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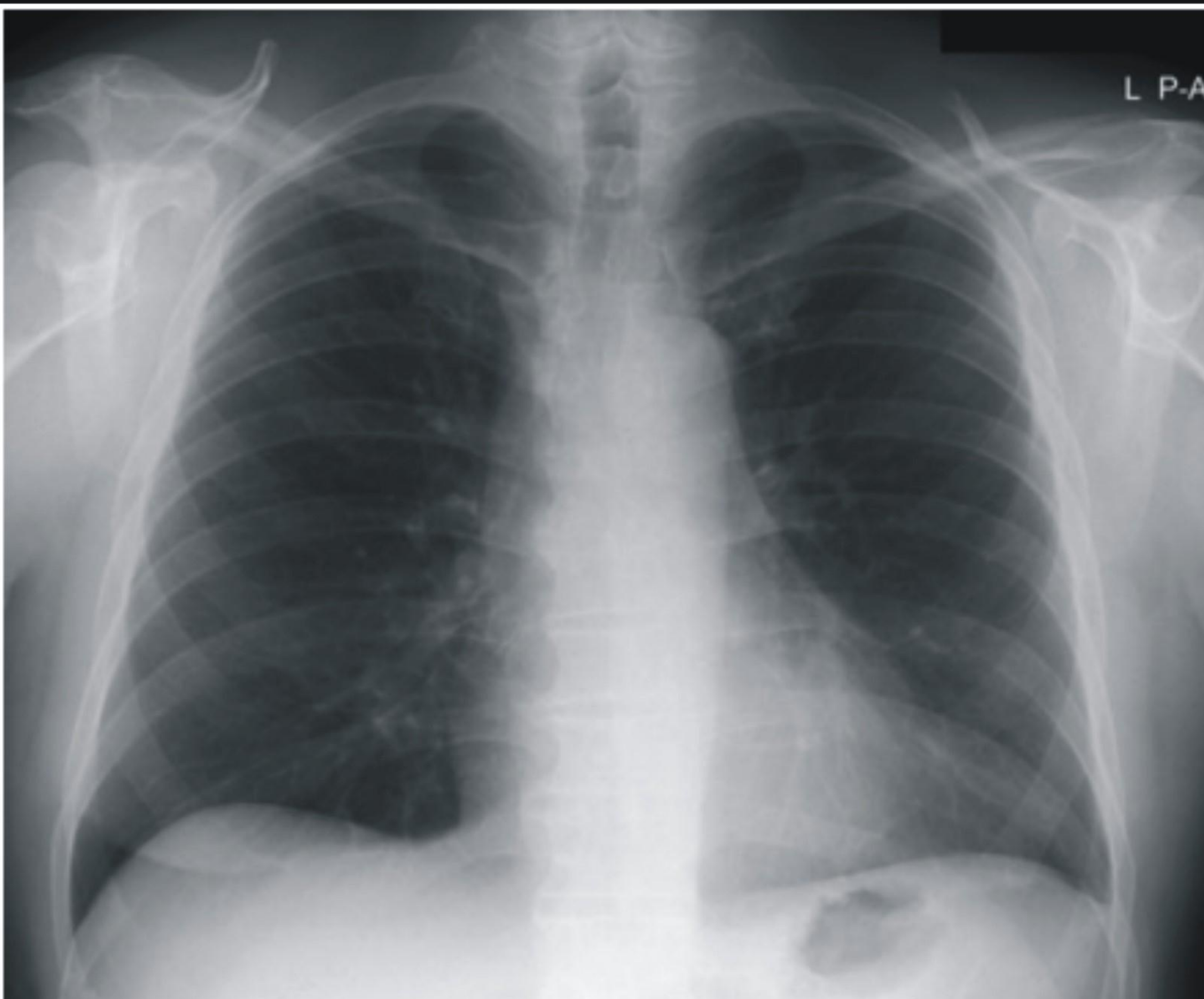

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X-Ray Dose Audit and Potential Local Diagnostic Reference Levels in Select Hospitals In Kaduna State, Nigeria

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ABSTRACT

Background: Dosimetry in diagnostic radiology is fundamental to providing information to practitioners regarding the level of their doses and to ensure adequate optimization of the protection of patients presenting for radiological examinations. The introduction and implementation of diagnostic reference levels (DRLs) in diagnostic radiology has proven to be a potent tool for quality control and dose reduction. This has not been comprehensively addressed in Nigeria.

Objective: To carryout dose audit of patients presenting for common radiographic projections in select hospitals in Kaduna State, Nigeria.

Methodology: Thermoluminescent dosimeters (TLDs) were used to measure entrance surface dose (ESD) on 420 randomly selected adult patients presenting for x-ray examination of the chest PA/Lateral, skull PA/Lateral, lumbar spine AP/Lateral, abdomen and pelvic AP, respectively. Results were compared with existing literature.

Results: The range of the mean ESD determined for the study population on various x-ray examinations were: chest PA (0.44 – 0.9 mGy), and lateral (0.9 – 1.5 mGy); skull PA (2.0 – 4.7 mGy), and lateral (1.7 – 3.4 mGy); lumbar spine AP (3.4 -7.8 mGy), and lateral (6.8 –11.3 mGy); abdomen AP (3.6 – 6.2 mGy); and pelvic AP (2.4 – 6.9 mGy). Comparison showed dose levels were below IAEA recommendations.

Conclusion: In the absence of arbitrary high doses, practice is generally safe and will not result in unwarranted hazards to the patients.

Key words: Dosimetry, Diagnostic Reference Levels, Optimization, Radiation Protection.

Introduction

Concerns about radiation dose to patients have been a major issue in the radiology service delivery [1]. Though, doses from diagnostic radiology are generally low, the magnitude of the practice can potentially cause negative radiation impact; Therefore, the control of exposure through the mechanisms of justification, optimization is crucial in minimizing the risk of adverse effects

[2].Dosimetry in diagnostic radiology is essential to give information to practitioners regarding the level of doses and to ensure adequate optimization of the protection of patients undertaking radiological examinations in the hospitals [3].

Diagnostic Reference Levels (DRLs) as a tool for dose reduction in diagnostic radiology have been defined as dose levels in medical radio-diagnostic practices or, in the case of radiopharmaceuticals, levels of activity, for typical examinations, for groups of standard sized patients or standard phantoms and for broadly defined types of equipment ICRP [4].

In Nigeria, in spite of the large number of examinations carried out yearly, the dose information available is grossly inadequate [5]. Although individual surveys have been carried out in some regions of the country, no coordinated effort have been made to establish national diagnostic reference levels. To normalize does protocols in Nigeria, the onus lies on relevant regulatory agencies to institute and harmonize a national dose survey with a view to establishing a diagnostic reference level.

The aim of the study was to carryout dose audit of patients presenting for common radiographic projections in the selected hospitals in Kaduna State through the measurement of entrance surfaces doses, determine dose reference levels for each radiology room, and compare with international DRLs for optimization of patients' protection.

Materials and Methods

The study was carried out in ABU teaching hospital, Zaria designated as (A), 44 Nigerian Army Reference hospital, Kaduna (B1 and B2), 461 Nigeria Air Force Hospital, Kaduna (C) and Barau Dikko Teaching Hospital, Kaduna (D).

Entrance surface dose (ESD) survey was quantified from 420 hospital subjects (222 males & 198 females) who came for x-ray investigations. Thermoluminescent dosimeter chips (TLD-100 LiF: Mg, Ti) which were calibrated and annealed using TLD reader (HASIO 4500) at the center for Energy Research and Training (CERT), Ahmadu Bello University, Zaria, were used as receptor for dose. The TLD chips were enclosed in small black radiolucent polythene sachets to shield them from sunlight and background radiation.

Subjects included were those aged ≥ 18 years and weighed 70 ± 10 kg [3, 6]. In addition, patients had justified request for medical exposure, were ambulatory and self-supporting, and gave consent to partake in the survey. The TLD chips were attached to the centering point on the patients for different anatomical regions with the aid of adhesive tape. After radiographic exposure, the TLD chips were detached from patients and labeled accordingly. When the examination involved two projections (AP and Lateral), a separate TLD chip was used for each view. For each anatomical region, 20 patients were involved. Technical parameters used for the examinations were also recorded. Data analyses were done using the statistical package for the social science (SPSS) version 20.00 and Microsoft excel 2010.

Results

The mean tube potential (kVp) and mean current (mAs) used for examinations in various centers are summarized in Table 1. Table 2 showed that the range of mean ESD measured for chest PA projection was 0.44 to 1.0 mGy and 0.9 to 1.7 mGy for the lateral. Table 3 showed that the mean values for skull PA/Lat were 2.0/1.7 to 4.7/3.4mGy, the mean value for L.spine AP/Lat recorded in Table 4 were 3.4/6.8 to 7.8/11mGy.

Table 5 indicates that the range of mean ESD obtained for abdomen and pelvis were 3.6 to 6.2 mGy and 2.4 to 6.9 mGy respectively. Table 6 show the range of 75th percentile of survey doses for various x-ray examinations conducted. These were, chest PA 0.5 to1.4 and lateral 0.9 – 1.7 mGy, skull PA/Lat 2.8 to 5.3/2.0 to 4.5 mGy, L. spine AP/Lat 5.4 to 8.3/7.4 to11 mGy, abdomen AP 4.6 to 8.1 mGy and pelvis 3.8 to 11 mGy. Values in bracket are percentage variation between this study and those indicated. Bold type figures are percentage lower.

Discussion

The audit of doses received by patients was done by evaluation of entrance surface dose (ESD) in chest, skull, lumbar spine, abdomen and pelvic x-ray examinations to check for procedures or facility with consistent and remarkable difference in level of doses delivered to patients. In Kaduna State, not much has been done in terms of estimation of radiation dose from medical application to the people. The results of each examination studied in the hospitals were profiled in a separate table.

Table 1: Summary of Patients' Mean Weight (kg) and Technical Factors Used for Examinations in the Hospitals

Examination	View	Patient's Weight	Mean kVp/mAs A	B1	B2	C	D	EC 1996
Chest	PA	69	89/5.9	110/2.6	77/10	67/8	71/56	125
	Lat		95/5.6	115/5.2	78/16	**	**	125
Skull	PA	73	76/5.0	72/4.9	79/8.5	64/31	**	70 - 85
	Lat		74/4.3	68/4.0	74/6.0	65/26	**	70 - 85
Lumbar	AP	71	72/34	86/37	78/32	74/30	**	75 - 90
Spine	Lat		86/36	92/23	81/36	80/27	**	80 - 95
Abdomen	AP	72	76/26	80/23	81/22	80/27	**	75 -90
Pelvis	AP	75	75/24	77/33	79/22	72/31	**	75 - 90

Table 2. Mean (Range) of ESD, 50th and 75th percentile (mGy) for Chest X-ray

Centre	View	Mean ESD (Range)	50th Percentile	75th Percentile
A	PA	0.52 (0.25-1.80)	0.45	0.66
	Lat	1.36 (0.9-1.70)	1.30	1.63
B1	PA	0.44 (0.20-0.68)	0.4	0,54
	Lat.	0.90 (0.48-0.90)	0.85	1.45
B2	PA	1.00 (0.42-2.00)	0.85	1.20
	Lat	1.70 (1.2-2.4)	1.60	2.00
C	PA	0.60 (0.4-1.2)	0.41	0.73
	Lat	**	**	**
D	PA	0.9 (0.47-3.65)	0.84	1.40
	Lat	**	**	**

** = No data collected.

Table 3. Mean ESD(Range), 50th and 75th Percentiles (mGy) for Skull

Centre	View	Mean ESD (Range)	50th Percentile	75th Percentile
A	PA	2.0 (1.75-4.0)	2.9	3.75
	Lat	1.9 (1.4-3.2)	2.0	2.5
B1	PA	2.2 (1.8-4.2)	2.3	2.8
	Lat	1.7 (1.2-3.0)	1.8	2.9
B2	PA	4.7 (2.9-6.8)	4.7	5.3
	Lat	3.4 (2.0-5.0)	3.6	4.1
C	PA	3.5 (2.1-5.0)	3.0	3.8
	Lat	2.0 (1.9-3.2)	2.2	3.1
D	**	**	**	**

** = No data collected.

Table 4. Mean ESD(Range), 50th and 75th Percentile (mGy) for Lumbar Spine X-ray

Centre	View	Mean ESD (Range)	50th Percentile	75th Percentile
A	AP	5.1 (3.4-7.6)	4.9	5.4
	Lat	7.1 (4.4-11)	5.8	7.8
B1	AP	3.4 (4.4-5.3)	4.5	6.2
	Lat	6.8 (5.1-14)	6.2	7.4
B2	AP	7.8 (4.8-12)	6.9	8.3
	Lat	9.9 (5.4-18)	7.5	10.6
C	AP	5.6 (4.2-8.4)	5.3	5.6
	Lat	11.3 (6.8-16)	7.6	9.7
D	**	**	**	**

** = No data collected

Table 5. Mean (Range) ESD, 50th and 75th Percentiles (mGy) for Abdomen and Pelvis

Centre	View	Mean ESD (Range)	50th Percentile	75th Percentile
A	Abdomen AP	3.6 (2.2-6.4)	3.4	4.6
	Pelvic AP	2.4 (2.2-4.8)	2.7	3.8
B1	Abdomen AP	4.9 (3.7-8.4)	4.0	6.0
	Pelvic AP	5.6 (2.8-8.4)	4.0	6.0
B2	Abdomen AP	6.2 (5.0-10)	7.3	8.5
	Pelvic AP	5.2 (3.5-12)	6.7	10.8
C	Abdomen AP	5.8 (3.6-9.4)	6.1	8.1
	Pelvic AP	6.9 (3.6-10.4)	4.9	6.8
D	**	**	**	**

** = No data collected

Table 6: Comparison of present studies with previous works

Exam	View	75th percentile of present study					Mean	Percentage variation (%) of other studies from mean of present study		
		This Study						Akpochofor *et al;* 2016	Joseph *et al;* 2017	IAEA 1996
		A	B1	B2	C	D				
Chest	PA	0.5	0.7	0.9	0.8	1.4	0.9	1.0 (10)	0.59 (**34**)	0.4 (**56**)
	Lat	1.4	0.9	1.7	**	**	1.3	**	1.02 (**22**)	1.5 (13)
Skull	PA	3.8	2.8	5.3	3.8	**	3.9	5.3 (26)	1.02 (**74**)	5.0 (22)
	Lat	2.5	2.0	4.5	3.1	**	3.0	4.1 (27)	1.01 (**66**)	3.0 (0)
L. Spine	AP	5.4	6.2	8.3	5.6	**	6.2	8.3 (25)	1.22 (**80**)	10 (38)
	Lat	7.8	7.4	11	9.7	**	9.0	10.6 (15)	1.59 (**83**)	30 (70)
Abdomen	AP	4.6	5.0	8.6	8.1	**	6.7	6.5 (**3**)	1.01 (**83**)	10 (33)
Pelvis	AP	3.8	5.2	11	6.8	**	6.7	5.0 (**1.5**)	0.82 (**88**)	10 (33)

** = No data collected

Discussion

The audit of doses received by patients was done by evaluation of entrance surface dose (ESD) in chest, skull, lumbar spine, abdomen and pelvic x-ray examinations to check for procedures or facility with consistent and remarkable difference in level of doses delivered to patients. In Kaduna State, not much has been done in terms of estimation of radiation dose from medical application to the people. The results of each examination studied in the hospitals were profiled in a separate table.

From the range of ESD obtained for chest x-ray, the mean dose range of 0.44 to 1.0 mGy for PA and 0.9 to 1.3mGy for the lateral projection were similar to the work done in North - East Nigeria [6] and South -West Nigeria [7, 8], but showed lower values than what was reported by Jibiri and Olowookere [5]. For skull x-ray, the mean ESD range of 2.0/1.7 to 2.0/4.7 mGy for PA/Lateral projections recorded across the hospitals did not differ significantly from one another. However, they were closely similar to two other local studies [5, 9], and higher than another local one [6].

Lumbar spine recorded mean ESD of 5.5/8.8 for AP/lateral views. The dose levels were found to be consistence with a study in Malaysia [2] and Nigeria [7], but were 36 to 65% lower than the outcome of a study of lumbar spine dose levels in Calabar, South-South Nigeria [1]. For abdomen and pelvis, the range of doses obtained differ from a corresponding reports in North-East Nigeria [6] but correlate with those reports from Switzerland [10], and lower than the values described in Nigeria [8, 9].

Adequate optimization of techniques is fundamental in the radiography of the abdomen and pelvis due to their proximity to the gonads with high radio sensitivity. Dose to patients in x-ray examinations is a function of exposure parameters [11], and often account for dose differential due to poor technique management. The technique factors used in this study agreed with those reported in some literature [5, 12]. Besides equipment, techniques and patient characteristics, disparity in doses could also be attributed to the system of dose metrics.

The median 50th percentile of the surveyed values should be taken as achievable dose levels [13]. The implementation of DRLs ought to make this possible as well as reduce the level of dose differential. The results of this study were slightly above those described in Brazil [14] indicating that achieving similar dose levels with those of developed practices is possible with proper optimization. A further comparison with IAEA [15] recommendations demonstrate 18 to 70% lower levels than ours. Also, a wider dose survey in the state and the entire country should be sponsored by relevant agencies for the establishment of NDRLs for various radiological procedures to determine a base line for comparison.

Conclusion

The ESDs for x-ray of the chest, skull, lumbar spine, abdomen and pelvis have been measured and analyzed. Based on the results, the level of doses obtained correlate with report of most literature and well below the recommendation of IAEA. Therefore, the doses received are safe and will not pose any undue hazards to the patients. However, until a wider survey is carried out, the results of this study are not meant to represent local DRLs for Kaduna State. Nevertheless, it can be regarded as triggers for further investigation.

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Conflict of Interest: None

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