JRRS

JOURNAL OF RADIOGRAPHY & RADIATION SCIENCES

OFFICIAL JOURNAL OF THE ASSOCIATION OF RADIOGRAPHERS OF NIGERIA (ARN)

ISSUE 1, VOL 33, MAY 2019/ ISSN:1115-7976

Patient X-Ray Entrance Surface Dose at a Tertiary Hospital in Sokoto, North-West Nigeria

Akpaniwo G. Mfoniso,* Suleiman A. Munir, Nwobi I. Chigozie[1], Yunusa G. Haruna[2], Sadiq A. Abubakar, Abubakar Umar, Mohammed Abacha, Iliyasu Y. Izge

Department of Radiography, Usmanu Danfodiyo University, Sokoto, Nigeria

[1]Department of Medical Radiography, University of Maiduguri, Borno State, Nigeria

[2]Department of Radiology, Usmanu Danfodiyo University Teaching Hospital, Sokoto, Nigeria.

*Corresponding author: *akpaniwo@gmail.com*, +2348140946558

Received: 27 March, 2019. Received in revised form: 26 April, 2019. Accepted: 20 May, 2019

ABSTRACT

Background: The entrance surface dose (ESD) has been used to determine the diagnostic reference levels (DRL) by regulatory bodies to help medical radiation workers to checkmate excessive dose to patients.

Objective: To peer review practice in our centre using recommended diagnostic reference levels (DRLs) as standard.

Methods: A prospective cross-sectional study of fifty x-ray patients who had thermoluminescent dosimeters (TLD-100) taped on their skin to quantify entrance surface dose (ESD) during x-ray investigation. The patients appeared in Radiology Department of Usmanu Danfodiyo University Teaching Hospital (UDUTH), Sokoto between 1st August and 30th September 2018. Their weights and heights were measured directly. Thereafter, they were divided into 5 groups of ten each for five specific anatomical areas: PA chest, AP of pelvis, abdomen, lumbosacral spine, and lateral lumbosacral spine. Irradiated TLDs were read, and the mean ESD was calculated.

Results: Entrance surface dose (ESD) was 0.26 mGy (chest), 0.46 mGy (AP lumbosacral), 0.71 mGy (pelvis), 1.3 mGy (abdomen), and 1.6 mGy (lateral lumbosacral). The ESD values were found to be lower than similar studies carried out in Nigeria, as well as diagnostic reference levels in UK.

Conclusion: Optimization of patient protection in UDUTH was comparable to recommended practices locally and internationally.

Keywords: Entrance surface dose, Diagnostic reference level, Thermoluminescent dosimeters

Introduction

Medical exposure of patients to ionizing radiation has immense benefits. Nonetheless, due to potential hazards that may arise, it is necessary to develop strategies to quantify the amount of radiation patients are exposed to in order to review optimization strategies [1]. The International Commission on Radiological Protection (ICRP) placed a moral obligation on radiation personnel to ensure that medical exposures are justified, optimized and limited [2, 3]. In Nigeria, there are specific efforts by government to ensure that patients' irradiation is carried out within the confines of standards of practice [4].

To effectively protect patients undergoing medical radiation exposure, constant periodic monitoring via dosimetry has become an imperative. Dosimetry provides information regarding the level of doses and optimization of protection for patients undertaking radiographic examinations [5]. Gray is the unit of absorbed dose, and when risk assessment is comtemplated, it is converted to effective dose in Sieverts. Specific concepts for dose estimation are applied to different modalities. Computed tomography benefits from volumetric computed tomography dose index (CTDIvol) and dose-length products (DLP), dose-area product (DAP) and mean glandular dose (MGD) are peculiar to fluoroscopy and mammography. Conventional radiography which is the modality for this work benefits more frequently from entrance surface dose (ESD) and exit surface dose [3, 6, 7, 8].

As part of measures to address radiation dose in Nigeria, several works have been undertaken cutting across different modalities with noticeable variations across facilities [6 - 11]. Variability for similar modalities and similar procedures often justifies the establishment of diagnostic reference levels (DRLs) [6, 8]. From the review of local literature, entrance surface doses from our environment are much lower than 1 mGy and not higher than 10 mGy [7, 9, 11].

Unlike other facilities, ours did not benefit from multiple dose research. This study was aimed at establishing preliminary dose optimization practice at the Radiology Department of Usmanu Danfodio University Teaching Hospital, (UDUTH) Sokoto. The result may be useful to researchers and regulatory authorities.

Materials and methods

A prospective cross-sectional study of 50 adult patients selected from a pool of those referred to Radiology Department of UDUTH, Sokoto for x-ray of chest, pelvis, abdomen, and lumbosacral (AP and lateral) between 1st August to 30th September 2018. The Research Ethics Committee of UDUTH approved the study. The leadership of Department of Radiography, UDUTH, equally granted permission. A non-probability, convenience-sampling technique was employed for this study whereby only adult patients who gave consent were enlisted for the study. In addition, they must be aged eighteen years or more. Ill and younger patients were excluded. Heights and weights of patients were determined by direct measurements using metre rule and electronic bathroom weighing scale. Patients whose average weight were lower or higher than 60 – 80 kg were excluded, in keeping with the recommendation of ICRP for weight standardization [2]. Body mass indices (BMI) were calculated from weight and height (kg/m^2). The 50 patients were divided into five groups of ten each [12] for five specific projections.

Radiation source was by a static, dual-foci x-ray machine manufactured by Varian Medical System (Salt Lake City, UTAH, USA) in July 2007 and installed in our centre in 2010. It had a maximum tube potential and current of 150 kVp and 630 mAs and total filteration of 2.6 mmAl. Detectors were film-screen system (cassettes). Thermoluminescent dosimeters (TLD-100) were used to measure the entrance surface dose to patients. The TLDs (lithium-fluoride crystals) were annealed at the Centre for Energy Research and Training (CERT), Ahmadu Bello University, Zaria, Nigeria. at 400^{o}C for 1 hour and then 800^{o}C for 18 hours using Harshaw 4500 dual TLD reader produced by Thermo-Fischer Scientific Inc. Annealing removes residual electrons within electron traps. After annealing, the TLDs were calibrated to diagnostic energy levels using cobalt 60 radiation source. The TLDs were carefully placed on the entrance surface of the patient and held down by gravity on areas that will not obscure the region of interest.

Three radiographers with ≥ 3 years' experience and who were fully registered with Radiographers Registration Board of Nigeria (RRBN), assisted in carrying out the selected radiographic examination of patients. The focus-to-skin distance and focus-to-film distance were recorded for each patient. The mean ESD of the 10 patients were used to represent ESD for each projection.

Results

Biometric information are shown in Table 1, while technical parameters for each of the examinations are shown in Table 2. Table 3 is descriptive statistics of ESD in mGy obtained in the study. The mean ESD were between 0.26m Gy to 1.6 mGy. Figures i – iii are comparative analysis of kVp, mAs and ESD.

Table 1: Patient biometric variables for the selected radiographic procedure

Examination	Gender		Age	Weight (kg)	Height (cm)	BMI (kg/m^2)
	Male	Female				
Chest PA	5	5	38 (22-63)	70 (47 - 91)	168 (156 -181)	25.1 (17.2 - 33.9)
Abdomen AP (supine)	6	4	42 (23-55)	71 (51- 89)	165 (151-175)	26.2 (18.6 - 33.6)
Pelvis	6	4	29 (23-40)	63 (50 -75)	163 (152 -171)	24.0 (19.8 - 31.1)
Lumbosacral AP	5	5	35 (18-60)	63 (44 - 88)	164 (150 -183)	23.4 (19.2 - 31.1)
Lumbosacral lateral	5	5	39 (28-60)	63 (49 - 88)	164 (151-183)	23.8 (19.2-31.1)

Table 2: Mean and range values of technical parameters for the examinations

Examination	Tube Potential kVp	Tube current-time product (mAs)	Focus-Film-Distance (cm)	Focus-Skin-Distance (cm)
Chest PA	72.8 (67-76)	11.5 (10-12.5)	165 (150-180)	141.7 (122.8-160)
Abdomen AP (supine)	84.9 (80-90)	16.8 (16-20)	104.4(100-110)	71.4 (73.3-87)
Pelvis	78 (70-85)	12.6 (10-16)	102.4 (100-112)	76.7 (72.3-80.8)
Lumbosacral AP	83.1 (15.8)	15.8 (12.5-20)	103.5 (100-110)	75.3 (71.5-78.3)
Lumbosacral lateral	91.9 (82-98)	21.5 (12.5-25)	108.5 (100-110)	75.7 (68-80)

Table 3: Range and mean of entrance surface dose (mGy)

Examination	Number of patients (n)	Minimum (mGy)	Maximum (mGy)	Mean ± SD (mGy)
Chest PA	10	0.1	0.37	0.26 ± 0.09
Lumbosacral AP	10	0.19	0.71	0.46 ± 0.2
Pelvis	10	0.39	1.66	0.71 ± 0.38
Abdomen AP (Supine)	10	0.21	2.97	1.30 ± 0.81
Lumbosacral lateral	10	0.15	6.14	1.6 ± 2.02

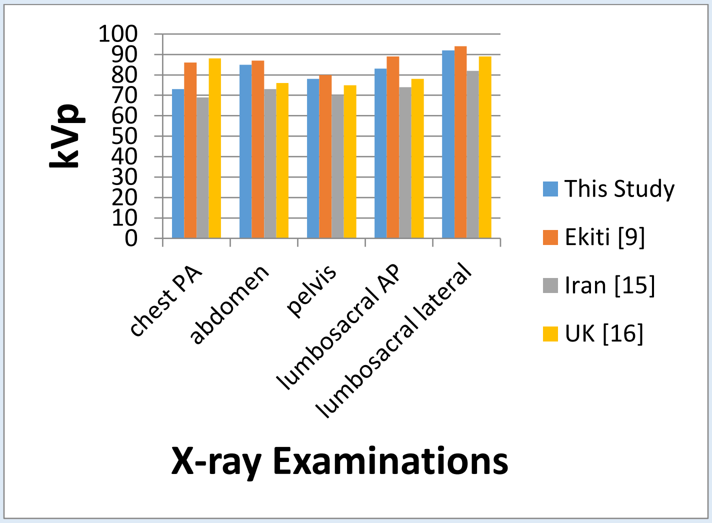

Figure i. Comparison of kVp amongst authors

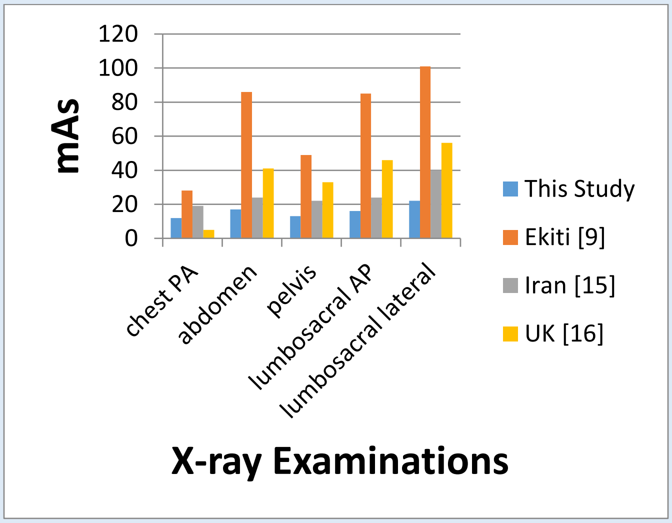

Figure ii. Comparison of mAs amongst authors

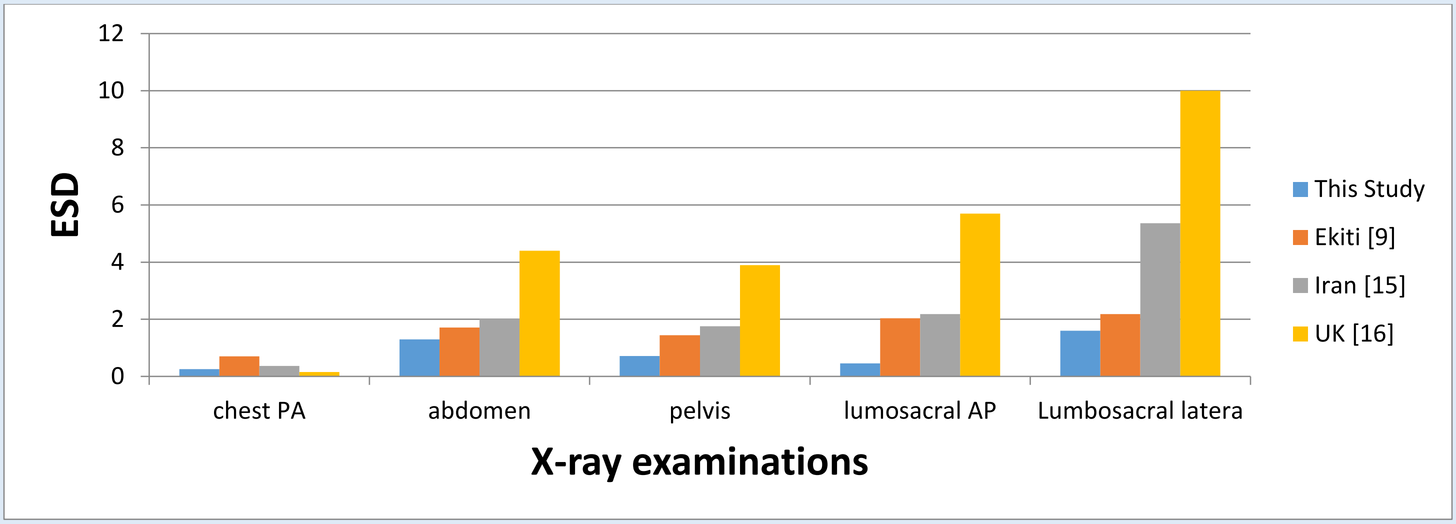

Figure iii: Comparison of ESD of present work with others

Discussion

In order to peer review practice in our facility, entrance surface doses (ESD) received by patients were surveyed. The results of the study revealed the ESD for PA adult chest x-ray to be between 0.1 mGy to 0.37 mGy with a mean of 0.26 mGy. This is lower than values reported in some studies within the country [7, 9, 11, 13], in an African country [14] and other non-African studies where 75th percentile were reported [15, 16].

The mean ESD for the abdomen was 1.30 mGy, and with a range of 0.21 mGy to 2.97 mGy. The mean value was also lower than the 4.7 mGy derived in a foreign country [16]. The difference is due to cut off value as the 3rd quartile was adopted whereas we used the mean. That our mean value fell below the 3rd quartile gives some hope of good practice.

Furthermore, the mean ESD for pelvis was 0.71 mGy with a range of 0.39 to 1.66 mGy. Values for lumbosacral AP (0.46 mGy) and lateral (1.6 mGy) were also derived in this present work. These values are lower than a 3rd quartile value of 3.6 – 11.7 mGy [16], and mean range 3.6 – 6.2 mGy [13] derived in similar works.

In this study, the mean ESDs observed were highest in lateral lumbosacral (1.6 mGy) and the lowest values were seen in chest PA (0.26 mGy). The FFD and FSD as shown in Table 3, were highest in chest PA, which is partly why the dose measured were lowest in accordance with the inverse square law. A continual dose assessment and monitoring just like that carried out in the United Kingdom and other nations is [2, 3] necessary in UDUTH to ensure substantial dose reduction and patient protection.

Conclusion

Optimization of patient protection in UDUTH was comparable to recommended practices locally and internationally.

Conflict of interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

References

1. Egbe NO, Inyang SO, Ibeagwa OB, Chiaghanam NO. Pediatric radiography entrance doses for some routine procedures in three hospitals within eastern Nigeria. J Med Phys, 2008; 33(1): 29 – 34.

2. ICRP. Recommendations of the International Commission on Radiological Protection. ICRP publication 60. Ann ICRP 1991; 21:1- 3.

3. ICRP. Radiological protection and safety in medicine. ICRP publication 73. Ann ICRP 1996; 26:1- 47.

4. Nigerian Nuclear Regulatory Authority. Nigerian Radiation Safety Regulation for Diagnostic and Interventional Radiology Practice. 2006; 19: 1-33.

5. Joseph DZ, Chinedu O, Nkubli, FB, Luntsi G, Shem SL, Dlama Y. Rationale for Implementing Dose Reference Level as a Quality Assurance Tool in Medical Radiography in Nigeria. IOSR Journal of Dental and Medical Sciences, 2014; 13(12): 41- 45.

6. Joseph DZ, Nzotta CC, Skam JD, Umar MS, Dambele MY. Diagnostic reference levels for mammography examinations in North Eastern Nigeria. African Journal of Medical and Health Sciences, 2018; 17(1): 54 – 59.

7. Akpochafor MO, Omojola AD, Adeneye SO, Aweda MA, Ajayi HB. Determination of reference dose levels among selected x‑ray centers in Lagos State, South‑West Nigeria. J Clin Sci 2016; 13:167‑172.

8. Ekpo E, Adejoh T, Akwo J, Onwujekwe EC, Ali AA, Abba M, Adesina K, Omiyi, D, Chiegwu HC. Diagnostic reference levels for common computed tomography (CT) examinations: results from the first Nigerian nationwide dose survey. Journal of Radiological Protection, 2018; 38:525 – 535.

9. Ezenma I, Isani B, Moi SA. Comparative study of patient entrance dose of two diagnostic centres in Ekiti state, Nigeria with diagnostic reference levels. Nigeria Journal of Medical Imaging and Radiation Therapy. 2013; 2(1): 23 – 29.

10. Nzotta CC, Egbe NO, Adejoh T, Nkubli FB, Ezeador IS. Radiation Dose from Exposure to Computed Tomography Scan of the Brain in a Reference Hospital in Nigeria. Pakistan Journal of Radiology, 2016; 26(2): 77-80.

11. Njiti MM, Nwobi IC, Garba I, Ahidjo A, Bashir T, Abubakar A, Hamidu AU., Luntsi G. Estimation of entrance surface dose to adult patients undergoing plain chest radiographic examinations in a Northern Nigeria population. Kanem Journal of Medical Sciences. 2014; (8)1: 27-32.

12. European Commission (EC). European guidelines on quality criteria for diagnostic radiographic images. Brussels, Luxembourg: EUR 16260-EN; 1996. Available at https://www.sprmn.pt/pdf/European Guidelineseur16260.pdf [Accessed on 29/5/2019].

13. Ishiekwen AC, Aliyu AS., Nwafor MS. X-Ray Dose Audit and Potential Local Diagnostic Reference Levels in Select Hospitals in Kaduna State, Nigeria. J Rad & Radiat Sci, 2018; 32(1):104 – 109.

14. Jumaa YT, Mohamed Y, Khadija M, Ahmed A, Abdelmoneim S. Assessment of entrance surface dose for patients from common radiology examinations in Sudan. Life Sci J, 2014;11(2):164 -168.

15. Gholami M, Maziar A, Khosravi HR, Ebrahimzadeh F, Mayahi S. Diagnostic reference levels for routine x-ray examinations in Lorestan Province, Iran. International Journal of Radiation Research 2015; 13(1): 85-90.

16. Hart D, Hillier MC, Shrimpton PC. Doses to patients from radiographic and fluoroscopic x-ray imaging procedures in the U.K:2010 review. Report number: HPA-CRCE–034, 2012;1-95.Available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/431134/HPA-RPD-029.pdf [Accessed on 29/5/2019]

How to cite: **Akpaniwo G.M., Suleiman A.M., Nwobi I.C., Yunusa G.H., Sadiq A.A., Abubakar U., Mohammed A., Iliyasu Y.I. Patient X-Ray Entrance Surface Dose at a Tertiary Hospital in Sokoto, North-West Nigeria. J Rad & Radiat Sci, 2019; 33 (1): 1 – 5**