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Investigation of Radiation Doses and Diagnostic Reference Level among the Patients with Abdominal Pains Undergoing X-ray Examinations

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Abstract
Aproperdosi metric estimate of the patient's radiation exposure is required due to the steadily rising radiation do sage used in diagnostic-ray imaging. Entrances kindose, effective dose, and dose reference levels are crucial management tools for correctly administering ionizing radiation doses to patients. The afore mentioned dutiesaremostly carried out by medical physicists who provide important services for the valuation required for each type of procedure carried out and periodically oversee any changes in the selection of exposure parameters to safeguard patients from radiation risk. In this study, CalDose_X5.0 software was primarily used to estimate the entrances kindose (ESD) and effective dosage (ED), while M.S. Word Excel spreadsheets were used to calculate the diagnostic reference levels (DRLs) and other statistical parameters. For both erectands upine projection, the ESD and ED obtained ranged from1.71m Gyto19.30mGy and from 0.12m Svto2.59mSv, respectively. For both centers (SMH&FMC), the average ESD and ED values were 6.78m Gy&0.87mSv. The DRLs assigned to SMH and FMC were 8.07. While the effective dose offered in this research work was below the threshold value of 1mSv per year set by national and internal organizations, the ESD values given in this work we re-noticeably greater than those obtained in some other literature. The DRLs number was higher than the value recorded in the UK in 2000 but was relatively lower than the values set by the European Commission in 1999 and the IAEA in 1996. In conclusion, the radiation dose to patients undergoing x-ray examination have Lesra dialogical risks.

Keywords: radiation; X-ray examinations; ESD

Introduction
Knowing the current trends in radiation exposure from conventional X-ray procedures and other X-ray modalities is crucial for identifying areas that require the greatest focus and effort to reduce patient doses to optimize radiological procedures and protect the nation's population. Conventional X-ray machines prolife rated in Kebbi State and throughout Nigeria as a result of economic prosperity. A recent increase in awareness of the harmful effects of X-rays necessitated the need for radiation dose estimation of adult patients during abdominal X-ray procedures. The general public recognized conventional X-rays as important and useful in early-stage diagnostic procedures such as abdomen, chest, skull, and lumbar spine examinations. Abdominal X-rays use a very small dose of ionizing radiation to produce pictures of the inside of the abdominal cavity. It is used to evaluate the stomach, liver, intestines, and spleen and may be used to help diagnose unexplained pain, nausea, or vomiting. When used to examine the kidneys, ureters, and bladder, it's called a KUB x-ray. Because abdominal X-rays are fast and easy, it is particularly useful in emergency diagnosis and treatment.

The radiation doses delivered to the patients are dependent on exposure factors such ask V,m As, body projection, film-focus distance, and filtration. Therefore, the increasing applications of x-radiation and risk in medical fields bring about great efforts of various researchers and organizations in radiation protection forgiving diagnostic reference values as a guide to protect patients referred to the radiological investigations. The radiological X-ray investigation has gotten a vital position in the medical field. It is one of the important and in dispensable tools. About 30%-50% were estimated for critical medical decisions on x-ray investigation. In Norwegian Association of Medical Personnel affirmed that new technology, people demand, and clinician in tolerance of uncertainty were the highest causes of increasing X-ray investigations.

The hazards of the dose delivered during any radiological examinations are classified into two probabilistic and non-probabilistic effects that have a threshold above which they occur, that is if the dose received by the patient is high enough one type of effect will appear. The probabilistic effects are those effects without a threshold of occurrence but whose severity does not depend on dose level. It has occurred in a random manner and random, the best-known examples are cancer and genetic mutations (Andisco*etal.*,2014). The research aimed to assess the radiation doses delivered to the patients undergoing abdominal X-ray examination in two selected hospitals in Kebbi State, northwestern Nigeria. The assessment involved the following parameters: entrance skin dose, effective dose, and diagnostic reference levels.

Material and Method

The criteria for the selection of the hospitals considered for this study is the high number of patients that visit the facility for X-ray examinations. And they are the most referral hospital in Kebbi State. Two X-ray machines in two major referral and busiest government hospitals were included in this research with an average work load of 115 per week for each X-ray unit. These x-ray machines are Shimadzu Mobile X-ray imaging system with model number: collimator R-20CA, while in FMC was Mobile X-ray with model number: 2185226. Both have a total filtration of 3.0mm Al for both inherent and added filters. Before the patient do simetric assessment, information on X-ray exposure parameters (kVp, mAs), geometric parameters (X-ray tube focus–film distance [FFD] and X-ray tube focus–skin distance [FSD]), and anthropometric parameters (age & sex of patients) used in radiographic examinations of adult patients of average body mass for abdomen radiographic projections were collected directly from the control panel. The X-ray exposure parameters were used later to estimate patient doses through a three-step protocol: X-ray tube output measurements, incident kerma estimation, and entrance surface aircrewman calculations. ESD, ED, and DRL values were assessed for 76 patients undergoing abdominal X-ray procedures (SamailaandRilwanu,2023). The entrance Air kerma and Backscattered factors were measured using CalDose_X5.0 software. And later converted into entrance skin dose using the equation below; ESD=ESAKxBSF [1].

Similarly, the effective dose was obtained using normalization factors in CalDose_X5.0 software by selecting ESAK output values, ED will be displayed as a weighted dose in the software Excel sheet. The diagnostic reference levels and other statistical parameters were estimated using MS Word Excel spread sheets for each patient in the two hospitals and presented in Table 1.

Result and Discussion

The radiation dose assessment of the patient in this work involved indirect calculation of entrance skin dose, effective dose, and dose reference levels. The statistical analysis of the above parameters including exposure factors involved estimation of minimum, maximum, median, mean, standard deviation, and ratio of max/min due to abdominal x-ray examinations are tabulated in Table 1. In recent years, variations in dosimetry quantities observed in various countries have stimulated worldwide interest in patient doses, and several major dose surveys have been conducted in any countries (Mohamed,2010). Tables 2-4 indicate comparisons between the assessed ESD, ED, and DRLs with national and international studies.

Table 1

Examination	SMH						FMC					
	Min	Med	Mean	Max	Mx/mn	STDEV	Min	Med	Mean	Max	Mx/Mn	STD
AbdErect												
Age (years)	20	38	45	50	2.5	12.19	23	25	41	70	3.04	17.9
FFD (cm)	100	100	102	111	1.11	4.16	100	110	115.2	180	1.8	19.4
FSD (cm)	85	90	90	95	1.12	4.08	75	90	92.3	140	1.87	12.9
KV	77	80	80.57	85	1.1	2.94	78	85	83.5	90	1.15	4.03
MAs	20	28	27.86	32	1.6	4.02	32	50	50	43.7	1.56	7.48
ESD (mGy)	3.85	5.02	4.99	6.13	1.59	0.78	5.63	8.4	8.87	19.3	3.4	3.1
ED (mSv)	0.58	0.65	0.68	0.84	1.45	0.09	0.73	1.16	1.32	2.59	3.55	0.49
Abdsupine												
Age (years)	20	38	35	70	3.5	13.33	23	36	40	70	3.04	17.1
FFD (cm)	100	100	102.83	130	1.3	7.2	100	110	109.2	116	1.16	4.54
FSD (cm)	68	80	82.56	113	1.66	9.29	88	89.5	88.9	97	1.21	5.79
KV	65	77	76.35	80	1.23	3.6	70	80	79.14	85	1.21	4.33
MAs	18	22	21.83	28	1.56	2.9	30	34	35.57	40	1.33	4.16
ESD (mGy)	1.71	4.02	3.99	7.41	4.32	1.3	3.39	6.32	6.29	9.91	2.91	1.76
ED (mSv)	0.12	0.49	0.47	0.84	7	0.14	0.73	0.96	1.08	1.91	2.62	0.32

Table 2

Present/Other studies	ESD (mGy)
This study	6.78
Hamza&Lamara,2020[Gombe]	0.95
Nsika & Obed, 2015 [AkwaI bom]	1.89
IRAN,2008	3.27
Gholami*etal*,2015 [Iran]	5.58
Gaetano*etal*,2005 [Italy]	2.58
ARPNSA, 2017	6.00
NRPB2000	6.00
Osib&Azevdo,2008[Brazil]	1.75
IacobandDiaconescu,2020[Romania].	15.8

Table 3

Present/Other study	ED(mSv)
This study	0.87
Olowookere, *etal*.,2011	3.20
Iacob and Diaconescu, 2020 [Romania]	2.31
Haval&Hariwan,2017	1.62
Kharita*etal*.,2010	1.07
Durga&Seife,2012	1.50
Mettler*etal*.,2008	0.70
Ernest&Johnson.,2013	0.14

Table 4

Present/Otherstudy	DRLs (75thpercentile)
This study	8.07
EuropeanCommission,1999	10.00
IAEA,1996	10.00
Sonowane*etal*.,2010[India]	7.08
PD,2005	6.18
Hart*etal*,2000[UK]	6.00

The need for radiation assessment of patients referred to hospitals under study from radiological x-ray procedures has been noticed by the increasing knowledge of risk due to low doses (Mohamed, 2010).

ESD obtained was comparably higher than the results of (ARPNSA, 2017 and NRPB 2000) but lower than the results obtained by (Iacoband Diaconescu, 2020 (Romania)). All other previous studies were lower than the results estimated in this research work as shown in Table 2. Effective dose provides an approximate indicator of potential detriment from ionizing radiation and should be used as one parameter in evaluating the appropriateness of examinations involving ionizing radiation. Standard radiographic examinations have average effective doses that vary by over a factor of 1000 (0.01–10mSv). The effective dose as an indicator of ionizing radiation hazard was comparably lower than the results obtained by, but higher when compared with the result obtained by is indicated in table 3. This shows that there is not much radiation delivered to the patients as a result of exposure factors selection during the procedures. The values of DRLs (third quartile value of SED (mGy)) obtained in this work were compared with other studies as shown in Table 4. The DRLs estimated were lower than the standard value of (the European Commission, 1999; IAEA, 1996 and Sonowane *et al*., 2010 [India]), but remarkably higher than the results of (PD, 2005 and Hart *et al*.,2000 [UK]). This indicated that the centers under study are justifying the investigated procedures. However, DRLs should be revised periodically and for this purpose, the establishment of a national patient dose database program may be considered.

Conclusion

The findings from the study demonstrate that the ESD received by the patients exceeded the reference values set by ARPNSA (2017) and NRPB (2000), exposing the patient to excessive radiation. As a result, there has been an improvement over past studies, which suggested instances of exceeding the reference dose, such as research in Romania (2020). However, the Nigeria Nuclear Regulatory Agency [NNRA] revealed that the risk indicator (effective Dose) was less than 1m Sv/year as specified. There is not much risk involved in this operation. The DRls were like wise below the minimum standards set by the IAEA in 1996 and the European Commission in 1999. In addition to providing local diagnostic reference levels for abdominal diagnostic X-ray exams at SMH, FMC, and other locations in Kebbi State, the data from this study will be helpful for the development of NDRLs. Future evaluations of the population's overall dosage from medical exposure and the radiation dangers associated with various radiological treatments can be based on these findings. To enhance exposure optimization and technical methods in plain abdominal radiography, additional national investigations are advised.

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