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Research Article

Determination of Diagnostic Reference Level in Dose-Area Product (DAP) and Evaluation of Dosimetry in Chest x-ray Examination at Bingerville Mother-Child Hospital, Cote D'Ivoire

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Abstract

X-rays have an undeniable advantage in medicine, especially for diagnosis. However, their use is not without risk. Following numerous studies carried out by the International Atomic Energy Agency and learned societies, it has been recommended to strengthen the principle of optimization in diagnostic radiology by implementing Diagnostic Reference Levels. The purpose of this study is to determine diagnostic reference levels (DRLs) in order to evaluate radiological practices and to reduce doses received by patients for frontal chest examination at the Bingerville Mother-Child Hospital (MCH). The work was carried out on a sample of 110 patients at the Mother and Child Hospital in Bingerville. We used a generator and a tube for the production of X-rays. The dose-area product (DAP) value was obtained using a dose calculator built into the generator. The determination of the DRLs in DAP (cGy.cm²) was made with the 75th percentile statistical method and yielded the following result of 14.32 cGy.cm². Comparing our DRL value with those obtained elsewhere, as well as comparing the median DAP from the present study with the DRLs in Abidjan and at the national level, radiological practices are satisfactory for frontal chest examination. However, after analysis of some radiological parameters used, it appears that efforts need to be made by acting on the kV, mAs, diaphragm and the filtration.

Keywords

Determination, Evaluation, Median, DRLs, Dose-Area Product

1. Introduction

Human exposure to ionizing radiation of artificial origin comes mainly from medical use. Diagnostic X-rays account for most of the population's exposure to artificial ionizing radiation. According to the World Health Organization (WHO), more than 3.6 billion diagnostic examinations are performed in radiology worldwide each year. DRLs were introduced by Publications 60 [1] and 37 [2] of the International Commission on Radiological Protection (ICRP) and

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immediately practiced by the European Union (EU) through Directive 97/43/Euratom [3] to avoid a dose to the patient that does not contribute to the clinical objective. In Côte d'Ivoire, DRLs determination work was carried out by Monnehan's team in two cities in the Southern part in 2009 [4]. Following this, Konaté's thesis work allowed him to determine the DRLs for the thorax and lumbar spine of the front and profile in eleven (11) radiology centers implemented throughout the Ivorian territory in the North, South, East, West and center [4].

The objective of this study is to continue the works on the determination of DRLs in order to evaluate radiological practices to reduce the doses received by patients for the frontal thorax radiology examination at the Mother-Child Hospital of Bingerville.

2. Materials and Methods

2.1. Materials

The study was done in the standard X-ray room called Bone Lung room. This room contained an X-ray generator, an X-ray tube, a wall stand and a leaded apron. In the monitored area, we used the image acquisition station on which the technician fixes the radiological parameters, voltage and charge values. For our study we used the hospital facility which is equipped with a built-in dose calculator that gives us the value of the dose. A thickness measuring device was also used to measure the thickness of the patient body part to be irradiated.

2.2. Methods

Sampling method

For the examination of the thorax we collected data of 110 patients, all of them were above 18 years old (all considered as adults) in order to comply with the recommendations of the NSRI (Nuclear Safety Radiationprotection Institute) [6]. Only adults who could stand and had a prescription form for a frontal chest X-ray were considered.

Data collection

For two months from (03 October to 03 December 2022), we went to the X-ray room from Monday to Friday. The data collection consisted of recording the name of the type of examination performed with the incidences, and the filtration on each device. For each appliance, the year of installation, the brand, the model and the total filtration were noted. For each of the patient, we measured the mass with a scale, the thickness of the part of the thickness of the part of the body through which the X-ray beam passes using a thickness measuring device. After positioning the patient against the wall stand, the medical imaging technician positioned himself at the same time as us in the controlled area. The radiological parameters (kV and mAs) are fixed. From our position, we could record these values as well as the DAP values on a screen.

3. Results

3.1. Determination of DRLs and Median Value

The dose calculator gives the DAP value for each patient. From the DAP values obtained, we determined the DRLs in DAP by the 75th percentile method [7]. The median value of dosimetry quantity has been calculated, which is denoted as DAPm, for 110 patients. The median of a statistical series is the value that separates the series (ordered in increasing values) into two groups of equal size [8]. The values of DRL and median of DAP are shown in Table 1 below.

Table 1. *DRLs and DAPm values.*

DRL (cGy.cm²)	DAPm (cGy.cm²)
14.32	12.20

3.2. Voltage and Charge

Taking into account the voltages (kV) and charges (mAs) recorded in our experiment, we established the minimum and maximum voltages, the average voltage and the minimum and maximum loads and the average load in the room. In fact, to carry out the radiology examination, for each patient, the technician sets a high voltage and load value and then sends the X-ray beam to the patient. These values are obtained for the 110 patients and calculated the average of the voltage and load from the statistical average. The values are shown in the table 2 below. The voltage and load range used can be seen.

Table 2. *Averages Voltage and Load Values.*

Examination	Voltage		Charge	
	Range (kV)	Mean (kV)	Range (mAs)	Mean (mAs)
Chest front	118-130	120.16	1.11-6.44	2.25

Table 3. Comparison of the DRLs of the study with those obtained in other rooms in Abidjan [4].

Radiology rooms	DRLs (cGy.cm^2)
The study	14.32
CHU COCODY	29.16
CHU YOPOUGON	31.75
HMA	61.63
ICA	24.1
PISAM	55.61

3.3. Comparison of the Median Value in DAP with the DRL Value in Abidjan and National DRL Value

In the following table, the values of the median of DAP, the DRL of Abidjan and the DRL of Côte d'Ivoire obtained in a previous study are shown.

Table 4. Median value of DRL from our study and values of DRL in Abidjan and National one [5].

DAPm	DRLs (Abidjan)	National DRL value
12.20 cGy.cm^2	53.26 cGy.cm^2	57.47 cGy.cm^2

3.4. Comparison Between DRLs of This Study and Those Obtained in Other Countries

In the following table, the DRL value and DRL values obtained in the literature in other countries are shown.

Table 5. DRLs in the study and those obtained in others countries.

countries	DRLs (cGy.cm²)
The study	14.32
French (2021) [9]	20
UK (2016) [10]	10

4. Discussion

For this review, the study shows that the Dose-Area Product is locally optimized because the median DAPm is lower than the DRLevel of Abidjan and Côte d'Ivoire (see Tables 1 and 4) [11, 12]. Comparing the DRLs obtained in the room with that of some rooms in Abidjan (Table 3). This value is the smallest, which is encouraging.

The analysis of the voltages and average loads of the measurements (Table 2) shows us that the mean values are well within the recommended intervals, [115-140] kV and [1.5-3] mAs [13].

However, when comparing the DRLs for the DAP in the study to that of some countries (Table 5), we note that the DRLs in this study is lower than that of France and higher than that of United Kingdom. There is therefore works to be done in the study room to further optimize with regard to the DRLs obtained in the United Kingdom. This is because the value of the DAP depends on both the value of the patients' exposure dose and the aperture of the diaphragm. Radiology practitioners can further increase the voltage to 140kV and reduce the charge to 1.5mAs [13]. Although they had the option to add additional filtration, the practitioners did not do so. Filtration reduces the dose received by patients and therefore reduces the DAP [14].

5. Conclusion

At the end of this work, we obtained 14.32 cGy.cm^2 results for the DRLs in DAP, for the exam of the X-ray of the front chest. The DAP is optimized because the DRL values of Côte d'Ivoire and Abidjan are higher than the mean (DAPm =12.2). However, practices can be improved by acting on kV, mAs, filtration and diaphragm.

Abbreviations

DAP	Dose-Area Product
DAPm	Median value of Dose Area Product
DRL	Diagnostic Reference Levels

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Conflicts of Interest

The authors declare no conflicts of interest.

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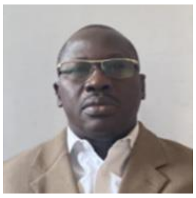
Biography



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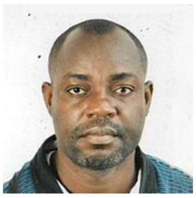

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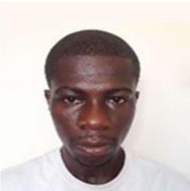

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Research Fields

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Kezo Ponaho: Nuclear Physics and Radiation Protection, Quality control in radiological facility, Dosimetry, Environmental Protection, Water quality and sustainable agriculture.