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Evaluation of Health Risk Due to Exposure to Radiation in Some Hospitals in Rivers State

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

An external background ionization radiation was carried out in Our Lady Health of the sick hospital, Colworth Medical and Olive Tree Medical Diagnostics Port Harcourt. The background radiation reading was taken using the radiation alert meter (Digilert 200). The estimated value for the excess lifetime cancer risk from the three hospitals are lower than the world average, also the annual effective dose equivalent from Our Lady Health of the sick hospital, Colworth Medical Centre and Olive three medical center are lower than the world accepted value. The average absorbed dose rates are higher than the world accepted value which is 84nGy/h. the average exposure rate from the three hospitals is lower than the world accepted value which is 0.013mR/h. the absorbed dose rate exceeded the safe limit for the general public.

Keywords: Annual effective dose equivalent; Digilert 200; Excess Lifetime Cancer Risk; Absorbed dose rates Background ionization radiation.

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1. INTRODUCTION

The advancement of science has led to the discovery of much medical equipment which has benefitted a great number of patients. This medical equipment used in the treatment of patients include: medical imaging, CT scans, X-ray imaging etc.

These medical devices that use electrical energy emits radiation, some of which poses great risk to both patients their operators. The risks to patients and their operators have been categorized broadly as stochastic and non-stochastic. There has been misconception and misperceptions of the effects of radiation or the use of radiation-based equipment in medical setting. Although radiological techniques and diagnostic imaging is on the increase for the treatment of injuries and diseases. The technology is still limited by its hazards to health care workers and patients [1].

The use of gamma ray spectrometry as a tool for mapping radioelement concentrations has found widespread acceptance in diverse fields. The method has evolved over several decades and continues to be developed. The method has benefited from continuing advances in instrumentation, field procedures and calibration and data processing procedures. Gamma ray spectrometry is widely used for environmental mapping, geological mapping and mineral exploration.

Several studies have been carried out in Nigeria to measure the natural background radiation levels of hospitals. Okoye and Avwiri [2] carried out a study on the radiation levels at Braithwaite Memorial Specialists Hospital, Port Harcourt. The indoor exposure dose rate ranged from 0.14± 0.02 μSvh^{-1} to 0.16± 0.01 μSvh^{-1}. Also, Ononugbo and Nwokeoji [3] carried out a study on “Radiation Risk Assessment from Background Radiation Exposures in Selected Hospitals in South – South Nigeria. The average indoor and outdoor exposure dose rates measured at University of Uyo Teaching hospital were 0.013±0.003 and 0.015±0.003 mRh^{-1}, average indoor and outdoor exposure rates measured at the University of Port Harcourt Teaching hospital were 0.015±0.005 and 0.015±0.005 mRh^{-1} and the average indoor and outdoor exposure dose rates for Braithwaite Memorial Specialist Hospital were 0.014±0.003 mRh^{-1} and 0.013±0.003 mRh^{-1}. The world standard threshold value for exposure dose rate is 0.013 mRh^{-1}, the values show that University of Uyo Teaching hospital indoor are within this range, while the others are higher. The average indoor and outdoor absorbed dose rate for all the hospitals exceeded the world average of 89 $nGyh^{-1}$”.

This study seeks to properly take a survey of background radiation and scatter radiation during x-rays examination in selected private Hospitals in Rivers State, Nigeria. And to provide accurate data as part of environmental monitoring research for the assessment of exposure dose rate due to scatter radiation within hospitals and their immediate environment.

2. MATERIALS AND METHODS

2.1 Study Area

The study area is within Port Harcourt metropolis. It is the capital of Rivers State and the largest city of Rivers State, Nigeria, it lies along the Bonny River and is located within the Niger Delta with an estimated population of 1,865,000 inhabitant. The study was carried out in three different hospitals,

i. Colworth Medical Centre, Opposite Market Square, L.K Anga Road, Off Peter Odili Road, beside Bluebell School, Trans Amadi, Port Harcourt, Rivers State.
ii. Our Lady Health of the sick Hospital, Nkpogu Road, Port Harcourt, Rivers State.
iii. Olive Tree Medical Diagnostic Imaging Centre, 23 Eastern Bypass Port Harcourt, Rivers State.

All these hospitals have Radiology Department which is equipped with X-ray Machines, fluoroscopy machine, mammography machines, helical 6- slice Computerized Tomography (CT) machine and a Magnetic Resonance Imaging (MRI) machine.

“An *in-situ* measurement of background ionizing radiation indoors and outdoors of the hospitals were measured using well calibrated Radalert-100 and Digilert-200 nuclear radiation meters (S.E. International INC. Summer Town, USA). The detector is halogen- quenched GM tube with thin mica end window of density 1.5 -2.0 mg cm^2 and diameter of 0.360 inch and side wall of 0.012 inch thick. The radiation meters detect alpha down to 2.5 MeV with 80% detection efficiency, beta at 50KeV with 35% detection efficiency and can also detect beta at 150 KeV with 75% detection efficiency. Digilert 200 and Radalert

100 is capable of detecting gamma and X-rays down to 10 KeV through the window, 40 KeV minimum through the case within the temperature range of -10°c to 50°c. The radiation meters were set to measure the exposure rate in milli-Roetgen per hour which has operating range of 0.001 (μRh^{-1}) to 200 mRh^{-1}" [4]. "The measurements were carried out within the radiology department and some other departments of the hospital. Measurements were also carried out outdoors at different positions within the hospital premises. Six readings were taken in triplicate whereby average value for each was recorded. The mean exposure rates were calculated along with their standard deviations. The absorbed dose rate (nGy/h) was obtained from the exposure dose rate in (μR/h) using the conversion factor" [4].

$$1\mu R/h = 8.7 nGy/h = 8.7\times10^{-3}\mu Gy/(1/8760)y = 76.212\mu Gy/y \quad (1)$$

3. RESULTS AND DISCUSSION

The *in-situ* results of the background ionizing radiation (BIR) and the calculated values of the absorbed dose, annual effective dose equivalent (AEDE) and excess lifetime cancer risk (ELCR) of the three hospitals are presented in Tables 1-3, ICRP, [5].

3.1 Annual Effective Dose Equivalent (AEDE)

The annual effective dose equivalent received by patients and staff of the three hospitals were estimated from the absorbed dose rate, a dose conversion factor of 0.7 Sv/Gy and the occupancy factor outdoor was 0.25. It has been estimated that people spend approximately 6 hours outdoors. The annual effective dose equivalent is determined using the following equations [6].

$$\text{AEDE (outdoor) (mSv/y)} = \text{Absorbed dose rate (nGy/h)} \times 8760\text{ h} \times 0.7\text{Sv/Gy} \times 0.25 \quad (2)$$

3.2 Excess Lifetime Cancer Risk (ELCR)

Excess lifetime cancer risk measures the stochastic effects produced by low dose background radiation. It is the additional cancer risk induced by exposure to ionizing radiation. Based on the calculated values of lifetime cancer risk is calculated values of lifetime cancer risk is calculated using the equation [7].

$$\text{ELCR} = \text{AEDE} \times \text{Average duration of life (DL)} \times \text{risk factor (RF)} \quad (3)$$

Where,

AEDE = Annual Effective Dose Equivalent
DL = Duration of life (70 years)
RF = Risk factor 0.05 (fatal cancer risk per Sievert)

The background ionizing radiation of the three hospitals in Tables 1,2 and 3 was carried out in Port Harcourt. The radiation levels were low in some areas and high in some other areas. These values are lower than the value reported by [8]. The radiation exposure rate level in the private hospitals is presented with the associated radiological parameters in Tables 1,2 and 3. The annual effective dose was calculated from the absorbed dose rate and also the excess lifetime cancer risk is presented in Tables 1,2 and 3. Comparison of the average absorbed dose rate, average annual effective dose rate and average excess lifetime cancer risk with their respective standards are shown in Figs. 1,2 and 3 respectively. The average annual effective dose rate in Colworths Medical Centre, Our Lady Health of the sick and Olive Tree Medical Diagnostic Centre are low compared to the average world accepted and [9-11]. The average for the excess lifetime is higher than the world accepted value which is 0.29×10^{-3}. The average absorbed dose for the three hospitals ranges from 0.47 to 0.52mSv/y is higher than the world accepted average. The study revealed that the background ionizing radiation levels of the areas exceeds accepted BIR average value and have been impacted by radiation-based equipment in the hospitals. the result from the study shows that the exposure rate due to scatter radiation in the x – ray rooms (during x – ray examination) in the three hospitals is higher than the accepted values. Therefore, the radiological department should be protected from over exposure of scatter radiation by providing all the necessary PPE for radiological staff.

Table 1. Radiation exposure rate and its radiological parameters in our lady health of the sick hospital

Sampling Point	BIR (mR/hr)	Absorbed dose (nGy/hr)	AEDE (mSv/y)	ELCR x 10^{-3}
Reception Area	0.011	95.70	0.15	0.51
X–Ray machine	0.013	113.1	0.17	0.61
Exposure cubicle	0.010	87.00	0.13	0.47
Behind the glass	0.008	69.60	0.11	0.37
X-ray office	0.008	69.60	0.11	0.37
Supervisor office	0.008	69.60	0.11	0.37
X-ray office lobby	0.010	87.00	0.13	0.47
X-ray Dark room	0.013	113.10	0.17	0.61
Backyard behind x-ray room	0.009	78.30	0.12	0.42
USS room	0.012	104.40	0.16	0.56
Private ward 1	0.009	78.30	0.12	0.42
Private ward 11	0.009	78.30	0.12	0.42
Mean	**0.01 ±0.01**	**87.0 ±16.17**	**0.13±0.02**	**0.47± 0.9**

Table 2. Radiation exposure rate and its radiological parameters in colworths medical centre

Sampling Point	BIR (mR/hr)	Absorbed dose (nGy/hr)	AEDE (mSv/y)	ELCR x 10^{-3}
Entrance door	0.008	69.60	0.11	0.37
The reception	0.009	78.30	0.12	0.42
X – ray room	0.015	130.50	0.20	0.70
The shielding	0.007	60.90	0.09	0.33
At the door of the first theatre,	0.009	78.30	0.12	0.42
Inside the first theatre	0.013	113.10	0.17	0.61
At the door of the second theatre	0.009	78.30	0.12	0.42
Inside the second theatre	0.013	113.10	0.17	0.61
The nurse station	0.009	78.30	0.12	0.42
The laboratory	0.008	69.60	0.11	0.37
Inside the laboratory	0.013	113.10	0.17	0.61
The consulting room	0.011	95.70	0.15	0.51
The computer room	0.011	95.70	0.15	0.51
The emergency room	0.012	104.40	0.16	0.56
The generator house	0.015	130.50	0.20	0.70
Mean	**0.001±0.003**	**89.9±22.36**	**0.14±0.03**	**0.48±0.12**

Table 3. Radiation exposure rate and its radiological parameters in olive tree medical diagnostic centre

Sampling Point	BIR (mR/hr)	Absorbed dose (nGy/hr)	AEDE (mSv/y)	ELCR x 10^{-3}
The reception	0.008	69.60	0.11	0.37
The lobby way	0.013	113.10	0.17	0.61
X – ray room (door)	0.009	78.30	0.12	0.42
X – ray room (inside)	0.015	130.50	0.20	0.70
The shielding point	0.011	95.70	0.15	0.51
First USS room (door)	0.007	60.90	0.09	0.33
First USS room (inside)	0.013	113.10	0.17	0.61
Second USS room (door)	0.011	95.70	0.15	0.51
Second USS room (inside)	0.013	113.10	0.17	0.61
Behind the x – ray room	0.012	104.40	0.16	0.56
Mean	**0.011±0.002**	**97.44±22.01**	**0.15±0.03**	**0.52±0.12**

Table 4. Mean exposure rate measured and their radiation parameters in the three Hospitals

Locations	Absorbed dose (nGy/hr)	AEDE (mSv/y)	ELCR x 10^{-3}
Our Lady Health of the Sick	87.0	0.13	0.47
Colworth Medical Centre	89.9	0.14	0.48
Olive Tree Medical Diagnostic Centre	97.44	0.15	0.52
World Average	**84.0**	**1.0**	**0.29**

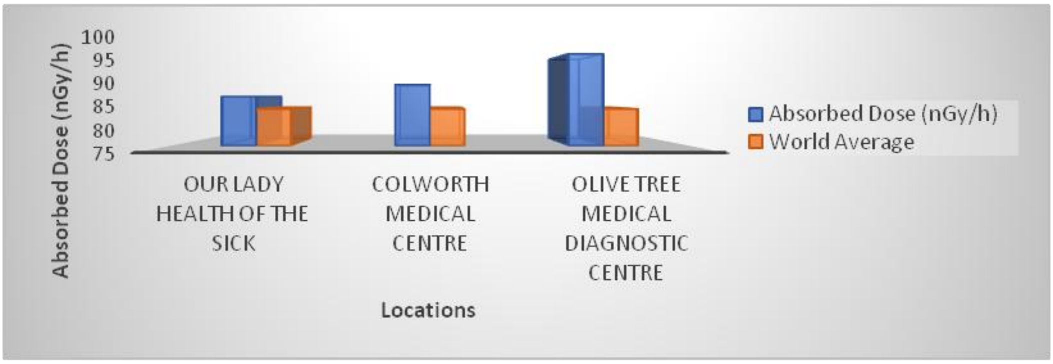

Fig. 1. Comparison of absorbed dose rate with world average

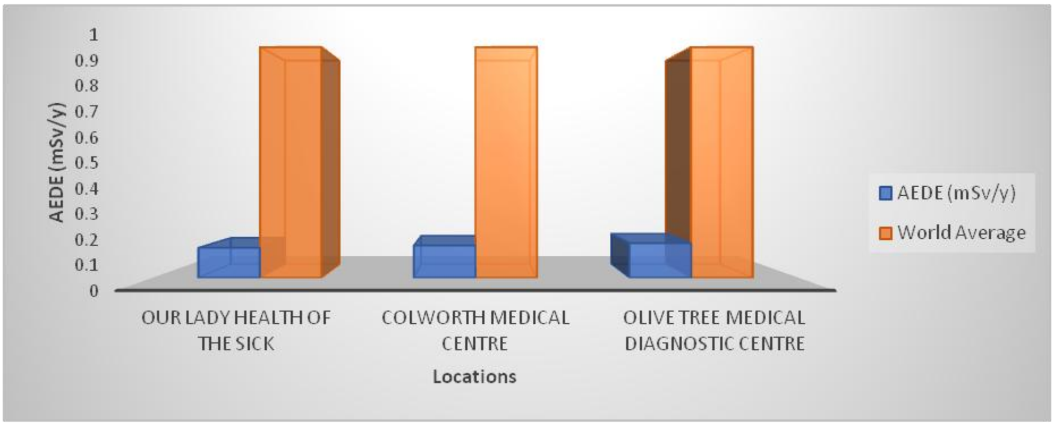

Fig. 2. Comparison of AEDE with world average

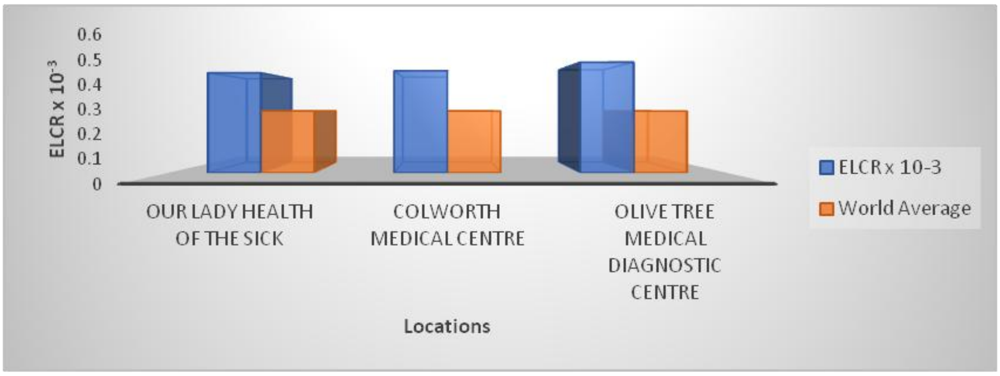

Fig. 3. Comparison of ELCR with world average

4. CONCLUSION

The background ionizing radiation of the three private hospitals was carried out in Port Harcourt. The radiation values were low in some areas and high in other areas. The following recommendations are necessary: the radiation room should be properly spaced such that the distance from the x – ray machine to the door will be at least 3m and properly shielded. The aprons and other PPE should be inspected fluoroscopically on an annual basis to detect deterioration and defects in the protective material. Regular training should be given to the radiological staff on the effect of over exposure to radiation.

DISCLAIMER

The product used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and the producers of the products because we do not intend to use these products as an avenue for any litigation but for advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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