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ENTRANCE SKIN DOSE (ESD) IN PATIENTS UNDERGOING FOREARM X-RAYS AT THE TARABA STATE SPECIALIST HOSPITAL, JALINGO, TARABA STATE

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ABSTRACT

This research is a means of quality control on radiation exposure because it investigates the rate at which patients undergoing forearm X-rays at the Taraba State Specialist Hospital Jalingo, Taraba State are exposed to through the measurement of their Entrance Skin Dose (ESD). The Entrance Skin Dose (ESD) for patients undergoing forearm X-rays was calculated using Edmond's 1984 formula for children with and without POP and adults with and without POP using X-ray exposure data collected for 40 patients, 20 for each age group and 10 for each category. The calculated Entrance Skin Dose (ESD) range from 0.2591mGy to 0.3440mGy for children without POP, 0.3487mGy to 0.4660mGy for children with POP, 0.35586mGy to 0.5980mGy for adults without POP and 0.5013mGy and 0.7526mGy for adults with POP. The maximum mean Entrance Skin Dose (ESD) of 0.5965mGy obtained is below the NNRA standard of 1mGy for a period of one year and does not pose any significant effect on patients undergoing forearm X-rays in the hospital. From the results, even though the estimated Entrance Skin Dose (ESD) is within NNRA's yearly limit, unavoidable exposures should be administered considering the NNRA's 5mGy for five years period when necessary while adhering to the ALARA principle of As Low as Reasonably Achievable.

Keywords: X-rays, Entrance-Skin-Dose, Radiation, Forearm, Exposures

1 INTRODUCTION

Ionizing radiation is a form of radiation with sufficient energy to remove electrons from their atomic or molecular orbital shells in the tissues they penetrate (CNSC, 2012b). These ionizations received in sufficient quantities over a period of time can result in tissues damage and disruption of cellular functions at the molecular level. The dose delivered to tissue from ionizing radiation can either be acute (the energy from the radiation absorbed over a few hours or day) or chronic (the energy absorbed over a longer period of months years or over a lifetime). For radioactive materials with effective half-lives longer than a day, even if the intake are brief (minutes to a few days), the energy is deposited in tissue where it remains over a period longer than a few days, so that the exposure to the surrounding tissue is of a chronic duration. The healthy population would decline if ionizing radiation techniques were not available to diagnose diseases and detect trauma. Meanwhile there is no excuse for complacency and it is a basic premise of radiation protection practice that any exposure should be justified by weighing the potential harm against the perceived benefit (Ibrahim *et al.*, 2014 and NASA, 2014).

X-ray is the most frequently used ionizing radiation for diagnostic imaging and it plays a significant role in effective health care delivery both in developed and developing countries (Oluwafisoye *et al.*, 2009; and Joseph *et al.,* 2014). X-ray is said to be the major contributor to the collective effective dose of ionizing radiation to the general public (Personal and Public). The need for radiation dose assessment of the patients during diagnostic X-ray examinations has been highlighted by increasing knowledge of hazard of ionizing radiation (Olowookere *et al.*, 2012; and Joseph *et al.,* 2014). Because of the deleterious effect of X-rays, it is necessary to protect patients undergoing diagnostic and therapeutic procedures. The aim of any diagnostic X-ray examination is to produce images of sufficient and optimum quality. However, a good quality radiograph is not the one that is most appealing to the eye but, that in which sufficient details can be easily elicited.

In keeping radiation dose to patients to a minimum in hospitals, it is useful to be able to estimate prior to medical examinations the dose to patients as a function of radiographic exposure parameters (Ibrahim, *et al.,* 2014, Taha *et al.,* 2014, Joeseph, *et al.,* 2014). According to Ibrahim *et al*. (2014) by Edmond's formula, radiation dose to patients from diagnostic X-ray machine assures a simple functional dependence on radiographic exposure parameters of tube potential (kVp), tube current and time of exposure (mAs), Source to Skin Distance (SSD) and filtration thickness. Monitoring of patients during the examination has been a major way of assessing radiation dose received in diagnostic and therapeutic radiography.

Joseph *et al.* (2014) further noted that for the purpose of optimization in radiation protection, dose delivered to patients during diagnosis is studied with assessment of image quality. This is a common practice in many parts of the world where patients with clinical cases requiring X-ray examination which are often times not properly done and it is largely due to lack of facilities and suitable qualified personnel, as a result, there is no sufficient information about patient's radiation dose.

Patient's dose has often been described by the Entrance Skin Dose (ESD) as measured in the centre of X-ray beam. The ESD is a measure of the radiation dose absorbed by the skin where the X-ray beam enters the patient. Because of the simplicity of its measurement, ESD is considered widely as the index to be assessed and monitored. ESD is measured directly using thermo luminescent dosimeter (TLD) placed on the skin of the patient's or indirectly from measurements of dose area products using a large area transmission ionization.

In the early 1990s, the United States Food and Drug Administration (FDA) received reports of significant radiation induced skin injuries associated with interventional fluoroscopy prompting the release in 1994 and 1995 of the guideline publications on documenting radiation use (Amis *et al.*, 2007). A number of professional radiological societies, including Society of Interventional Radiology (SIR) have been working since then to reduce the frequency of these events. In 2007, the American College of Radiology (ACR) published its recommendations on issues related to patient's radiation exposure in medicine. The document focused mostly on diagnostic imaging procedures.

In radiological exposure, a periodic dose assessment should be made to enhance the optimization of the radiation protection of the patients and to deliver minimum dose to the examinations. Dose measurements are required to comply with some international guidelines and regulations. (Stecker *et al.*, 2009).

In this research, ESDs for some patients undergoing forearm X-rays at the Taraba State Specialist Hospital, Jalingo were measured by method of X-rays output factors.

2 MATERIALS AND METHOD

The X-ray machine at FMC Jalingo is the General Electrical AMX-4 model with a source to skin distance (SSD) of 90cm and a filtration thickness of 2.0mmAl. With an exposure range of 12 – 15s and the focal spot reduced to small so as to cover just the forearm and reduce scattered radiation as the elbow was placed at 90^0 and the forearm placed against the cassette, the transparent positioning aid was centred on the cassette and the dominate forearm was placed on it. The forearm was then slightly positioned in ulna deviation so that it fell along a straight line before the patient was exposed to the radiation in which could either be anterior-posterior, posterior-anterior or lateral.

The survey method in this work was based on the guidelines established by the Nigerian Nuclear Regulatory Authority (NNRA). The skin dose to patients was determined by calculation from the X-ray tube parameters and exposure radiographic parameters using Edmonds (1984) skin dose formula which is given as:

$$Skin\ Dose(\mu Gy) = 418(kVp)^{1.74} \times mAs\,\frac{\left(\frac{1}{T}+0.114\right)}{(SSD)^2} \quad (1)$$

Where kVp is the peak voltage responsible for the quality of penetration, mAs is the tube current and exposure time responsible for quantity of electrons from the filament, T is the total filtration of the beams always a constant for each X-ray machine type and SSD is source to skin distance.

The sampling population/size used in this research was 40 patients which was broken into 10 samples for children without POP, 10 samples for children with POP, 10 samples for adults without POP and 10 samples for adults with POP

3 RESULTS AND DISCUSSION

The results obtained from this research is presented in Tables 1 and 2 below. The maximum mean Entrance Skin Dose recorded was 0.5965mGy which was for adults with POP and this is due to the age and body size of patients exposed to ionizing radiation in this hospital as well as the filtration thickness used in this hospital which is 2.0mmAl.

The column chart in Figure 1.0 below indicates that the Entrance Skin Dose (ESD) increases with POP and with age. Even though the mean Entrance Skin Dose (ESD) for the Taraba State Specialist Hospital, Jalingo could be high when compared to some other hospitals, it is not above the 1mGy per annum of NNRA standard. Also from this results, children with POP could be exposed at most twice in a year while children without POP could make use of this facility up to three times maximum in a year and will still be within the NNRA's 1mGy per year limit considering the fact that children are more likely to incur fractures, broken arms and dislocations from playgrounds, etc., as any exposure above this could increase the patients risk level to effects of X-ray radiations. Adults with or without POP who wish to make use of the X-ray machine at the Taraba State Specialist Hospital, Jalingo can be exposed only once for a period of a year as exposures above this may place the patients at risk of effect of high exposure to X-ray radiations.

However, when need for higher or more frequent exposures to X-rays as discussed above for a period of one year from the hospital arises, patients could be exposed to X-rays bearing in mind that the 5mGy limit for a duration of 5years must not be exceeded.

Table 1: X-ray Entrance Skin Dose (ESD) on Children with and without POP.

TARABA STATE SPECIALIST HOSPITAL, JALINGO							
AGE 0-18							
Children without POP				**Children with POP**			
Peak kilo-voltage (kVp) (kV)	**Exposure Current-Time (mAs)**	**Entrance Skin Dose (mGy)**	**Mean Entrance Skin Dose (mGy)**	**Peak kilo-voltage (kVp) (kV)**	**Exposure Current-Time (mAs)**	**Entrance Skin Dose (mGy)**	**Mean Entrance Skin Dose (mGy)**
45.0000	13.0000	0.3100		52.0000	15.2000	0.4662	
44.0000	11.3000	0.2591		50.0000	14.0000	0.4011	
45.0000	11.0000	0.2623		49.0000	16.0000	0.4425	
45.0000	12.0000	0.2861		51.0000	14.2000	0.4210	
50.0000	10.0000	0.2865	0.2684	54.0000	12.0000	0.3930	0.3923
44.0000	13.0000	0.2981		53.0000	11.0000	0.3487	
46.0000	12.8000	0.3172		53.0000	11.6000	0.3678	
42.0000	15.0000	0.3173		53.0000	11.0000	0.3487	
49.0000	10.9000	0.3014		50.0000	13.0000	0.3724	
44.0000	15.0000	0.3440		53.0000	11.4000	0.3614	

Table 2: X-ray Entrance Skin Dose (ESD) on Adult with and without POP.

TARABA STATE SPECIALIST HOSPITAL, JALINGO							
AGE 19-70							
Adult without POP				**Adult with POP**			
Peak kilo-voltage (kVp) (kV)	**Exposure Current-Time (mAs)**	**Entrance Skin Dose (mGy)**	**Mean Entrance Skin Dose (mGy)**	**Peak kilo-voltage (kVp) (kV)**	**Exposure Current-Time (mAs)**	**Entrance Skin Dose (mGy)**	**Mean Entrance Skin Dose (mGy)**
60.0000	15.2000	0.5980		63.0000	17.0000	0.7280	
63.0000	13.0000	0.5567		69.0000	15.0000	0.7526	
50.0000	16.0000	0.4583		67.0000	15.4000	0.7341	
51.0000	14.0000	0.4151		63.0000	17.0000	0.7280	
65.0000	11.3000	0.5110	0.4650	62.0000	16.3000	0.6789	0.5965
54.0000	14.0000	0.4585		62.0000	16.0000	0.6664	
51.0000	15.4000	0.4566		50.0000	18.0000	0.5156	
51.0000	12.0000	0.3558		67.0000	14.0000	0.6673	
50.0000	15.6000	0.4469		62.0000	15.9000	0.6622	
60.0000	10.0000	0.3934		50.0000	17.5000	0.5013	

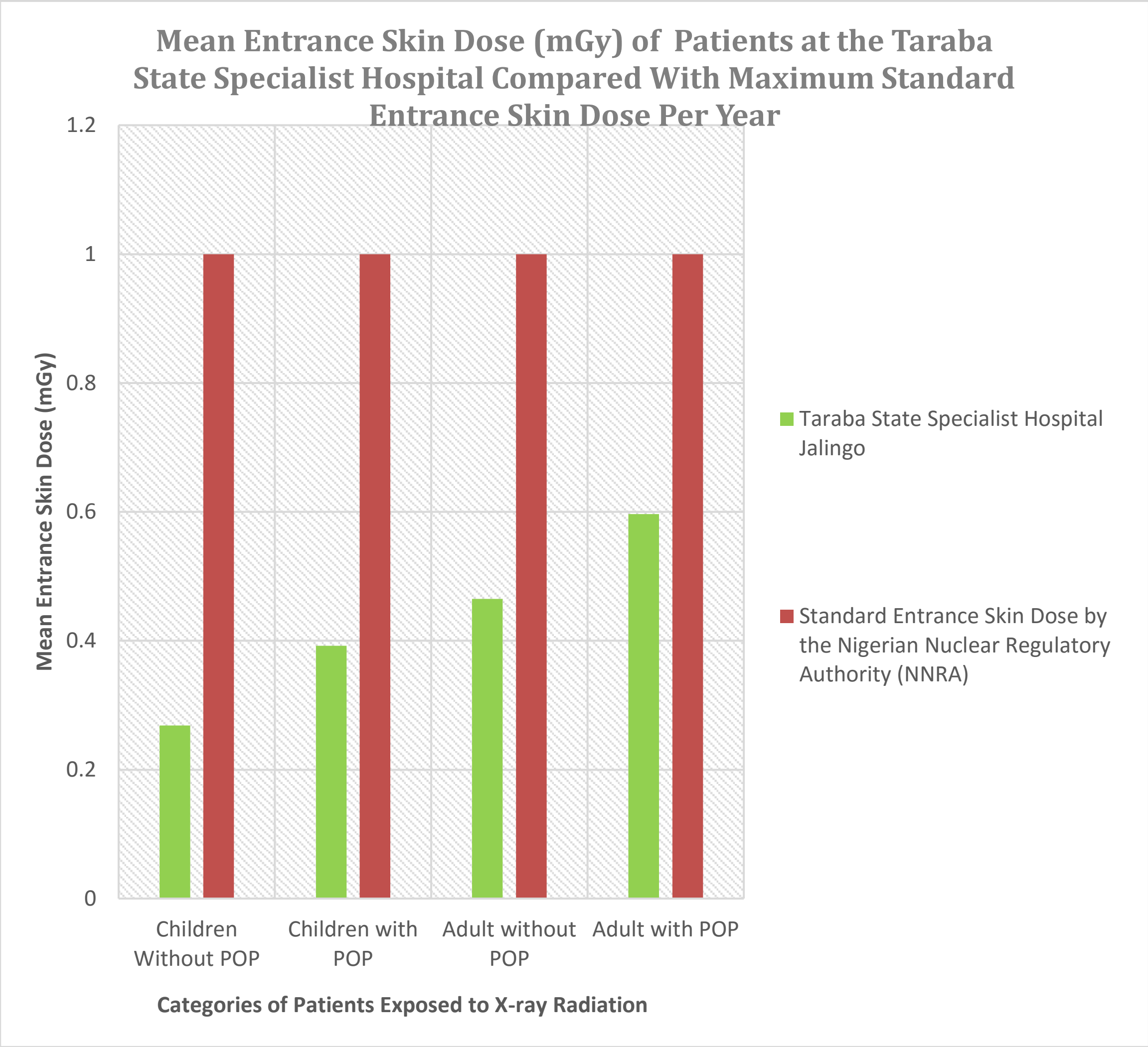

Figure 1: Chart of Mean Entrance Skin Dose (mGy) at the Taraba State Specialist Hospital grouped according to age with or without POP.

4 CONCLUSION

Results presented in this research indicates that Entrance Skin Dose (ESD) received by patients undergoing forearm X-rays at the Taraba State Specialist Hospital, Jalingo is not above the 1mGy standard guideline of the Nigerian Nuclear Regulatory Agency (NNRA) for a year, and exposure of patients to X-rays at such rate can be done more than once in a year for children with and without POP. The maximum mean Entrance Skin Dose (ESD) recorded is 0.5965mGy for adults with POP and this rate can only exceed 1mGy if patients are exposed up to twice in a year.

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