



Perspective

Evaluation of cumulative radiation exposure among dental workers at Usmanu Danfodiyo University Teaching Hospital, Sokoto, Nigeria

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ABSTRACT

Continuous surveillance for radiation protection is imperative when employing ionizing radiation-emitting devices, such as those used at Usmanu Danfodiyo University Teaching Hospital (UDUTH) in Sokoto, Nigeria. In adherence to national regulations, it is mandatory for all personnel involved in activities with ionizing radiation to participate in a regular individual dosimetric monitoring program. This study evaluates the occupational radiation exposure of dental healthcare practitioners over the course of 2017, with assessments conducted on a quarterly basis. For this purpose, the HARSHAW 4500 Reader, in conjunction with Thermoluminescent Dosimeters (TLDs), was employed for individual radiation monitoring. This method ensures precise and reliable measurements of both skin and deep tissue doses, providing comprehensive data on the cumulative annual effective dose for each worker. The findings from this investigation reveal significant variations in the cumulative radiation doses among the dental staff. The practitioner identified as DN24b recorded the highest cumulative dose at 15.60 man Sieverts (manSv), highlighting a notable exposure level within the group. Conversely, the practitioner labeled DN13 registered the lowest annual effective dose at 5.33 manSv, indicating effective adherence to radiation safety protocols. These results underscore the importance of rigorous and continuous radiation monitoring to ensure occupational safety. While the observed doses are within acceptable limits, the variation in exposure levels suggests the need for ongoing education and adherence to radiation protection principles. The study advocates for enhanced protective measures and continuous training to minimize radiation exposure and ensure the well-being of all dental healthcare workers at UDUTH.

1. Introduction

Utilizing ionizing radiation in dental practices is pivotal for diagnostic imaging and therapeutic interventions. However, this essential tool carries inherent risks of radiation exposure for healthcare workers, necessitating continuous monitoring and evaluation of their cumulative radiation exposure. This study focuses on assessing cumulative radiation exposure among dental workers at Usmanu Danfodiyo University Teaching Hospital (UDUTH) in Sokoto, Nigeria. Ionizing radiation, such as X-rays used in dental radiography, possesses the potential to ionize atoms and molecules within human tissue, thereby posing risks of cellular damage and increased cancer susceptibility [1]. Dental healthcare workers, due to their frequent exposure to low-dose radiation over prolonged periods, are particularly susceptible to these risks. Hence, regular monitoring of

occupational exposure is crucial to ensuring radiation levels remain within safe limits and mitigating potential health hazards. Regulatory bodies like the International Commission on Radiological Protection (ICRP) and the Nigeria Nuclear Regulatory Authority (NNRA) provide guidelines and standards for radiation protection. The ICRP recommends an occupational exposure limit of 20 millisieverts (mSv) per year, averaged over five years, with no single year exceeding 50 mSv [1]. Adherence to these guidelines is critical for minimizing risks associated with prolonged radiation exposure. Previous research underscores the significance of regular radiation monitoring in dental practices. Studies demonstrate that consistent use of dosimetry, such as Thermoluminescent Dosimeters (TLDs), effectively measures and manages radiation exposure among dental workers. Furthermore, implementing radiation protection principles,

including maintaining appropriate distance, using protective barriers, and minimizing exposure time, is essential for reducing occupational exposure [2]. This study aims to evaluate the cumulative radiation exposure of dental workers at UDUTH over a one-year period. Utilizing the HARSHAW 4500 Reader and TLDs for individual monitoring enables precise measurements of both skin and deep tissue doses. Analyzing quarterly dose records seeks to determine the annual effective dose for each dental worker and assess compliance with national and international radiation safety standards. Understanding cumulative radiation exposure among dental workers is crucial for several reasons. Firstly, it ensures the safety and health of workers by identifying potential overexposures and implementing corrective measures. Secondly, it contributes to the body of knowledge regarding occupational radiation exposure in dental settings, informing policy and improving safety protocols. Lastly, it underscores the importance of continuous education and training in radiation protection for healthcare workers.

2. 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 [3].

$$D = \frac{H_T}{W_R} \tag{1}$$

Where D = Absorbed dose, H_T = Equivalent dose, W_R = Radiation weighting factor.

3. Results and discussion

In this study, the statistical information is based on the dental personnel in the year 2017 at Usmanu Danfodiyo University Teaching Hospital in Sokoto. The presented Table 1 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 (Figure 1) indicate 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 reference [4].

The data depicted 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. The findings indicate that the collective dose received by dental workers in 2017 followed an ascending order, as

illustrated in Figure 2. DN13 received the smallest collective dose at 5.33 man mSv, whereas DN24b received the highest collective dose at 15.60 man mSv.

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

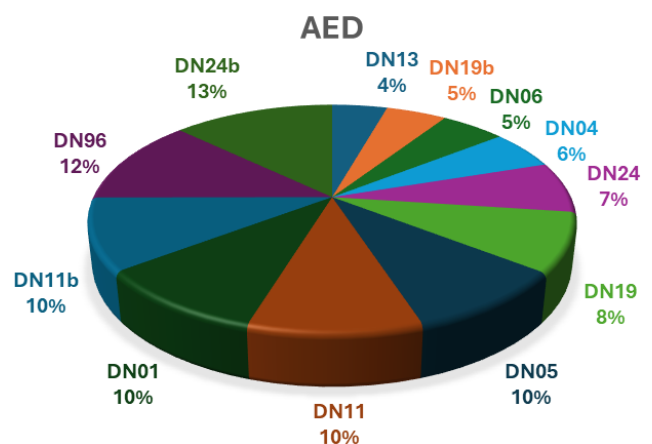


Figure 1. Pie chart for dentists' annual effective dose in mSv for 2017

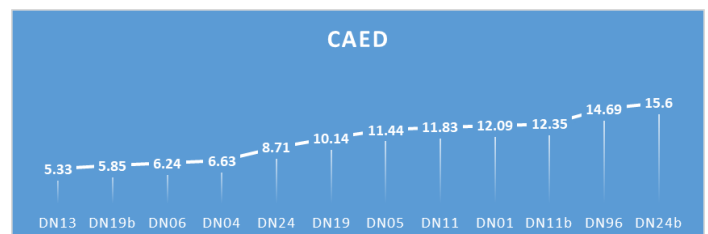


Figure 2. Dentists collective annual effective dose in man mSv

4. Conclusion and recommendations

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. 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:

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

Ethical issue

The author is aware of and complies with best practices in publication ethics, specifically with regard to authorship (avoidance of guest authorship), dual submission, manipulation of figures, competing interests, and compliance with policies on research ethics. The author adheres to publication requirements and states that the submitted work is original and has not been published elsewhere.

Data availability statement

The datasets analyzed during the current study are available and can be given upon reasonable request from the corresponding author.

Conflict of interest

The author declares no potential conflict of interest.

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