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Background Radiation Dose in Selected X-Ray Facilities in Southwest Nigeria

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Abstract. Radiation exposure monitoring is essential to ensure that dose limits are not exceeded. The goal of this study is to assess the level of radiation exposure from radiography facilities in the study environment in order to promote radiation safety. Digilert 200 was used to determine the level of exposure in and around radiography facilities in five X-ray diagnostic centres in southwest Nigeria. The mean background exposure in centres A, B, C, D and E were 0.137 *µSv/h*, 0.170 *µSv/h*, 0.164 *µSv/h*, 0.183 *µSv/h* and 0.148 *µSv/h* respectively. The cumulative mean exposure in a year for centres A, B, C, D and E were 0.961 mSv/y, 1.193 *mSv/y*, 1.146 *mSv/y*, 1.281 *mSv/y* and 1.034 *mSv/y* respectively. The background radiation dose from the exposure level in all the centres exceeded the recommended limit but for centre A. High quality standard lead shielding and periodic radiation protection monitoring should be employed in centres with high radiation exposure.

Keywords: Background radiation, radiography facilities, exposure level, radiation safety

1. Introduction

Radiation exposure from diagnostic radiology is fast increasing and it has become a growing concern [1-3]. Dramatic explosion in imaging technology and the extensive use of these modalities are responsible for the increased in background radiation exposure. All X-ray tubes are known to have some radiation leakage [4]. This warrants the measurement of the background radiation to ensure the exposure is within the acceptable limits. Based on this finding, it is recommended that X-ray diagnostic facilities should be subjected to standard safety operations considering the risks of ionizing radiation [5]. Contrarily, several X-ray diagnostic facilities are not radiologically safe. Poor radiation protection measures in diagnostic radiology have been reported in literature [4, 6-8]. Report of [4] showed that the fluoroscopy and CT rooms were not adequately lead lined and the radiation exposure exceeded the reference limit in Gaza. However, the radiography and mammography rooms exposure were within the permissible limit. Lack of radiological protection act and monitoring has been reported in Nepal [7]. Another study reported the absence of radiation protection tools and equipment in Saudi Arabia [8]. This further confirms the poor radiation protection measures in some X-ray unit.

Association between radiation exposure and diagnostic X-ray imaging has been reported [8]. The biologic effect of diagnostic X-ray exposure is largely stochastic effects [9, 10]. The major stochastic effects of concern for diagnostic X-rays are cancer induction and genetic effects [9] Though there have been several arguments on stochastic effect at low dose of exposure yet, recent studies has further confirmed that low radiation exposure can induce DNA damage regardless of the dose [11-13]. Literature has also reported induce DNA damage, chromosomal aberration, genotoxic effects and other radiation hazards in tissue for non-ionizing radiation [14-16]. Hence, there is need for safety. Therefore, this study goal is to assess the background radiation exposure in and around selected radiography facilities in southwest Nigeria in order promote safety and minimize health hazards associated with radiation exposures.

2. Materials and Methods

The study was conducted in five (5) secondary/tertiary healthcare institutions in southwest Nigeria with an average of 400 radiography examinations per day. The scatter radiation was determined using the pre-calibrated Digilert 200 survey meter. The survey meter was calibrated to standard at the Secondary Standard Dosimetry Laboratories (SSDL) of National Institution for Radiation Protection and Research, University of Ibadan. Determination was made at distance of 1 m from the back, front, left and right of the X-ray system. Also, measurements were made at the console, patient waiting rooms, reception, dark room and corridors. At each location measurements were made at a distance of 1 m above the ground with an average of 5 radiation counts recorded. The mean values were obtained in mR/hr and later converted to µSv/h.

3. Results and Discussion

The results of the mean background radiation in and around each radiography unit in the study centres are as presented in Table 1. The estimated cumulative mean exposure in centres A, B, C, D and E were 0.137 µSv/h, 0.170 µSv/h, 0.164 µSv/h, 0.183 µSv/h and 0.148 µSv/h for centres respectively (Figure 1). The cumulative mean exposure in a year is as shown in Figure 2. The estimated background radiation exposure was above the recommended limit of 1 mSv/y in all the centres but for centre A.

Radiation monitoring is essential to ensure that dose limit is not exceeded [17-18]. The results from this study showed that the cumulative background radiation exceeded the recommended limit of 1 mSv/y in all the centres but for centre A. The report in this study is in consonance with study conducted in Gaza and Saudi Arabia [4, 8]. The high exposure level recorded in the study centres can be attributed to poor lead shielding, structural fault and lack of radiation monitoring. Research has shown that any defects in the structural design of the imaging room can lead to higher exposure levels [7, 19].

Centre A has low radiation exposure compared to other centres because of high quality of lead shielding although it has structural defect. The exposure level in the console has the least value as compared to others locations. The value of 0.090 µSv/h and 0.110 µSv/h was recorded against the corridor and reception respectively in centre E. This might be due to the fact that the corridor and reception are farther away from the scanning room. This is envisaged as X-rays obeys the inverse square law. Centre D has the highest value (0.183 µSv/h). This might be due to the fact that the radiography facility is old and lack adequate maintenance. The lead shielding is very poor and might have expired. The result from this study further confirms the literature report of poor radiological protection in some medical X-ray diagnostic centres.

The challenge of radiation protection in diagnostic radiology can be attributed to unavailability of devices for the assessment of radiation exposure, ignorance of health implications of low dose exposure, poor enforcement of radiation protection policy, insufficient skilled radiological personnel, and engagement of unskilled personnel in radiological department among others. Improvement of radiation protection measures in the study centres is therefore important to enhance safety.

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Table 1: Background radiation (*μSv/h*) around radiography equipment in the study centres

Centre	X-Ray room	Console	Changing room 1	Changing room 2	Processor room	Reception	Corridor	Mean
A	0.157	0.110	0.157	0.157	0.150	0.115	0.115	0.137
B	0.163	0.158	0.130	0.120	0.140	0.240	0.240	0.170
C	0.217	0.177	0.158	0.153	0.160	0.140	0.140	0.164
D	0.210	0.197	0.210	0.210	0.180	0.130	0.143	0.183
E	0.190	0.125	0.190	0.000	0.180	0.110	0.090	0.148

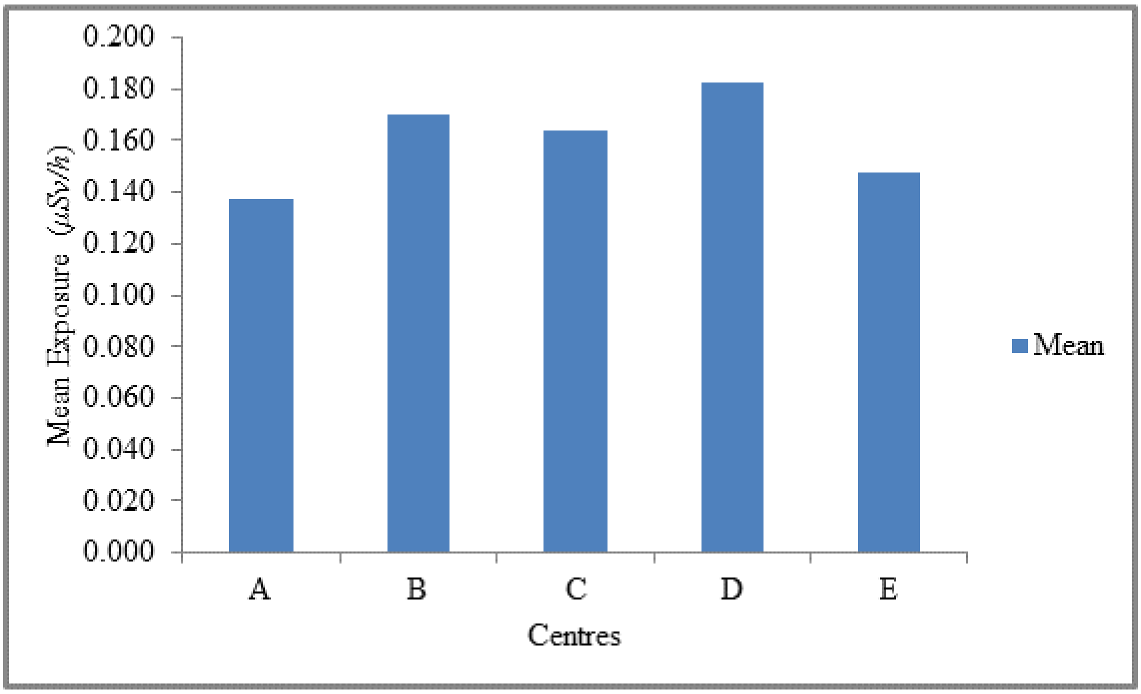

Figure 1: Mean background radiation in the study centres

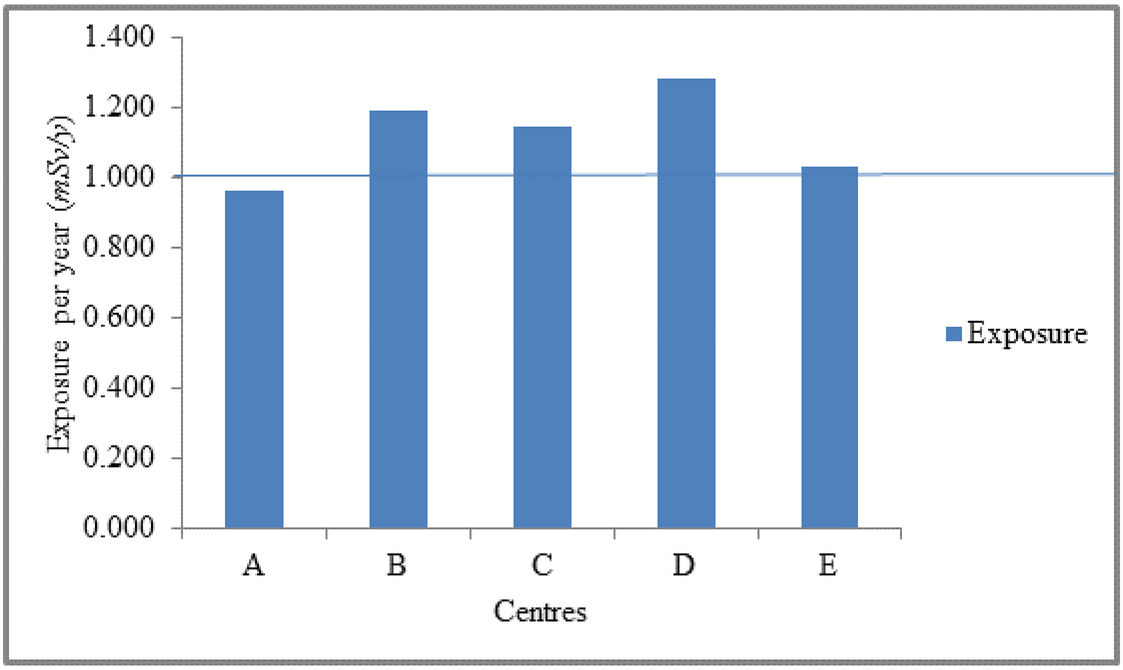

Figure 2: Cumulative background radiation per year in the study centres

4. Conclusion

Increased knowledge and training on radiological protection enhance safety and minimize health hazards associated with radiation exposures. It is evident that the study centres lack adequate radiation protection measures. As the radiation exposure level in most centres were above the recommended limit. It is necessary that centres with high exposure should seek professional advice to change their lead shielding to high quality standard. Also, periodic radiation protection monitoring should be constituted.

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