



## INVESTIGATING THE PROTECTIVE EFFECTIVENESS OF THE SHIELDING PARAMETERS FOR DIAGNOSTIC X-RAY ROOMS IN SOME SELECTED HOSPITALS IN AGBOR METROPOLIS - DELTA STATE

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### ABSTRACT

Over exposure to x-rays is capable of producing serious health hazards and capable of causing death due to its ionizing nature. In the determination of effective primary and secondary shielding parameters of some hospitals in Agbor, a radiation detector, Geiger Muller Counter 320 plus was used for the measurement of radiation in the selected x-ray centers chosen in order to ascertain the degree of exposure of x-ray machines at exactly 1m from the primary source. The work was carried out for a period of 12 weeks in each of the selected hospitals simultaneously. A total of 145 patients were examined in central hospital Agbor, 110 in central hospital Abavo and 125 in Nkonye hospital Agbor. The patient's examination records containing types of examination each day, peak tube voltage, tube current and exposure time including the actual number of films used were obtained. Results obtained from the three hospitals investigated were found to be in conformity with the recommendations of National Commission on Radiological and Protection (NCRP) (70) and (116) protocols. Protective shielding parameters' results obtained in this study were lower than the standard recommended maximum values. The study showed that the walls of the x-ray rooms of these hospitals investigated have adequate shielding parameters and as such may not require any additional primary structural shielding barriers. It is therefore concluded that the X-ray shielding facilities for diagnostic x-ray rooms in the selected hospitals in Agbor metropolis were adequate and safe radiologically for patients and staff respectively.

**Keywords:** Exposure, Parameters, Patients, Radiologically, Shielding, X-Ray

### INTRODUCTION

Predictive medicine was superficial until the discovery of x-rays by Wilhelm Comrade Roentgen in 1895. X-rays have become very useful in the field of science especially in medical science all over the world. The production and scattering of x-rays provides additional examples of the quantum nature of electromagnetic radiation. X-rays are produced when rapidly moving electrons that have been accelerated through a potential difference of the order of  $10^3$  to  $10^6$  V strikes a metal target.

In an x-ray machine (Fig.1) below, sufficient intensity of electrons flow when high voltage power supply of 50 kVp to 125 kVp is applied, producing diagnostic x-rays for clinical diagnosis and treatment (Sadiq and Agba, 2011). Abdominal and chest examinations are normally performed at about 70 – 80 kVp and 100 kVp (Benjamin, 1982). X-rays have many practical applications in medicine and industry. They can penetrate several centimeters of solid matter and can be used to visualize the interiors of materials that are opaque to ordinary light such as bones or defects in structural steel. It is

generally known that over exposure to x-rays is capable of producing serious damaging health effects and can even lead to death at a higher level of exposure (Sadiq and Agba, 2011). Due to the ionizing nature of x-rays, it has become very necessary that exposure to x-rays from x-ray rooms be minimized. External radiation in radiology can be minimized or reduced by limiting the duration (time) of exposure, increasing distance between source and patients and placing a shielding material between the radiation source and the patients (Johnson *et al.*, 2009). Since x-ray radiation exposure from x-ray machines is considered as an external radiation, its effect can easily be minimized using source and structural shield in and around diagnostic and therapeutic x-ray rooms. The objective of this work therefore, is to ascertain the level of effectiveness of these shielding parameters (primary and secondary structural shielding) in minimizing the attendant effects of x-rays on therapeutic patients in diagnostic x-ray rooms in some selected hospitals in Agbor metropolis Delta State.



Figure 1a: Modern day x-ray machine.



Figure 1b: Modern day x-ray machine.

**BASIC THEORETICAL CONCEPT**

The physical parameters that determine the primary and secondary structural shielding of x-ray radiology rooms includes tube workload, use factor, operating potential and occupancy factor. These parameter are related by the equation  $K = \frac{Pd^2}{WUT}$  ..... ( Zuk, 2002).

K is exposure per unit workload at unit exposure, P is the maximum permissible exposure in R/week for controlled area, D is distance (m) from the target to primary area, Wis the workload (MA – mm/week), T is the occupancy factor and U is the use factor.NCRP (2004) gave the following definitions:

- i Workload: this is the amount of x-rays emitted per week (MA –mm/week)
- ii Occupancy factor (T) is the fraction of time that a maximally present individual is present in the area while the beam is on and the barrier protecting the area is being irradiated.
- iii Use factor (U) is the fraction of primary beam workload that is directed to an individual

**MATERIALS AND METHODS**

A nuclear radiation detector Geiger Muller Counter 320 plus was used for the measurement of radiation in all the selected x-ray centers to ascertain the exposure of x-ray machines at exactly 1m from the primary source.

The work was carried out for a period of 12 weeks in each of the selected hospitals. The patient’s examination records containing types of examination each day, peak tube voltage, tube current and exposure time including the actual number of films used were obtained. A total of 145 patients were examined in central hospital Agbor, 110 in central hospital Abavo and 125 in Nkonye hospital Agbor for a period of 12 weeks.

The following distances were measured:

Primary distance

Leakage distance

Scattered distance

Wall thickness (with the aid of measuring tape).

The primary distance measured for the x-ray tube focal spot was at 0.4 m beyond the wall to serve as the primary barrier

while the distance from the source to the scattered distance was measured from the surface of the patients (scattering material) to 0.4 m beyond the primary barrier.

The exposure per week contributed by the primary exposure, scattered exposure and the leakage exposure were evaluated. It should be noted here, that the method used here has also been used by other researchers of similar interest.

**RESULTS AND DISCUSSION**

The results obtained after some series of computations arising from the measurement of radiographic parameters and shielding distances at the selected hospitals are as shown in the tables below.

**Table1. Measured Radiographic parameters at the various hospitals.**

Measured parameters	Hospitals		
	Central Hospital Agbor	Hospital Abavo	Nkonye Hospital Agbor
Tube voltage (kvp)	100	100	100
Exposure rate (mR/hr)	25.2 ± 1.3 x10 <sup>1</sup>	9.4 ± 0.3 x10 <sup>1</sup>	5.6 ± 1.8 x10 <sup>1</sup>
Exposure time (s)	1	1	1
Field size (cm <sup>2</sup> )	1275	1275	1250

**Table 2. Measured shielding Distances at various Hospitals**

Measured parameters	Hospitals		
	Central Hospital Agbor	Hospital Abavo	Nkonye Hospital Agbor
Primary distance (m)	2.52	2.41	2.12
Secondary distance (m)	0.91	0.82	0.99
Leakage distance (m)	2.31	1.91	2.11
Scattered distance (m)	1.36	1.01	1.20
Source image distance (m)	1.35	1.50	1.23
Film to coat distance (m)	0.35	0.39	0.41
Wall thickness (m)	0.31 ± 3 x10 <sup>-2</sup>	0.30 ± 3 x10 <sup>-2</sup>	0.28 ± 2.6 x 10 <sup>-2</sup>

**Table 3. Measured Shielding Distances at various Hospitals**

Measured parameters	Hospitals		
	Central Hospital Agbor	Hospital Abavo	Nkonye Hospital Agbor
Tube workload (mA-min/wk)	48.40	30.30	98.35
Use factor	0.42	0.41	0.39
Occupancy factor	1	1	1
X-ray tube output (mR/mA-min) at 1m from source	4.2 x10 <sup>-3</sup>	3.98nx10 <sup>-3</sup>	3.0 x10 <sup>-3</sup>
Exposure towards (mR/wk) primary beam	0.68	0.49	0.35
Exposure per unit workload (mR/wk) towards primary beam at unit dist	0.64	0.50	0.41
Exposure per unit workload towards secondary barrier	0.014	0.04	0.005

**DISCUSSION OF RESULTS**

From Table 1, tube voltage (kvp) was 100 in each hospital studied. However, there was variable exposure rate (mr/hr) as follows: Central Hospital Agbor (25.2 ± 1.3x 10<sup>1</sup>), Central Hospital Abavo (9.4 ± 0.3 x 10<sup>1</sup>) and Nkoye Hospital Agbor (5.6 ± 1.8 x 10<sup>1</sup>). Furthermore, exposure time (s) was uniform in all the hospitals, while the field size (cm<sup>2</sup>) were 1275 cm<sup>2</sup> for Central Hospital Agbor and Central Hospital Abavo, respectively but 1250 cm<sup>2</sup> for Nkoye Hospital Agbor.

From the results obtained in table 2, it was observed that the primary and secondary shielding barrier of the concrete

thickness of the walls of the x – ray rooms at these hospitals were 310 ± 3.0 x 10<sup>1</sup> mm for Central Hospital Agbor, 300 ± 30 x 10<sup>1</sup>mm for Central Hospital Abavo and 280 ± 2.6 x 10<sup>1</sup> mm for Nkonye Hospital respectively.

From table 3, it was observed that the tube workload of 48.40, 30. 30 and 98.35 mA – min per week recorded for Central Hospital Agbor, Central Hospital Abavo and Nkonye Hospital Agbor, respectively, were found to be lower than the NCRP 49 (1970) recommendation which is 250 mA – min per week for a solo practice and 1000 mA – min per week for busy radiographic units. The tube workload recorded at the Nkonye

Hospital was comparatively higher due to higher rate of usage.

The findings from this work as shown in Table 3 also showed that the workload obtained in the study lies within the range (73 to 530 mA min/week) recommended for orthopedic facilities and (500 mA min /week) for shielding design purposes and this is in agreement with the recommendation by Nassef& Kinsara (2017).In addition, More, Acum & Rica, (2011) reported that so many results have reported that the weekly workload does not exceed 100 mA – min even for very busy radiographic x-ray rooms and this is also in agreement with the results obtained in this study from the three hospitals investigated.

Again, in table 3, the exposures per week without shielding at position of 0.3 m above the primary/secondary protective barriers in the three hospitals were found to be lower than the recommended standard value for exposure limit/week of 2 mR/wk. These values were 0.68 and 0.64 for Central Hospital Agbor, 0.49 and 0.50 for Central Hospital Abav and 0.35 and 0.4 mR/wk for Nkonye hospital respectively. These results were in agreement with the findings of Agba et al., (2010) which showed that the walls of the x-ray units of these hospitals have adequate primary shielding effectiveness which in effect, takes care of the secondary protective shielding.

**CONCLUSION**

The X-ray shielding parameters for diagnostic X-ray rooms deployed in the selected hospitals in Agbor metropolis were adequate as results obtained were lower than recommended maximum values prescribed by the National Commission on radiological and protection NCRP 70 protocols. In conclusion the x-ray units of the hospitals were adjudged to be safe radiologically for both patients and radiology health service personnel.

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