radiation dose in whatever form when exposed to it over short or long time is capable of producing biological effect to man (IAEA, 1982). However, when radiation is used at controlled level in life sciences, a large benefit is provided.

Lithium fluoride (LiF) TL dosimeters are routinely used for a number of different types of *in vivo* radiotherapy measurements (personal monitoring around Co-60 machine) in centers throughout the world because of its atomic number ($Z_{ef}$) 8.2 and its nearly tissue equivalent of 7.4 (Cember,

$$Dose = Dose\ rate \times time \quad (1)$$

$$Dose\ rate = \Gamma \frac{A}{r^2} \quad (2)$$

where;

$A$ is the activity of the source and $r$ is the distance from the radiation source to the exposed TLD materials. The specific gamma activity $\Gamma$ is given by equation (3)

$$\Gamma = 0.302 \frac{mGy\ m^2}{GBq\ h} \quad (3)$$

The activity of the radiation source $A\ (in\ GBq)$ at the time of exposure relative to its

initial activity $A_o$ is obtained using equation (4)

$$A = A_o e^{-\lambda t} \quad (4)$$

Where the radioactivity decay constant λ is given by equation (5)

$$\lambda = \frac{0.693}{T_{½}} \quad (5)$$

Four points were marked in each room at the unit and the Atomtex was held 1m above the ground at each survey point and the dose rate were read and recorded. Some distances away from the centre within the ABUTH were marked as sample points and the same procedure was carried out to obtain the radiation level.

Pairs of annealed TLD chips were then placed at the same marked points for the second radiation dose measurements. The fixed TLD were exposed for three days when all the operating machines were switched off. They were then read off from the Solaro TLD reader. The numbers of count obtained were used to determine the corresponding dose rates from the TLD calibration curve considering the period of their exposure.

The radiation dose within the premises of hospital is purely background radiation and as such it is so small to be measured with TLD over a small period of time therefore the radiation dose was measured with the dose rate metering only

## Results and discussion

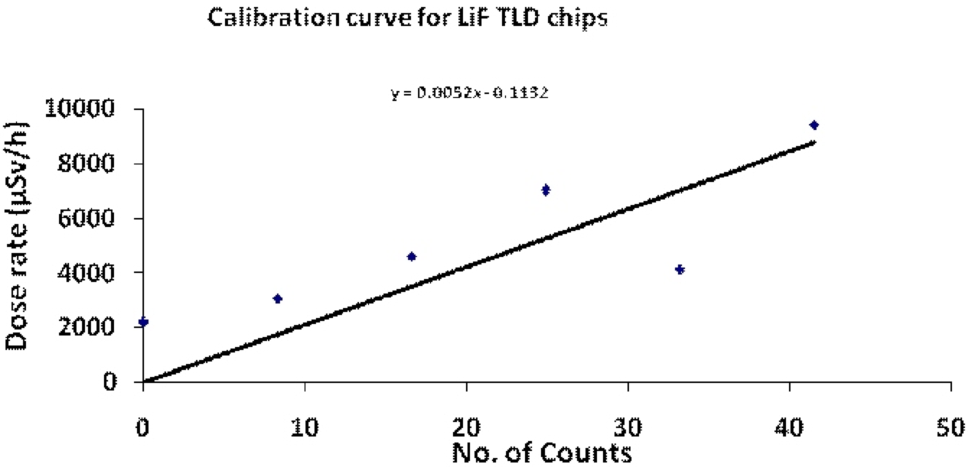


**Figure Calibration curve of LiF TLD chip with Cs-137 gamma radiation source**

**Table Radiation dose rate at the rooms with meter and TLD** (error 5%)

| Place (Room) | Code | Dose rate (Atomtex) ( Sv/h) | Dose rate (TLD) ( Sv/h) | Mean dose rate ( Sv/h) |
|---|---|---|---|---|
| **Mould** | MO | 0.215 | 0.210 | 0.213±0.003 |
| **Simulator** | SL | 0.215 | 0.250 | 0.233±0.020 |
| **Cubicle** | CU | 0.212 | 0.210 | 0.211±0.002 |
| **Marking** | MA | 0.203 | 0.220 | 0.212±0.020 |
| **Theater** | TH | 0.200 | 0.256 | 0.228±0.010 |
| **Bracheterapy** | BR | 0.218 | 0.250 | 0.234±0.020 |
| **Radiographers** | RR | 0.227 | 0.200 | 0.214±0.020 |
| **Chemotherapy** | CT | 0.165 | 0.221 | 0.193±0.040 |
| **Control** | CR | 0.189 | 0.200 | 0.195±0.010 |
| **Orthovoltage** | OR | 0.208 | 0.300 | 0.254±0.040 |
| **Cobalt-60** | CO | 0.500 | 0.540 | 0.520±0.001 |
| **Mean** | | **0.205** | **0.232** | **0.238±0.020** |

**Table Radiation Dose Level within ABUTH compound**

| S/No. | Description of Points from the Center | Dose Rate (µSv/h) |
|---|---|---|
| **1.** | 50m South | 0.160±0.008 |
| **2.** | 80m West | 0.120±0.006 |
| **3.** | 80m North | 0.140±0.007 |
| **4.** | 60m South | 0.140±0.007 |
| **Mean** | | 0.140±0.007 |

## Discussion

The calibration curve for the TLD presented in figure 1, indicated a linear relationship with radiation dose and number of count. The equation of the graph obtained made it easier to calculate corresponding dose rate.

The result presented in table 1 is the consolidated radiation dose rates measured in each room with their codes using both Atomtexmeter and TLD.The average calculated dose rates obtained ranged from 0.165µSv/h to 0.500µSv/h (Atomtex) and 0.200µSv/h to 0.540µSv/h (TLD).

The dose rate measured with TLD was higher than that measured with Atomtex meter by 13.17% which is not highly significant and this is due to different inbuilt radiation materials in the two detectors. The relative high dose rate at RR (Atomtex) is likely due to radiation from Cobalt-60 source. The higher dose rate recorded (TLD) at OR is likely due to the sharing of common wall with RR. The aggregate mean (combined readings of meter and TLD) radiation background level of all the rooms concerned in the unit was found to be 0.24 ± 0.02µSv/h and this is the average radiation dose rate received by the radiation workers. The results presented in Table 2 is purely outdoor radiation dose level with slight decrease as distance increases from the center. The mean dose rate of table 2 is 0.14 ± 0.01µSv/h and a determined dose rate of 0.10±0.01µSv/h was the radiation dose rate increased (10%) above the normal background radiation level in the environment. This is due to the medical applications of radiation facilities in the unit. Equivalent dose recommended by ICRP for occupational exposure has limit of 20m Sv/y. The principal limit for long term exposure is 1.0 mSv/y for individual members of public (UNSCEAR, 2000) and (MLA, 2009). Therefore the measured radiation level (of 0.21Sv/h and 0.23Sv/h) within the unit and 0.14Sv/h in the environment are small and insignificant for human health hazards.

Most of the radiation level inside the rooms is due to radon and the remaining is due to the medical radiation sources. A larger percentage of radiation in the environmental surveyed area is due to activities of naturally occurring radionuclides, mainly $^{226}U$, $^{232}Th$, and $^{40}K$ which have high concentrations in granites and the remaining being cosmic radiation. It can be deduced therefore that there is a large deposit of granite in the study area(Oladipupo and Yabagi, 2015) A comparison with some similar work is shown in table 3

**Table 3 Comparison of dose rate from this work and other regions**

| Region | Dose rate (µSv/hr) |
|---|---|
| **World average** | 0.056 |
| **Turkey** | 0.253 |
| **Spain** | 0.057 |
| **Bangalore (India)** | 0.117 |
| **Offa** | 0.132 |
| **Ilorin** | 0.134 |
| **Minna** | 0.154 |
| **Lapai** | 0.158 |
| **This Work** | 0.140 |

Oladipupo and Yabagi, (2015)

## Conclusion

Dose rate meter or TLD can be used for radiation monitoring and evaluation successfully. The cobalt-60 and orthovoltage machines were radiation leakage free and proper shielding of chemotherapy and brachetherapy radiation sources were ensured (measurement of high radiation dose rate around the radiation machines could lead to radiation leakage). The walls of the rooms in the unit were not highly radioactive and radiation workers were working within ICRP recommendation. The measured radiation dose rate within the unit(0.22Sv/h) was slightly higher than the background radiation level (0.14Sv/h) within the hospital and mostly contributed by cosmic rays. Radiation dose by the facilities (average 0.205Sv/h, and 0.232Sv/h) is lower than the estimated manmade global standard of 0.4mSv/year for medical exposures. It can be concluded that there is insignificant radiation health detriment by the workers and members of the public in and around the (ABUTH) the study area, for the present research.

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