EVALUATION OF BACKGROUND IONIZING RADIATION LEVELS IN JOS UNIVERSITY TEACHING HOSPITAL, NORTH CENTRAL NIGERIA

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ABSTRACT

Background: Exposure of patients to radiographic examination (computerized tomography, fluoroscopic procedures, dental diagnosis, and routine exposure to x-rays), radioisotope procedures and radiation therapy have contributed to increase in background radiation and radiation levels of patients and many occupational workers. The aim of this study was to measure and establish the background ionizing radiation level in different parts of Jos University Teaching Hospital.

Methods: Measurement of background ionizing radiation level was performed using a well calibrated Radiation Alert (Inspector$^+$ and Inspector EXP$^+$) monitor manufactured by S.E. International, INC. USA; 2013. The total count was taken for a period of 10 minutes which was carried out three times for each location, the average was calculated and recorded. This was carried out in all 71 locations within the hospital, the values were then converted to Sievert (Sv) using the relation: 1CPM=0.01μSv/hr (Radiation Alert User's manual 2007).

***Results**:* The results obtained range from 0.218±0.0608 μSv/hr to 0.308±0.01 μSv/hr with a mean of 0.243±0.02 μSv/hr within Radiology Department, 0.279±0.017 μSv/hr for the wards, 0.254±0.026 μSv/hr for the clinics, and 0.27±0.0382 μSv/hr for the laboratories and other location in the Hospital.

Conclusion: The mean measurement from the wards is slightly above the standard of 0.274 μSv/hr recommended as worldwide average natural dose of background ionizing radiation while the average measurement for Radiology Department and the clinics were within permissible allowed values. The results from this study indicates that some locations such as the Radiology Department and the clinics as safe while the wards are relatively unsafe.

***Keywords**:* Background ionizing radiation, hospital, measurement, Jos, Plateau state.

Introduction

Radiation is part of our daily lives. It is all around us and has been present since the birth of this Planet. It is energy that travels in the form of waves and makes up the electromagnetic spectrum. The electromagnetic spectrum is divided into two major categories: ionizing radiation and non-ionizing radiation.

Non-ionizing radiation includes both low frequency radiation and moderately high frequency radiation, including radio waves, microwaves and infrared radiation, visible light and lower frequency ultraviolet radiation while ionizing radiation includes higher frequency ultraviolet radiation, x-rays and gamma rays .[1]

Ionizing radiation has enough energy to break chemical bonds in molecules or remove tightly bound electrons from atoms, creating charged molecules or atoms (ions) .[1]
Background radiation consists of three primary types: Primordial, cosmogenic and anthropogenic. Primordial radionuclides are present in the earth's crust and found throughout the environment. Cosmogenic radionuclides are produced when cosmic radiation interacts with elements present in the atmosphere and are deposited through both wet and dry deposition. Anthropogenic sources of radiation result from human activities, but are considered background because their presence is ubiquitous .[2]

Radiation from hospitals and medical research institutes has been of great concern because of the known effects of high dosages. Radiations in hospitals come from three main sources namely: medical exposures, cosmic-terrestrial radiation and radioactivity from the background.[3,4] Some of the materials used in the construction of buildings are also known to be radioactive.[5]

Exposure of patients to radiographic examination (computerized tomography, fluoroscopic procedures, dental diagnosis, and routine exposure to x-rays), radioisotope procedures and radiation therapy have contributed to increase in background radiation and radiation levels of patients and many occupational workers .[6,7,8]

Background radiation levels in Nigeria and other developing countries are lower than those of industrialized countries even though the level is on the increase due to rise in illegal mining and poor environmental management.

It is reported that the global average natural dose of background ionizing radiation to humans is about 0.274 μSv/hr. Eighty percent (80%) of which comes from nature, while the remaining 20% results from exposure to man-made radiation sources, primarily from medical imaging. Average background ionizing radiation exposure is much higher in developed countries, mostly due to numerous industrial and medical activities .[9] Literature search has shown that there is no data about the background ionizing radiation at the Jos University Teaching Hospital (JUTH) and couple to the fact that there is limited knowledge to the level of background radiation staff and patients are exposed to daily. It is against this background that this study was carried out to determine the background ionizing radiation level at different locations within the Jos University teaching hospital.

Materials And Methods

Study design.

It was a hospital-based cross-sectional study.

Study Area.

This study was conducted in January, 2016 in 71 locations within the Jos University Teaching Hospital, Plateau State, Nigeria. These locations were randomly selected where there was high staff, patients and patient's relatives' traffic as well as suspected high radiation activities. The hospital is a 600-bed tertiary hospital that sub-serves neighboring states such as Bauchi, Nassarawa, Benue, part of Kaduna, Gombe and Taraba states. It has a functional radiology department that has machines that produce ionizing radiation such as Computed Tomography, Conventional X-ray machines, Mammography machine, Fluoroscopy machine and other non-ionizing radiation producing machines.

Data sources and measurements.

A Radiation Alert (Inspector^{+} and Inspector EXP^{+}) Inspector Survey Meter was used for the measurement; manufactured by S.E. International,

INC. USA; 2013. The Radiation Alert monitor is a device with Geiger-Muller (GM) tube which detects or monitor radioactivity in an area. The monitor was set in total count mode and the total count was taken for a particular period time.

The monitor was placed on a stool that was constructed for the purpose of this study. The stool is one meter (1m) tall above the ground with an open top to suite the detector window of the Radiation Alert monitor which was placed face down. The total count was taken for a period of 10 minutes for every location since the number of counts detected by the monitor varies from minute to minute due to random nature of radioactivity. The reading was taken at three different spots within each location, then the average of the three readings was calculated and recorded. This was carried out in all the 71 locations within the hospital. The values were then converted to Sievert (Sv) using the relation:
1CPM=0.01μSv/hr (Radiation Alert User's manual 2007).

Statistical analysis.
The exposure rates were entered into excel sheet and the mean exposure rates were calculated along with their standard deviations. The results were presented in tables and bar charts in microsievert (μSv/hr).

Results
Table 1 below shows background ionizing radiation for Radiology Department of the hospital. The values range from 0.218±0.0608μSv/hr to 0.298±0.032μSv/hr with a mean of 0.262±0.02μSv/hr. The mean value from CT suite (0.22±0.06 μSv/hr)
and Fluoroscopy room had the lowest while the Lounge had the highest equivalent dose rate (0.30±0.03 μSv/hr). **Figure 1** (below) illustrates the mean values within radiology department and the standard natural background ionizing radiation (0.274 μSv/hr).

Table1: Dose rate for radiology department of the hospital

S/N	LOCATION	Mean Dose equivalent (μSv/h)
1	Reception	0.27±0.01
2	X-ray room	0.26±0.02
3	Dark room	0.28±0.02
4	Fluoroscopy room	0.22±0.06
5	CT suite	0.22±0.06
6	Mammography room	0.25±0.03
7	MRI suite	0.24±0.05
8	Ultrasound room 1	0.27±0.02
9	Ultrasound room 2	0.27±0.02
10	Lounge	0.30±0.03
11	Entrance	0.26±0.02
12	Exposure cubicle 1	0.26±0.05
13	Exposure cubicle 2	0.24±0.02
14	Film reporting room	0.25±0.05
15	Doctors call room	0.27±0.01
16	Radiographers call room	0.28±0.03
17	Secretary's office	0.24±0.01
18	HOD's office	0.24±0.02
19	Residents' office	0.26±0.02
20	Nurses' office	0.25±0.03

Mean(±SD): 0.26±0.02

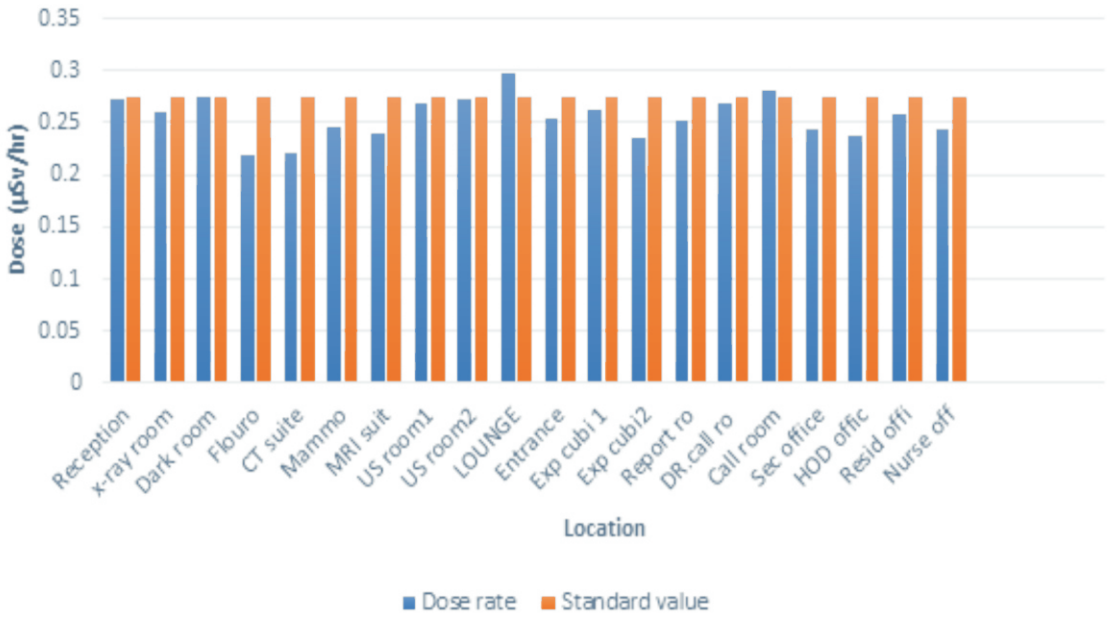

Fig. 1: Radiology department dose rate compared to the standard value.

Table 2 below shows background ionizing radiation in the wards of the hospital. The values range from 0.248±0.01µSv/hr to 0.308±0.01µSv/hr with a mean of 0.279±0.017 µSv/hr. Neurosurgical ward had the lowest equivalent dose rate of 0.25±0.01 µSv/hr while Gynaecology and antenatal wards had the highest equivalent dose rates (0.31±0.01µSv/hr). **Figure 2** (below) represents the mean equivalent dose rate for the different wards and the standard mean natural background ionizing radiation (0.274µSv/hr).

Table 2: Dose rate for the wards within the hospital.

S/N	LOCATION	Mean Dose equivalent (µSv/h)
1	Male medical ward 1	0.27±0.01
2	Male medical ward 2	0.26±0.01
3	Female medical ward 1	0.26±0.01
4	Female medical ward 2	0.26±0.01
5	Neurosurgical ward	0.25±0.01
6	Male Orthopaedic ward	0.29±0.01
7	Female Orthopaedic ward	0.29±0.01
8	Post natal ward 1	0.29±0.01
9	Post natal ward 2	0.29±0.02
10	Gynae ward	0.31±0.01
11	Antenatal ward	0.31±0.01
12	Paediatric medical ward	0.28±0.03
13	Paediatric surgical ward	0.29±0.02
14	Special care baby unit	0.30±0.02
15	Intensive care unit	0.27±0.01
16	Emergency paediatric unit	0.29±0.03
17	ENT ward	0.29±0.02
18	E/A ward	0.27±0.02

Mean (±SD): 0.28±0.02

Fig. 2: Wards dose rate compared to the standard value.

Table 3 shows background ionizing radiation for clinics within the hospital. The values range from 0.22±0.049 µSv/hr to 0.298±0.0287 µSv/hr with a mean of 0.254±0.026µSv/hr. The clinic with the lowest equivalent dose rate was the MOPD (0.22±0.05µSv/hr) while the clinics with the highest were GOPD2 (0.30±0.01 µSv/hr) and O&G OPD (0.30±0.03 µSv/hr). Figure 3 represents the mean values at the clinics and the standard natural background ionizing radiation (0.274µSv/hr).

Table 3: Dose rate for clinics within the hospi tal.

S/N	LOCATION	Mean Dose equivalent (µSv/hr)
1	Gynae. Emergency	0.26±0.03
2	Paediatric OPD	0.23±0.02
3	Medical OPD	0.22±0.05
4	Surgical OPD	0.23±0.01
5	Orthopaedic OPD	0.24±0.04
6	Maxillofacial OPD	0.25±0.03
7	O&G OPD	0.30±0.03
8	A&E	0.25±0.02
9	CMC/IMMUNIZATION	0.28±0.04
10	GOPD1	0.25±0.08
11	GOPD2	0.30±0.01

Mean (±SD): 0.25±0.03

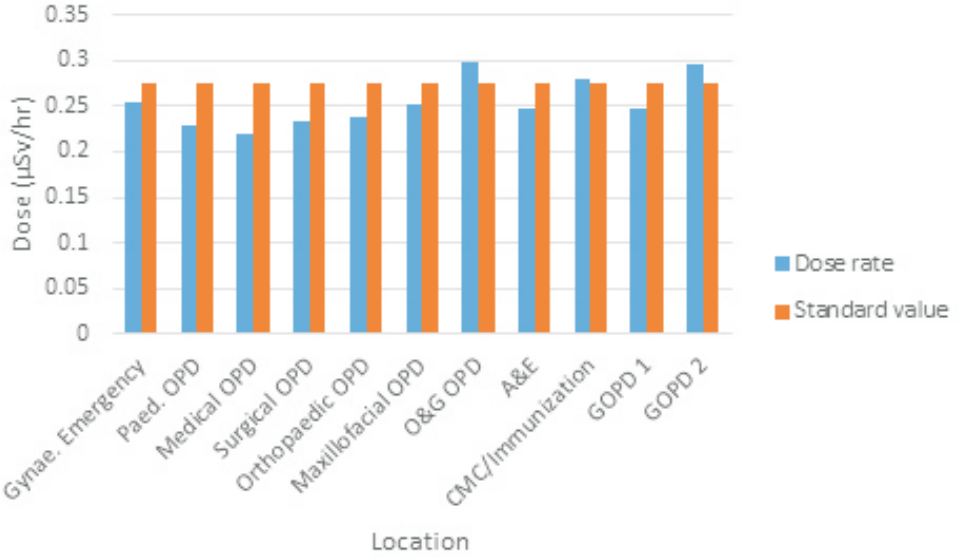

Fig. 3: Clinics dose rate compared to the standard value.

Table 4 shows background ionizing radiation within the laboratories and other locations within the hospital. The values range from 0.203±0.01µSv/hr to 0.328±0.0189µSv/hr with an average of 0.27±0.0382µSv/hr. Two locations (Main store and Record library) had the lowest value (0.21±0.02µSv/hr) while Physiotherapy had the highest reading (0.34±0.06µSv/hr). Figure 4 shows the mean equivalent dose rate from the laboratories and the mean standard natural background ionizing radiation (0.274µSv/hr).

Table 4: Dose rate for the laboratories and other locations

S/N	LOCATION	DOSE RATE **(µSv/hr)**
1	Endoscopy	0.27±0.03
2	Mortuary	0.27±0.03
3	Record library	0.21±0.02
4	Main pharmacy	0.29±0.03
5	Physiotherapy	0.34±0.06
6	Main passage	0.27±0.02
7	Theatre	0.28±0.02
8	Dialysis	0.23±0.01
9	Library	0.30±0.03
10	Power House	0.27±0.01
11	CMC/IMMU	0.28±0.04
12	Admin block	0.25±0.01
13	Works dept	0.25±0.04
14	Main store	0.21±0.02
15	Laundry	0.22±0.04
16	Histology lab	0.32±0.03
17	Chemical pathology lab	0.33±0.02
18	Hematology lab	0.29±0.01
19	Blood bank	0.27±0.04
20	Bacteriology lab	0.30±0.03
21	Parasitology	0.23±0.02
22	Immunology lab	0.30±0.01

Mean (±SD): 0.27±0.03

Fig. 4: Laboratories and other locations dose rate compared to the standard value.

Discussion

The location with the highest value of background radiation in radiology department was the departmental lounge with a value of 0.298+/-0.032µSv/hr even though there is no machine emitting ionizing radiation within 10 meters radius to the lounge. There is no documented record of radiology lounge from previous studies because this study is more comprehensive covering more locations than other similar researches. The high value from the lounge could likely be due to the building materials used which are mainly gotten from old mining site where there is likely high radioactivity from poor environmental management. Overall, the mean value recorded in the radiology department is 0.256+/-0.029µSv/hr which is higher than the value of study carried by Okoye et al in Port Harcourt who documented a mean value of 0.146+/-0.02µSv/hr, this could possibly be due to the fact that there are more radiation emitting machines in the radiology department of JUTH than in Braithwaite memorial specialist hospital Port Harcourt. Conversely, the JUTH radiology department value is lower compared with the work by Jwanbot et al who documented a mean value of 0.29µSv/hr and 0.37µSv/hr for Skene Radiodiagnostic center and Radiology department, Plateau Specialist Hospital respectively. The reason for the low mean value in radiology department in JUTH could be that as a tertiary health institution, it was built using standard universal precautionary measures such as such as leaded walls and glasses as well as the radiation exposure safety guides used by the highly trained staff who keep the level of radiation exposure at a lower permissible level when compared to most private diagnostic center where global standards are not always put into consideration. The mean value recorded from the wards within the JUTH radiology department is 0.279±0.017µSv/hr which is higher than the global average natural dose of background ionizing radiation to human and also that documented by Okoye et al (0.136 ± 0.02µSv/hr). This could possibly be contributed by the soil used for the construction of the building which were gotten from mining site which is known to have high level of radioactivity.

The highest value for background ionizing radiation in this study was obtained from the physiotherapy department with a value of 0.34+/-0.06µSv/hr. This could be from the building materials used and possibly from some of the equipment being used in the department. In a study done by Mohammed et al[4]. it was also shown that the physiotherapy department had one of the highest values of background ionizing radiation.[4] Similarly, a study conducted by Okoye et al.[7] physiotherapy department had the highest value (0.17+/-0.02µSv/hr) among other locations, even though it is much lower than the standard natural

background dose of ionizing radiation (0.274μSv/hr). More studies should be carried out on the level of background ionizing radiation in the physiotherapy department to ascertain the possibility of emission of ionizing radiation by some equipment used in the department.

In general, the values of background ionizing radiation obtained from this study are higher than those obtained by Mohammed et al.[4], Okoye et al.[7] and James et al.[8], whereas the values recorded in this study is similar to the values obtained by Jwanbot et al.[5] The high values documented in these two studies carried out in Jos, Plateau state even though at different hospitals and at different years, these high values could mainly be due to the greater concentrations of radioactive materials in the soils of Jos resulting from the mining activities in Jos and environs as well as to some extent the increase in cosmic radiation at higher altitudes in the study area Jos.

Conclusion

The measurements of the background ionizing radiation different departments and locations at the Jos University Teaching Hospital (JUTH) are as documented, most of the values were within permissible limits while some departments were above the permissible limits.

Recommendation

Regular yearly interval measurement of the background ionizing radiation level of the hospital should be carried out and documented by the radiation safety committee lead by the radiation safety adviser.

Those departments such as physiotherapy with higher values of ionizing radiation be studied further to determine source of radiation in other to take measures in preventing unnecessary exposure of hospital staff and patients.

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