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Determination of Entrance Surface Dose of Patients Undergoing X-Ray Examination in Federal Neuropsychiatric Hospital Maiduguri, Nigeria

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Abstract: *The number of patients undergoing diagnostic X-ray examinations is increasing in Maiduguri due to injuries inflicted in road traffic accidents, collapse of buildings and at battle field caused by Boko-Haram insurgency. These impose high risk of ionizing radiation to patients. Therefore, this work determined the entrance surface dose (ESD) of 150 adult patients randomly selected underwent an X-ray examination in Federal Neuropsychiatric Hospital Maiduguri and access if they are at high risk of radiation exposure. The demographic information of patient such as sex, weight, age, thickness and exposure parameters: kilovolt peak (kVp), milliampe seconds (mAs), focus to skin distance (FSD) and back scatter factor (BSF) are all recorded and to determined the ESD of 50 adult patients for each skull, chest and abdomen X-ray examinations was measured. The result showed that the mean entrance surface dose (ESD) for skull AP/PA is 6.5±08 mGy, chest PA 0.6±0.02 mGy, chest LAT 2.0±0.03 mGy and abdomen AP is 5.0±0.20 mGy. The international standard reference values for International Atomic Energy Agency (IAEA) and National Radiation Protection Board (NRPB) were 2.5/5.0 mGy for skull AP/PA, 0.2/0.3 mGy for chest PA, 1.5 mGy for chest LAT and 5.0/10 mGy for abdomen. This implies that the ESD values obtained from this result for AP abdomen X-ray examination lies within the required diagnostic reference values. Whereas the ESD values obtained for skull and chest X-ray examination are higher than the diagnostic reference values as given by IAEA and NRPB. The results also showed that the ESDs received by patients undergoing AP/PA skull and PA/LAT chest x-ray examinations using conventional x-ray machine are higher than the guidance levels set by radiation protection bodies, while for an AP abdomen examination, the value of ESD lies within the required guidance levels. Thus, there is need to optimize the practice so as to reduce the radiation dose received by patients undergoing X-ray examination in Federal Neuropsychiatric Hospital Maiduguri.*

Key Word*: Ionizing radiation; X-rays; entrance surface dose; Radiography; diagnostic.*

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I. Introduction

Humans have always been exposed to natural or artificial radiation. Radiation is energy that travels through space or matter in the form of a particle (alpha and beta) or wave (X-rays and gamma rays). X-ray radiation transfers a certain amount of energy, which is dangerous, when interacts with the biological system. The energy transferred has the ability to break apart biologically important molecules such as DNA in exposed cells and can cause harm. Increasing application of X-ray radiation in radiography involves some risk of developing cancer. Radiation protection is concerned with the control of the manner in which sources of ionizing radiation, such as X-rays, are used so that the user of the sources and also members of the public are not irradiated above acceptable levels recommended by the International Commission on Radiological Protection (ICRP). Thus, the radiation received by radiographic patients who is frequently undergoing X-ray examinations has to be quantified. Recently, great attention has been paid to monitor and estimate the dose limits of public exposure to X-ray in order to provide an appropriate protection of patients/workers [1-8]. Quality control and dose measurement are used to figure out on what amount of radiation exposure has occurred during diagnosis. These help the physician and physicist to inspect the level of radiation dose received by the patient during the radiological examination and to prevent the excess health risk of exposure [6,9-10]. This study aimed at determining the entrance surface dose (ESD) of patients undergoing skull, chest and abdomen X-ray examinations in federal neuropsychiatric hospital Maiduguri.

The discovery of X-rays by Wilhelm Conrad Rontgen in 1895 has revolutionized medical care. Now-a-days, diagnostic X-ray examinations play a significant role in identifying diseases and other problems during medical examinations both in developed and developing countries. Diagnostic X-ray examinations produce images of patients with essential details and sufficient image quality so as to guide practitioners for effective and efficient diagnosis and treatment of various disease conditions. However, due to the ionizing nature of the X-rays, its increasing application involves some potential health risks to patient being exposed. Various parameters are used to estimate detriment from cancer and genetic effects caused by X-ray radiation. It should be noted that the patient dosimetery is dependent on the quality of the radiological image and therefore of the dose at the entrance surface of the skin. Patient dosimetery is a functional operation parameter such as high voltage or kilovolt (kV_p), current intensity or milli-amperage (*mAs*), morphotype, postero-anterior (PA), antero-posterior (AP), focus-skin distance (FSD), filtration and thickness. The patient dose is usually specified by means of determining the ESD for patient being exposed to diagnostic X-rays. The ESD is one of the important parameter in evaluating the dose received by a patient in radiography. It is the basic criterion for comparing dose received by patient with other international reference dose levels. In conventional radiography, ESD can be obtained either by direct measurements using thermoluminescent dosimeters stacked on the patient's skin or indirectly via mathematical model calculations based on the X-ray machine output. These methods have relatively small differences. Application of thermoluminescent dosimeters in measuring the ESD involves time consuming and using special equipments which may not be available at the most radiographic centers. The mathematical method appears reliable and is an effective alternative for measuring the entrance skin dose [11-12].

II. Material And Methods

This work covered a total of 150 adult patients, 50 for each skull, chest and abdomen X-ray examinations in Federal Neuropsychiatric Hospital Maiduguri. The X-ray machine used for the study is Siemens with minimum inherent filtration Aluminum equivalent 2 *mm Al*/75. The accuracy of the machine was tested by standard quality control at the beginning of radiological examination. Demographic information of patient such as sex, age, weight and thickness were recorded. The gender distribution of the research participants in the study group was presented in Table 1 with 87 (58%) males and 63 (42%) females.

Table 1: The gender distribution of the research participants

Sex	Frequency	Percentage (%)
Male	87	58
Female	63	42
Total	**150**	**100**

III. Result

The corresponding exposure parameters: time of exposure, kilovolt peak (*kVp*), mili-ampere second (*mAs*), focus to skin distance (FSD) and back scatter factor (BSF) were recorded during the procedure and the values are presented in Table 2. The Tung and Tsai, (2014) equation was then applied to determine the entrance surface dose (ESD) by making some substitution [13]:

$$\mathrm{ESD}(mGy) = \mathrm{OP} \times \left(\frac{Kvp}{80}\right)^2 \times \left(\frac{100}{\mathrm{FSD}}\right)^2 mAs \times \mathrm{BSF} \qquad (1)$$

where OP is tube output measured in *mGy/mAs*, *kVp* is peak tube voltage applied, FSD is focus-to-skin distance (distance between X-ray tube and patient skin) measured in *cm*, *mAs* is exposure current (the product of the tube current (*mA*) and the exposure time (*s*) and BSF is back scatter factor. The data obtained was analyzed using excel 2016 and presented in Table 3. It can be observed from Table 3 that the mean values obtained for ESD for skull AP/PA is 6.5±0.08 *mGy*, chest PA 0.6±0.02 *mGy*, chest LAT. 2.0±0.03 *mGy* and abdomen AP is 5.0±0.20 *mGy* respectively. The results obtained are then compared with the mean values obtained from other related work.

Table 2: Summary of X-ray examination technique procedures from conventional radiography examination

Radiograph	Projection	No. of Patients		Mean Exposure parameter	
		Male	Female	*kVp*	*mAs*
Skull	AP/PA	32	18	75	26
Chest	PA	17	13	85	5
Chest	LAT.	12	08	80	5
Abdomen	AP	26	24	80	31

Table 3: Comparison of the present work with established international DRLs

Radiograph	Projection	Mean ESD (*mGy*)				
		Present Study	**Taha *et. al.* [14]**	**Musa *et. al.* [15]**	**IAEA [16]**	**NRPB [17]**
Skull	AP/PA	6.5±0.08	2.10±0.12	3.72±0.21	2.50	5.0
Chest	PA	0.6±0.02	0.14±0.04	0.24±0.01	0.20	0.3
Chest	LAT	2.0±0.03	-	-	1.50	1.5
Abdomen	AP	5.0±0.20	2.50±0.14	4.77±0.26	5.00	10

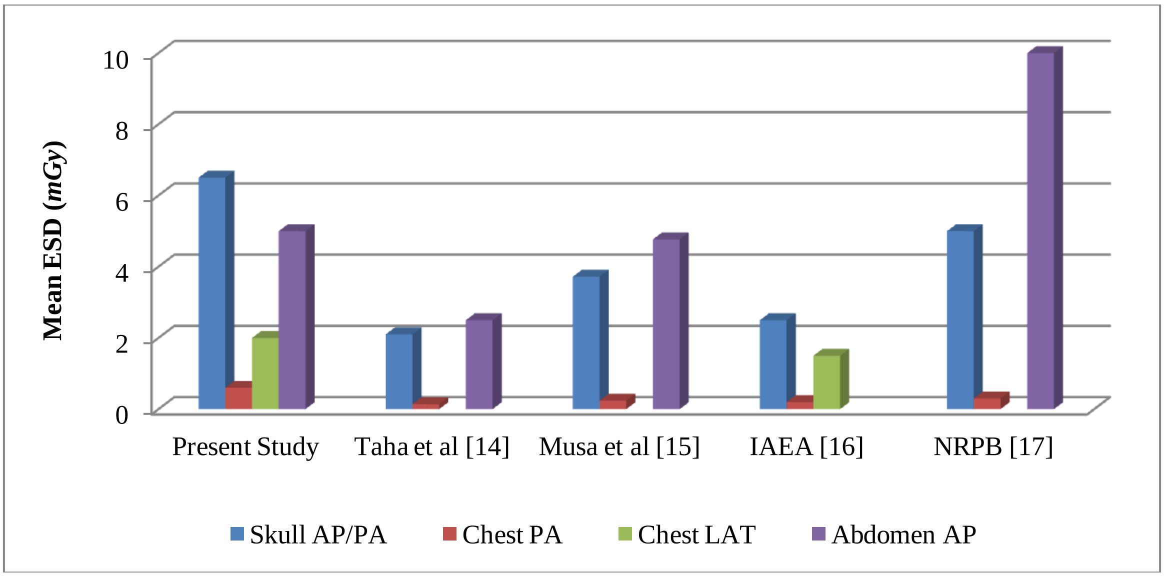

Figure 1: Comparison of the present work with established international DRLs

IV. Discussion

Figure 1 showed the bar chart of comparison of the present study with international diagnostic reference values IAEA (2007) and NRPB (2000). The international standard reference values for International Atomic Energy Agency (IAEA) and National Radiation Protection Board (NRPB) were 2.5/5.0 *mGy* for skull AP/PA, 0.2/0.3 *mGy* for chest PA, 1.5 *mGy* for chest LAT and 5.0/10 *mGy* for abdomen. The results obtained showed that ESD, for patient undergoing AP abdomen X-ray examination in Federal Neuropsychiatric Hospital Maiduguri, lies within the required diagnostic reference value. Whereas the ESD values for patient undergoing skull and chest X-ray examination in Federal Neuropsychiatric Hospital Maiduguri is higher than the diagnostic reference values given by IAEA (2007) and NRPB (2000).

V. Conclusion

The results presented in this research work indicated that the ESDs received by patients undergoing AP/PA skull and PA/LAT chest x-ray examinations using conventional X-ray machine are higher than the guidance levels set by radiation protection bodies, while for an AP abdomen examination, the value of ESD lies within the required guidance levels.

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