



RADIOLOGICAL EVALUATION OF LEAD APRON INTEGRITY IN FIVE SELECTED HOSPITALS IN ABUJA, NIGERIA

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ABSTRACT

Background: The general consensus is that any exposure to ionising radiation carries a risk. Diagnostic radiology is the largest (87%) contributor to man-made ionising radiation, therefore any economical and socially acceptable means of reducing dose without compromising the diagnostic value of the procedure must be worth implementing.

Aim: This study is aimed at evaluating lead apron integrity in five selected Hospitals in Abuja, Nigeria.

Methodology: The methodology approach includes the application of a large area beam for transmission measurement with the placement of OSLD before and behind the ten (10) lead aprons to determine the entrance and exit dose as well as the transmission factor. In this study, lead apron consisting of 0.25mm and 0.35mm thickness were examined.

Results: The result shows that the transmittance factor of the entrance and exit dose through the lead equivalent aprons is directly proportional to the age of the apron with NHA1 having the highest transmission factor (0.83) and oldest age (16 years). WGH2 has the lowest transfer factor (0.12) and the least age (1 year).

Conclusion: Lead aprons loses their attenuation capability over time and should be replace after 15 years at most for effective protection against ionizing radiation.

Introduction

Despite the various applications of x-rays in medicine, forensic and industries, they pose health effects on human tissues [1]. The International Commission on Radiological Protection (ICRP) recommend three principles for dose

reduction namely: justification, limitation and optimization (the ALARA principle) [2,3]. The principle of dose reduction could be achieved, in addition to other factors, by considering time, shielding and distance from the source of ionizing radiation.

When examinations are carried out in close proximity to radiosensitive organs such as the eye, gonads and thyroid, local protection should be provided if practicable to these organs [1,2].

There have being dramatic rise in the prevalence of adverse health effect in occupational radiation workers such as skin erythema following exposure to ionizing radiation sources over the past two decades, hence the need for the weighing of the amount of the absorbed dose [4]. The world average individual dose received due to exposure

from natural sources as observed from previous research showed about 6-15 mSv/year and a dose limit of about 20mSv/year. With this specified limit on absorbed dose there is the necessity to evaluate the integrity of the protective devices such as the lead apron [4,5].

Radiation safety is very necessary for occupational workers that are susceptible to x-ray sources as they can be exposed to three-tenth of the annual dose limit of 20mSv which is recommended for occupational workers [3,6,7]. Protective lead or lead-equivalent aprons play an important role in providing the necessary protection from secondary radiation to these workers. Vital information on the integrity of the shielding garments during their purchase is very important to ensure adequate radiation safety [7,8].

Most of the times, spine surgeons do get exposed to scatter beams as they are usually close to the patients undergoing treatment and even radiation source. Due to the growing prevalence of minimally invasive approaches, radiation doses in the treatment room have risen by exposing the treatment team to the harmful effects of radiation. The range includes amongst others ocular morbidities and tumors, thyroidal disorders, malignant solid neoplasms and leukemia [2,5,9].

Also noted was the poor compliance with radiation protection regulations as reported by the radiographers. The reproductive organs needs to be protected and importantly so because the Deoxyribonucleic acid (DNA) changes to sperm or egg cells of the patient and may pass on genetic defects to the offspring of the patient, as a result causing serious and unwarranted hardship for child and parents. Also susceptible to x-ray exposure is the thyroid gland. Care therefore is necessary to be taken by placing lead apron over the thyroid gland before any dental radiographs procedures [9,10].

The guidelines and regulation for radiation safety have been enacted in areas where personnel work with radiation. Furthermore, all institution are required to take precautions for radiation safety within its own structures. By establishing Radiation Safety Committees within their structures, health institutions have been making efforts to maintain their safety in job and protect their employees' health who are working in radiation areas [2,3,5]. Screening of lead aprons for qualitative assessment is usually performed with

the use of Computer Tomography (CT), fluoroscopy, or radiographic imaging in order to test for integrity of lead apron. In this study, evaluation of Lead Apron Integrity Test in Five Government Hospitals in Abuja, Nigeria was carried out.

Materials and Methods

Five health institutions from Abuja metropolis (National Hospital, Garki Hospital, Asokoro Hospital, Maitama Hospital, Wuse Hospital) were systematically selected for this study as shown in Figure 1. The radiographers and other auxiliary members of staff of the radiology department from these health institutions have been chosen as population sample size for the study.

Radiological integrity was evaluated for two randomly selected lead aprons from each selected hospital to determine the entrance and exit dose for a total of ten apron using Optically Stimulated Luminescence Dosimeter (OSLD).

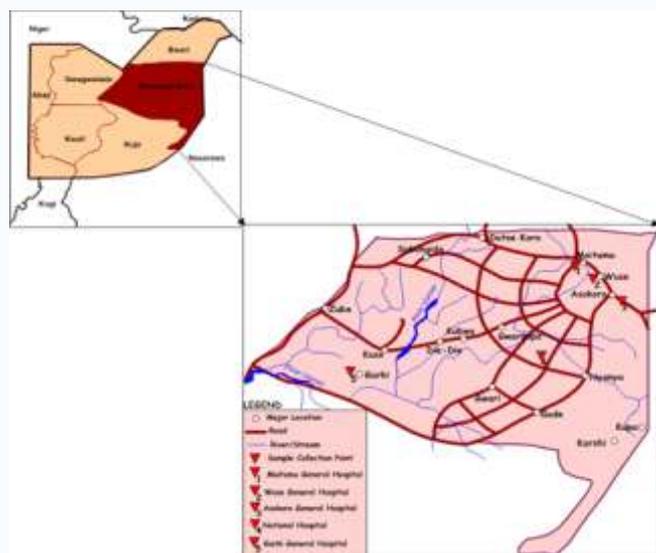


Figure 1: Map of Abuja Municipal Showing the Locations of the Government Hospitals

The exposure of the lead apron to x-ray radiation source was carried out in the center selected for the study. The front protector lead thickness, back protector lead thickness, and number of years in use were recorded for each lead apron selected as shown in Table 1. The lead apron was hanged 1 m above the ground level at a distance of 1 m away from the x-ray machine. The lead apron was exposed to x-ray radiation source to produce an image. From the image produced, tear, crack and others were examine.

The percentage transmittance was determined by positioning the apron upright at a distance away from the x ray tube and the OSLD was placed before and after the lead apron to determine the entrance and exit dose on exposure to x-ray radiation. The x -ray machine was set at 100 kVp and 100 mAs exposure parameters for all exposure procedure. A phantom which served as a scattering material was used to achieve maximum scattered from the unit. The exposed Optically Stimulated Luminesce Dosimeter were read using an OSL reader presently installed at the national hospital Abuja and analyzed using Excel computer software. This study is a non-invasive research as there was no discomfort or harm done to the participants involved in the research. Approvals were also duly obtained from the relevant authorities for the use of all equipments needed at the various centers.

placing the OSLD directly before and after each lead apron while a phantom was placed 100cm from the focal point of the x-ray machine and are exposed at 100 kVp for each lead apron.

The transmission rate was calculated using percentage transmittance given by

$$\text{Transmission, } T = \frac{\text{Exit Dose}}{\text{Entrance Dose}} \times 10$$

4. Result

Ten lead aprons (Two from each of the five hospitals) were examined in which eight aprons were 0.35mm thick, while two were of 0.25mm thickness. The entrance and exit doses determined at 100 kVp are presented in Table 1.

Table 1: Entrance Dose and Exit Dose and Transmission Factor

The Entrance and Exit Dose were determined by

S/no	Hospital	Type	Age	Entrance Dose	Exit Dose	Transmission Factor
1	NHA1	0.35	16	0.12	0.1	0.83
2	NHA2	0.35	16	0.11	0.08	0.73
3	MGH1	0.25	15	0.12	0.09	0.75
4	MGH2	0.35	8	0.17	0.09	0.53
5	AGH1	0.35	5	0.16	0.05	0.31
6	AGH2	0.25	3	0.108	0.02	0.19
7	GGH1	0.35	5	0.12	0.022	0.18
8	GGH2	0.35	2	0.128	0.018	0.14
9	WGH1	0.35	2	0.105	0.017	0.16
10	WGH2	0.35	1	0.10	0.012	0.12

The entrance dose range from 0.1 (WGH2) to 0.17 (MGH2) with an age of 1 and 8 respectively. The exit dose range from 0.012 (WGH2) to 0.1 (NHA1) with an age of 1 and 16 years respectively. The result indicate direct proportionality between exit dose and numbers of years spent by the apron.

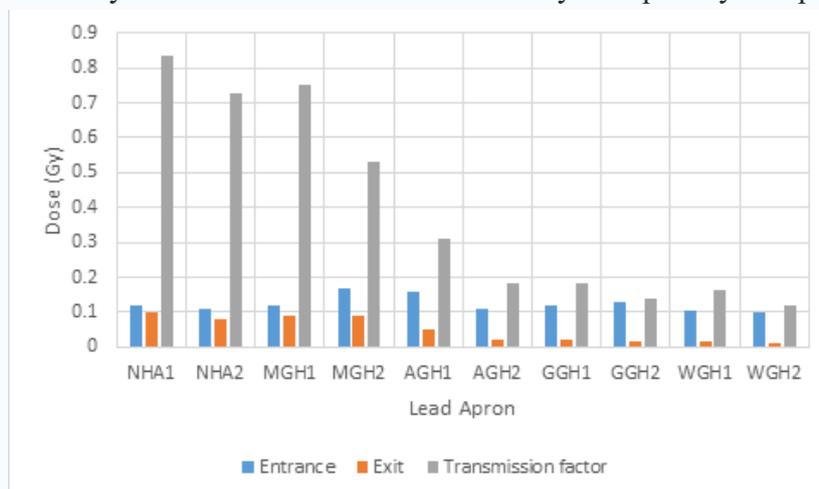


Figure 1: Comparison between Entrance, Exit and Transmission factor

Discussion

Lead aprons are generally expected to limit ionizing radiation to organs that are radiosensitive when worn, as indicated by most researchers. Studies has shown that lead aprons of 0.25 to 0.50 mm thickness are expected to attenuate over 90% and 99% of radiation dose, respectively. In a study by Johansen [11], transmission of radiation was found toranged from 2.9 to 7.6% for 0.25 mm lead and 0.4 to 2.2% for 0.50 mm lead, which has been supported by others. However, higher rates of transmission have been reported by other studies ranging between 20 and 35% for 0.25 mm lead aprons [12, 13]. If lead aprons are not worn appropriately, there is potential for ionizing radiation to increase. The National Radiological Protection Board [2] reported that loosely fitted lead aprons were shown to increase ionizing radiation to the breast. Whilst lead aprons are widely accepted to limit doses to humans, a risk of increasing radiation dose is still a thing of concern. The dose reduction for most radiosensitive organs was reported by authors [13, 14], the thyroid indicated a 20% increase and could therefore be attributed as 'secondary scattered' radiation.

Conclusion

The management of lead equivalent aprons to ensure safety of the users and patients will require adequate monitoring in the areas of their ages, regular inspection, and handling. The sensitivity of these aprons requires predetermined routine replacement to reduce risk of users. However, thicker lead equivalent aprons from assessment would be more protective against radiation leaks, a good number of the hospitals seem to prefer the medium sized aprons because of the weight. The older the aprons reveals more risk in usage as the experiment showed higher transmittance of radiation on aprons with high age. The weaker the lead aprons by reason of age translate to higher transmittance of scattered radiation and by extension the risk involved in usage of these aprons as protective gadgets.

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