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Patients Exposure Assessment Undergoing Conventional Radiology in the Central Region of Cote d'Ivoire

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Abstract: Our study takes place in the radiology room of the University Hospital Center (CHU) of Bouaké in the central region of Cote d'Ivoire. The work involved 60 patients, including 30 for the examination of the front chest and 30 for the examination of the front lumbar spine. We used a DAP- meter to measure the dose in the air each time the beam was sent to the patient by the technician medical imaging. By a calculation we were able to obtain the Entrance Surface Dose ESD for each patient and the 75th percentile allowed us to obtain the Diagnostic Reference Level (DRL) for each of the two examinations at the CHU of Bouaké. The comparison of the DRL to the mean dose ESDm allows us to say that the dose is not optimized for the examination of the front chest and that corrective measures are to be taken by choosing appropriately the voltage, the charge, the distance focus detector (DFD) and using a total filtration of at least 2.5mm Al. However, for the examination of the front lumbar spine, although the dose is optimized, we can further increase the voltage and decrease the charge within the limits recommended by the learned societies of radiology, to reduce the dose. The DFD can be increased to 140 cm and also increase the total filtration to at least 2.5mm Al.

Keywords: Entrance Surface Dose (ESD), Dose in Air (Dair), Mean Dose (Dem), DRL, Optimization

1. Introduction

Nowadays X-rays are an important tool for medical diagnosis. However, they are an important source of patient exposure to ionizing radiation [1]. Studies conducted in the USA show that diagnostic radiology and nuclear medicine contribute 88% to the overall exposure of the population to ionizing radiation of artificial origin [2] and 96% in the United Kingdom [3]. There is therefore a need to estimate and manage radiation dose received by patients during radiology examinations. In order to reinforce the principle of optimization, the International Commission on Radiological Protection (ICRP) has introduced the use of a reference value called Diagnostic Reference Level (DRL) [4] determined for measurable dosimetric quantities such as the Entrance Surface Dose (ESD) and the Dose-Area Product (DAP). The determination of DRL will make it possible to evaluate the radiological practices in each room, each center, each country for each examination (especially the most practiced ones) and to take corrective action if necessary [5].

Our study aims to determine the DRL for ESD, for examinations of the front chest and front lumbar spine at the radiology room of the University Hospital Center (CHU) of Bouaké located in the center of Côte d'Ivoire. This determination will make it possible to assess patient exposure for each of the two examinations and take corrective action in case of non-dose optimization.

2. Materials and Methods

2.1. Methods

After the agreement of the hierarchical managers of the University Hospital of Bouaké, we were able to verify that the radiology room met the Ivorian standards in terms of dimensions [6] and that it underwent an inspection by the competent services of the Sub-Directorate of Radioprotection in this year. We considered 30 patients for the examination of the thorax and 30 patients for the examination of the lumbar spine of face consecutively according to the order of arrival in accordance with the recommendations of the Institute for radiation protection and nuclear safety (IRNS) [7]. All of these patients had an examination prescription form. The patient was correctly positioned at the stative. From the console the beam was triggered by the technician after choosing the corresponding voltage and charge. We stood behind the leaden screen next to the technician. It was from this position that we could read from the DAP electrometer the Dair for each patient [8]. We then obtained the ESD by calculation [9] for each patient for each examination by weighting the dose in air with the backscatter factor. By the 75th percentile method, the values of ESD are placed in ascending order and the DRL corresponds to the dose of order k = 75Xn / 100 [10] for the front thorax and for the front lumbar spine. We also calculated the mean entry dose value for each test using the arithmetic mean [11]. we compare the DRL for the examination to the mean entry dose ESDm [12].

2.2. Materials

The examinations were carried out using a high-voltage generator and a 1mm Al total filtration X-ray tube. The wall stand in which the film was slipped made it possible to position the patients. The console placed behind a leaded screen allowed the technician to fix the voltages and load and to trigger the beam. We brought with us a calibrated Diamentor M4 KDK 11017 DAP-meter to the secondary laboratory in PTW Freiburg, Germany. This device consists of an ionization chamber that we have fixed on a rail at the exit of the tube and an electrometer that we have placed at the level of the console. The two are connected by two cords. When the beam passes through the ionization chamber, it ionizes the gas there. The displacement of ions creates a current that is conducted by the beads to the electrometer and converted into Dair [13].

3. Results

3.1. The Front Chest Examination

3.1.1. Determination of the DRL and the Mean of ESD for Examination of the Front Chest

The DRL and the mean value of ESD for the front chest examination are shown in Table 1 below:

Table 1. DRL and ESDm.

DRL (mGy)	ESDm (mGy)
0.261	0.298

3.1.2. Comparison of the DRL to the ESDm

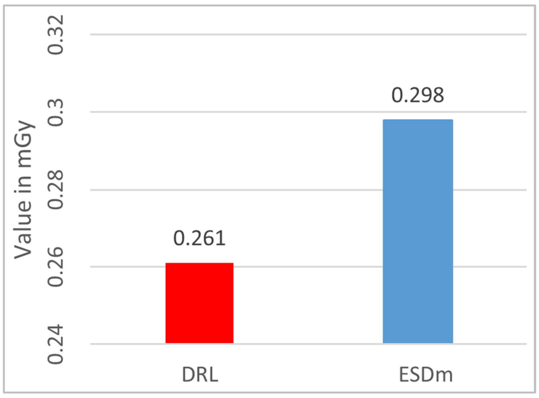

Figure 1. *Graph representing the DRL and the mean dose for the front lumbar spine.*

We observe that the ESDm is higher than the DRL for the front lumbar spine examination at the radiology center of the CHU of Bouaké.

3.1.3. Radiological Parameters and Tube Filtration

Table 2. *Voltage, charge, focus-film distance and filtration in the radiology room of CHU Bouaké.*

voltage (kV)	Charge (mAs)	Distance Focus-film	Filtration
104.33 [77-122]	7.28 [1.6-64]	150 cm [100-150] cm	1mm Al

3.2. The Front Lumbar Spine Examination

3.2.1. Determination of the DRL and the ESDm

Table 3. *DRL and ESDm in Bouaké.*

DRL (mGy)	ESDm (mGy)
5.196	4.178

3.2.2. Comparison of the DRL to the ESDm

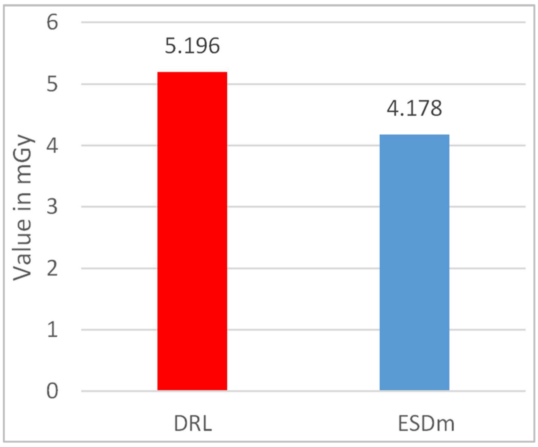

Figure 2. *Graph representing the DRL and the mean dose for the examination of the front lumbar spine.*

We observe that the DRL is higher than the mean value dose ESDm for the examination of the front lumbar spine at the radiology center of the CHU of Bouaké.

3.2.3. Radiological Parameters and Tube Filtration

Table 4. *Voltage, charge, focus-film distance and filtration in the Bouaké room.*

Voltage (kV)	Charge (mAs)	Distance Focus-Film	Filtration
75.1 [60-87]	75.3 [25-160]	100 cm	1mm Al

4. Discussion

For the examination of the front chest front in Bouaké, the ESDm is larger than the DRL (Figure 1) which means that the dose is not optimized. Patients are exposed to unnecessary doses of X-rays. This situation can be explained by the low voltage value used on average 104.33 kV over an interval of [77-122] kV and a high charge of 7.28 mAs over an interval of [1.6-64] mAs. Indeed the higher the charge than the dose received is high. The higher the voltage in the recommended proportions, the lower the dose received with good image quality [14]. The French Society of Radiology (SFR) [15] recommends for the examination of the front chest an average voltage of 125 kV with an interval of [115-140] kV and a charge between [1.5-3] mAs. Also the total filtration of the 1 mm Al tube is very low. Additional filtration avoids unnecessary irradiation of human tissues and promotes better X-ray transmission [16]. The SFR recommends a minimum total filtration of 2 mm Al and maximum filtration of 2.5 mm Al [15]. Corrective action must therefore be taken to the examination of the front chest by making a suitable choice of tension and loads to carry out this examination in Bouaké. It is also necessary to use an adequate filtration of the tube and to make the examination at a distance focus detector which tends towards 200 cm.

For the examination of the front lumbar spine in Bouaké, the ESDm is lower than the DRL (Figure 2). The dose received by patients is optimized. However, an analysis of radiological parameters and filtration makes us say that the dose can be further optimized. Indeed for this examination the average voltage used is 75.1 kV (see table 4), but it is recommended by the learned societies of Radiology) [15] to use a voltage in the rank [65-80] kV with a tendency to increase the voltage. The charge used is 75.3 mAs (see Table 4) which is very large compared to that recommended [15]. Indeed the recommended charge for the examination of the lumbar spine of face is in the rank [30-70] mAs with a tendency to reduce the load towards 30 mAs. The average distance focus detector of 100 cm (see Table 4) may be increased to 110 cm to further reduce the dose. Indeed the recommended distance focus detector interval is [100-110] cm [15] taking the greatest possible distance [17].

5. Conclusion

This research work carried out at the University Hospital of Bouaké allows us to evaluate radiological practices in the radiology room of this large megalopolis that Bouaké represents in the center of Côte d'Ivoire. Thus, for the examination of the chest front, the dose is not optimized, in other words patients run the risk of exposure to unnecessary x-rays. Corrective action must be taken by increasing the voltage and decreasing the charge while remaining within the limits compatible with the examination of the chest. Also it requires an additional filtration greater to tend towards 2.5 mm Al and a focal length detector between 150cm and 200cm.

Conflicts of Interest

The authors declare that they have no conflict of interest.

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