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Assessment of Combined Radiation Exposure for Dental Workers at Usman Danfodiyo University Teaching Hospital in Sokoto, Sokoto State, Nigeria

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Abstract

Continuous surveillance for radiation protection is obligatory when utilizing ionizing radiation-emitting devices at Usman Danfodiyo University Teaching Hospital. In compliance with national regulations, all individuals involved in activities with ionizing radiation are required to undergo regular monitoring through an individual dosimetric program. The evaluation of each worker's radiation exposure is carried out on a quarterly basis. The HARSHAW 4500 Reader, along with Thermo luminescent Dosimeters (TLDs), is utilized for individual monitoring at Usman Danfodiyo University Teaching Hospital.

This investigation centers on the cumulative radiation dose received by dental healthcare practitioners in 2017. The findings distinctly reveal that within the dental professionals, those identified as DN24b recorded the highest cumulative dose at 15.60 man Sieverts (manSv), whereas DN13 registered the lowest annual effective dose at 5.33 manSv.

Keywords: *Cumulative dose, Annual effective dose, Radiation.*

INTRODUCTION

Ionizing radiations, such as x-rays and gamma rays emitted by radioactive materials, have an electromagnetic origin and possess the capability to penetrate substances, causing harm upon absorption. While they offer various beneficial applications, their inappropriate usage can result in damage [ICRP, 2007]. These radiations can either eliminate living cells or induce undesirable changes without causing cell death, posing a risk to exposed individuals. In your field, where you work with such radiation, understanding the associated risks and comparing them to everyday hazards is essential. This handbook addresses these concerns.

All operators of X-ray equipment and users of radioactive materials must have certifications meeting recognized standards and qualifications as outlined by relevant Nigerian regulations. Operators must: I. Be acquainted with the content of the Nigeria Radiation Act, regulations, and license conditions. II. Recognize the radiation hazards related to their work and acknowledge their responsibility to protect themselves and others. III. Possess a thorough understanding of their profession, safe working methods, and specialized techniques. IV. Endeavor, through conscientious use of proper techniques, to minimize all exposures to the lowest practical levels. V. Be 18 years of age or older.

Female operators are encouraged to inform their employers if they suspect pregnancy, allowing appropriate measures to align work duties with accepted maximum radiation exposure during pregnancy [ICRU, 1998].

The behavior of X-rays involves emanating outward from the focal spot of the X-ray tube, akin to light from a bulb. These rays can be obstructed to create shadows. In contrast to light, X-rays can penetrate materials to varying degrees based on their generation and material nature. Radiographic images emphasize bones due to their higher X-ray absorption compared to soft tissue. Lead and steel act as effective barriers to X-rays. Lead integrated into the tube housing prevents X-rays from escaping in all directions. The size of the useful X-ray beam is determined by the shield's opening, impacting what can be observed at a time and the production of scattered X-radiation. Both primary and scattered X-rays diminish rapidly with distance from the source.

X-rays are present only when the X-ray machine is operational and do not render the operator or examined material radioactive. In contrast, gamma rays emitted by radioactive materials are continuous and cannot be switched off. Their intensity and penetration depend on the emitting radioisotope, sharing similarities with X-rays.

Beyond occupational exposure to X-rays and radioisotopes, humans are exposed to a background level of environmental radiation from cosmic rays, the air we breathe, and our bodies' radioactivity. Any exposure from work adds to this background.

Concerning the biological effects of radiation, X- and gamma rays play pivotal roles in diagnostic and therapeutic medicine, industry, and research. Establishing an acceptable level of radiation exposure (beyond the unavoidable background) compared to other everyday hazards is crucial. The International Commission on Radiation Protection (ICRP) periodically publishes recommended limits, reflecting the "As Low As is Reasonably Achievable" (ALARA) principle, aimed at minimizing radiation risk while allowing essential applications.

Effects of radiation on humans include genetic changes and cancer induction [Oyeyinka et al., 2012]. Badges, utilized to monitor personal exposure, contain sensitive crystalline chips and should be worn for a designated period before measurement. Safeguarding the badge from radiation when not worn and wearing it close to the body during X-ray use are essential practices. The individual issued the badge is responsible for wearing it when X-rays are likely present.

METHODOLOGY

Information for this research was obtained from individuals employed in the Radiotherapy Departments of Usman Danfodiyo University Teaching Hospital in Sokoto, Nigeria. We obtained anonymous records containing quarterly dosage measurements from these departments for the period spanning 2014 to 2018. We secured documented information on the levels of medical radiation exposure. To adhere to Health Research Ethics Board (HREB) regulations, the collected documents were intentionally devoid of any information revealing the identities of the personnel. Instead, each participant was assigned a unique TLD code to ensure their anonymity. These depersonalized and coded records included details about quarterly whole-body and extremity doses for medical radiation workers in the department, and the cumulative annual dose was subsequently calculated using the formula from Rahman et al. (2016).

$$D = \frac{H_T}{W_R} \qquad 1.0$$

Where D = Absorbed dose

H_T = Equivalent dose

W_R = Radiation weighing factor

RESULTS AND DISCUSSION

Statistical information regarding dental personnel in the year 2017 at UsmanuDanfodiyo University Teaching Hospital in Sokoto.

Table 1: Descriptive Statistics

DENTISTS	AED	CAED
DN13	0.41	5.33
DN19b	0.45	5.85
DN06	0.48	6.24
DN04	0.51	6.63
DN24	0.67	8.71
DN19	0.78	10.14
DN05	0.88	11.44
DN11	0.91	11.83
DN01	0.93	12.09
DN11b	0.95	12.35

DN96	1.13	14.69
DN24b	1.2	15.6

The presented table indicates that throughout the entirety of 2017, the Dentist identified with the TLD code DN 24b recorded the highest annual effective and collective doses at 1.2 mSv and 15.6 man mSv, respectively. These findings suggest that DN 24b experienced higher radiation exposure compared to other Dentists. Conversely, DN13 registered the lowest annual and effective dose. The annual effective doses for Dentists ranged from 0.41 to 1.20 mSv, falling below the recommended limit of 5 mSv according to UNSCEAR (2008). Additionally, the collective doses varied from 5.33 to 15.60 man mSv, remaining below the 240 man mSv threshold recommended by UNSCEAR (2008).

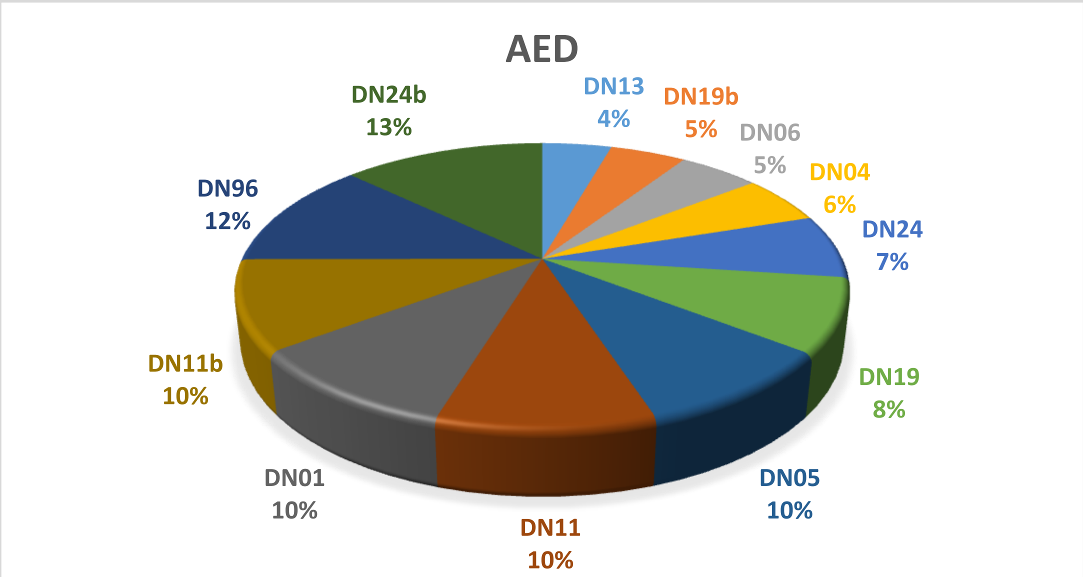

Figure 1: Pie chart for Dentists Annual effective dose in mSv for 2017

The data depicted in the figure reveal that in 2017, the Dentist identified by the TLD code DN24b had the highest exposure percentage at 13%. In contrast, DN11b, DN 01, DN 11, and DN 05 recorded exposure percentages of 10%, while DN13 had the lowest percentage at 4%. These findings indicate that DN13 experienced comparatively lower radiation exposure.

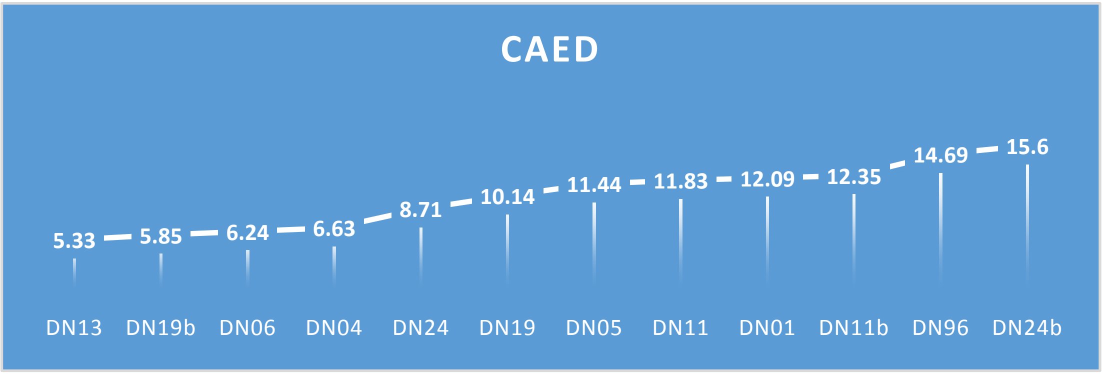

Figure 2: Dentists Collective Annual Effective Dose in man mSv

The findings indicate that the collective dose received by dental workers in 2017 followed an ascending order, as illustrated in the above figure. DN13 received the smallest collective dose at 5.33 man mSv, whereas DN24b received the highest collective dose at 15.60 man mSv.

Conclusion

The results obtained for the entire year did not surpass the recommended threshold limits of 5 mSv for individual doses and 240 man mSv by UNSCEAR (2008). The collective dose results fell within the range of 5.33 to 15.6 man mSv.

Recommendations

Assessing the level of radiation exposure across various medical departments at Usman Danfodiyo University Teaching Hospital is crucial given the widespread use of ionizing radiation. Based on the findings, the following recommendations are suggested:

1. It is recommended to regularly calibrate the Harshaw 4500 manual TLD reader, utilized in this study, using 137Cs beam exposure before its application.
2. A comparable investigation should be conducted using Harshaw automatic TLD reader models 8800/6600 due to their improved precision and accuracy.
3. Evaluation of radiation exposure among professionals other than dentists, such as radiotherapists, radiologists, and porters, should also be undertaken.
4. Measures to reduce workloads on radiation workers, which contribute to human errors, should be implemented through realistic scheduling.
5. Development of a model capable of detecting cancer in radiosensitive organs is recommended.
6. TLDs should be read after one month to prevent chip fading, considering Sokoto's temperature.
7. Increasing staffing levels to alleviate the workload within the departments is advisable.

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