Open Journal of Radiology, 2015, 5, 44-49
Published Online March 2015 in SciRes. http://www.scirp.org/journal/ojrad
http://dx.doi.org/10.4236/ojrad.2015.51008

Adult Patient Doses for Chest, Skull and Lumbar Spine Examinations

Kouther E. M. Mohamadain[1], F. I. Habbani[2], S. M. Ibrahim[3]

[1]Department of Physics, Faculty of Science, Sudan University of Scienceand Technology, Khartoum, Sudan
[2]Department of Physics, Faculty of Science, Khartoum University, Khartoum, Sudan
[3]Department of Physics, Faculty of Science, Gassim University, Qassim, Kingdom of Saudi Arabia
Email: kouther@hotmail.com

Received 10 February 2015; accepted 23 March 2015; published 26 March 2015

Abstract

A dosimetry study for chest, skull and lumbar spine examinations in adults has been carried out at two hospitals. The aim of the study was the assessment of adult patient's dose for chest PA, chest LAT, skull AP and lumbar spine AP examinations. The Entrance Surface Dose (ESD) and the Effective Dose (ED) for each examination were obtained using DoseCal software. For each examination, different results were obtained at the two hospitals. At hospital A (IFF Hospital), the total number of patients studied was 140. The mean ESD values obtained for chest PA, chest LAT, skull AP and lumbar spine AP were 0.20 mGy, 0.47 mGy, 1.25 mGy, and 1.61 mGy, respectively. At hospital B (HGB Hospital), the total number of patients studied was 369 for similar examinations and projections. The ESD values were 0.10 mGy, 0.28 mGy, 0.66 mGy and 2.47 mGy, respectively. The mean ED values at hospital A and B were 0.02 mSv and 0.01 mSv for chest PA, 0.04 mSv and 0.03 mSv for chest LAT, 0.1 mSv and 0.06 mSv for skull AP, and 0.15 mSv and 0.26 mSv for lumbar spine AP, respectively. The results were compared with the European Community Reference Levels. Although the doses were low, there was still a need for personnel training and national guidance on good practice for optimization of patients' doses.

Keywords

Entrance Dose, Effective Dose, Dose Cal Software

1. Introduction

The increasing knowledge of the hazards of ionising radiation has necessitated the need for radiation dose assessment of patients during diagnostic X-ray examinations especially the Effective Dose equivalent which is a

How to cite this paper: Mohamadain, K.E.M., Habbani, F.I. and Ibrahim, S.M. (2015) Adult Patient Doses for Chest, Skull and Lumbar Spine Examinations. *Open Journal of Radiology*, **5**, 44-49. http://dx.doi.org/10.4236/ojrad.2015.51008

risk related factor for describing the detriment of the exposure to radiation as introduced in ICRP 26 [1] which defines the stochastic radiation effects as a lethal cancer or a mutation expressed in the first two post-irradiation generations.

A quality assurance (QA) programme in diagnostic radiology should include the patient dosimetry as the most relevant item to be assessed, together with image quality. Council Directive 97/43/Euratom [2] introduces the concept of Diagnostic Reference Levels (DRL), defined as dose levels in medical radiodiagnostic practices to patients of standard-sized groups or standard phantoms, for typical examinations and broadly defined types of equipment. These levels should not be exceeded for standard procedures when good and normal practice is applied, regarding diagnostic and technical performance.

This study aims at establishing Entrance Skin Dose (ESD) and Effective Dose (ED) for three examinations, chest PA and LAT, skull AP and lumbar spine AP in two hospitals, and the main goal of this study is to improve the diagnostic information and to reduce the patient's dose to a minimum.

2. Materials and Method

Dose measurements were performed in two different hospitals namely A(IFF) and B(HGB) hospital, with 140 patients and 369 patients respectively. Data were collected on patient doses for a period of 5 months. The dose values were obtained with the use of DoseCal software that provides ESD and ED. This software has been used successfully to perform patient doses in some UK hospitals [3]. The software, which uses manually entered tube output, exposure factors and patients details, calculates the doses with entries from National Radiation Protection Board (NRPB) data files. The tube output of all the X-ray machines was measured using calibrated ionisation chambers, Radcal-Corporation model 2025 radiation monitor with electrometer model 20X5-3. The manually entered information includes the exposure details such as: tube output, type of examination, projection, focus-to-skin distance, kV and mAs, together with the patients details such as: age, sex and weight. The ESD was calculated according to the following equation:

$$\mathrm{ESD} = \mathrm{S} \times \mathrm{mAs} \times \left(\frac{\mathrm{kV}}{80}\right)^2 \times \left(\frac{1}{\mathrm{FSD}}\right)^2 \times \mathrm{B}$$

where:

S is the standard output factor in $\left(\frac{\mathrm{mGy}}{\mathrm{mAs}}\right)$ for the particular radiographic equipment used, measured under minimal scatter conditions at 1m from the tube focus at nominal 80 kV;

mAs is the product of tube current and exposure time;

kV is the tube potential;

FSD is the Focus-to-Skin Distance; and

B is the backscatter factor.

3. Results and Discussion

The descriptive statistics of ESD (mGy), mean, standard deviation, CV%, minimum, first and third quartile, maximum, and the mean Effective Dose, ED (mSv) are given in **Table 1**.

Figures 1-4 show the distributions of ESD (mGy) with first and third quartiles, mean, NRPB and EC reference dose levels for chest LAT and Lumbar Spine AP in the two hospitals.

Table 2 shows comparison of the results obtained in this study with the reference dose levels (RDLs) [4]-[6]. **Table 3** and **Table 4** give the range of the exposure factors, focus-to-skin distance FSD and the filtration for the two hospitals.

The two hospitals give different ESD values for all the examinations. Despite the fact that the exposure factors used in hospital B are higher, than hospital A, Hospital A still gives higher ESD values for all the examinations except lumbar spine AP. This may be as a result of the difference in filtration and technical factors as shown in **Table 3** and **Table 4**.

The results obtained in **Table 2** show that the two hospitals give lower ESD values as compared to those of the RDLs.

The mean ESD values of 1.25 and 0.66 mGy for skull AP and 1.61 and 2.47 mGy for lumbar spine AP for

Table 1. The Entrance Surface Dose (mGy) and Effective Dose (mSv) for the three examinations.

Examinations and Projection	Hospita A (lFF)	Hospital B (HGB)
Chest PA		**ESD (mGy)**
Mean	0.20	0.10
SD	0.07	0.03
CV (%)	5.0	2.0
Minimum	0.07	0.03
First Quartile	0.13	0.08
Third Quartile	0.24	0.12
Maximum	0.47	0.29
Median	0.18	0.09
Sample Size	61	215
Effective Dose (mSv)	0.02	0.01
Chest LAT		**ESD (mGy)**
Mean	0.47	0.28
SD	0.25	0.15
CV (%)	7.1	5.7
Minimum	0.07	0.02
First Quartile	0.21	0.19
Third Quartile	0.66	0.30
Maximum	1.33	0.91
Median	0.45	0.25
Sample Size	56	88
Effective Dose (mSv)	0.04	0.03
Skull AP		**ESD (mGy)**
Mean	1.25	0.66
SD	0.41	0.31
CV(%)	8.7	16.6
Minimum	0.23	0.33
First Quartile	0.83	0.40
Third Quartile	1.47	0.56
Maximum	2.47	1.77
Median	0.40	0.52
Sample Size	14	8
Effective Dose (mSv)	0.10	0.06
Lumbar Spine AP		**ESD (mGy)**
Mean	1.61	2.47
SD	0.74	1.24
CV (%)	14.5	2.2
Minimum	0.14	0.29
First Quartile	0.82	1.42
Third Quartile	2.08	3.36
Maximum	3.06	6.29
Median	0.71	2.21
Sample Size	10	57
Effective Dose (mSv)	0.15	0.26

Table 2. Comparison of mean ESD results obtained with the reference dose levels, RDLs (mGy).

Examination	A	B	*RDLs
Chest PA	0.20	0.10	0.3
Chest LAT	0.47	0.28	1.5
Skull AP	1.25	0.66	5.0
Lumbar Spine AP	1.61	2.47	10.0

*RDLs: NRPB 1999 [4], EC 1996a [5], EC 1999a [6].

Table 3. Range of exposure factors, focus-to-skin distance (FSD) and filtration used for each projection in hospital A.

Examination	Tube Potential (kV)	(mAs)	FSD (cm)	Filtration (mm Al)
Chest PA	55 - 90	4 - 16	110 - 180	2.00 - 2.50
Chest LAT	62 - 100	4 - 32	100 - 180	
Skull AP	50 - 80	16 - 32	100 - 150	
Lumbar Spine AP	54 - 75	16 - 50	100 - 150	

Table 4. Range of exposure factors, focus-to-skin distance (FSD) and filtration used for each projection in hospital B.

Examination	Tube Potential (kV)	(mAs)	FSD (cm)	Filtration (mm Al)
Chest PA	48 - 100	5 - 20	115 - 170	2.00 - 3.00
Chest LAT	70 - 117	6.4 - 42	68 - 165	
Skull AP	52 - 70	10 - 50	76 - 150	
Lumbar Spine AP	65 - 96	20 - 160	75 - 112	

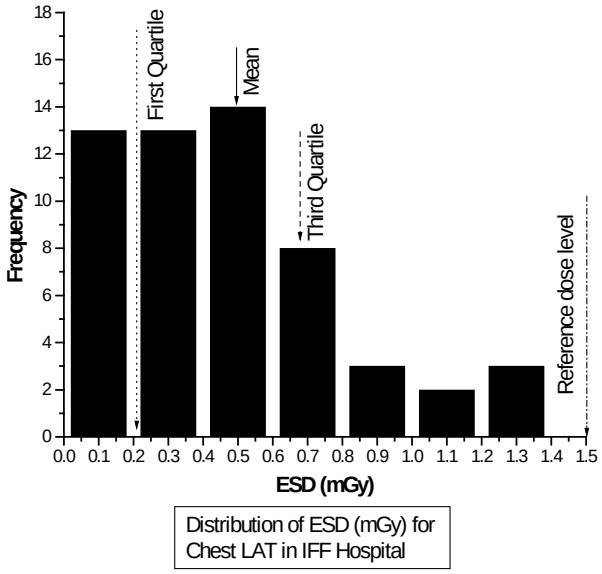

Figure 1. Distribution of ESD per radiograph for chest LAT examinations in IFF Hospital.

both hospitals respectively show a clear difference between the two hospitals. This difference may be due to the different technical factors used. For lumbar spine AP, the mAs used in hospital B was 3 times higher than in

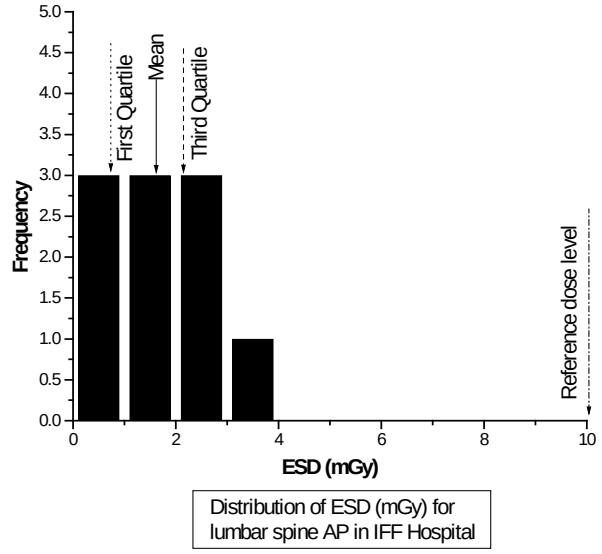

Figure 2. Distribution of ESD per radiograph for lumbar spine AP examinations in IFF Hospital. First and third quartiles values are indicated by dot and dash lines respectively while mean values are indicated by solid lines. NRPB and EC reference values are indicated by dash dot lines.

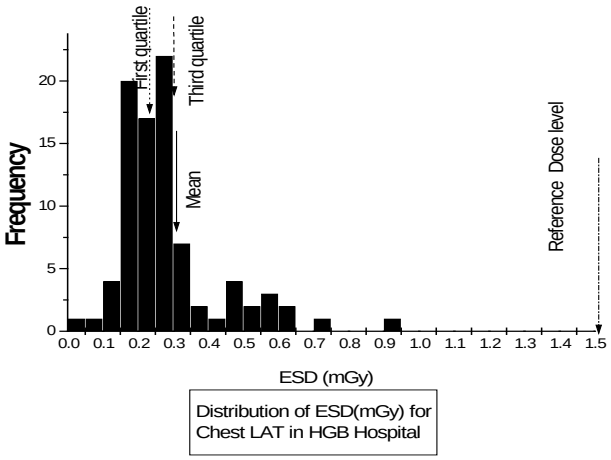

Figure 3. Distribution of ESD per radiograph for chest LAT examinations in HGB hospital.

hospital A, and the FSD was lower.

Similar examinations carried out in Sudan at four hospitals eight X-ray units and a sample of 346 radiographs. Hospital mean ESDs estimated range from 0.17 to 0.27 mGy for chest AP, 1.04 - 2.26 mGy for Skull AP/PA, 1.46 - 3.33 mGy for Lumbar Spine AP [7].

These values are also lower than those of the RDLs. However, they are higher than those obtained in this study at the two hospitals with 5 X-ray machines,

The Effective Doses obtained at the two hospitals, hospital A and B, were 0.02 and 0.01 mSv for chest PA, 0.04 and 0.03 mSv for chest LAT, 0.1 and 0.06 mSv for skull AP, 0.15 and 0.26 mSv for lumbar spine, respectively. The results obtained at the two hospitals were found to be lower than the EC reference dose levels.

4. Conclusions

For all the examinations studied in the two hospitals, the mean ESD values obtained are found to be within the

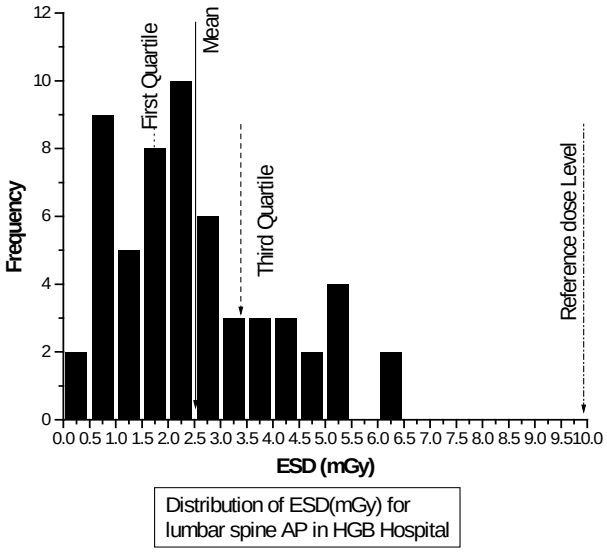

Figure 4. Distribution of ESD per radiograph for lumbar spine AP examinations in HGB hospital.

established international reference doses. For chest examinations, the results obtained are very close to the reference dose level. It is concluded that there is no potential health hazard to patients due to exposure during X-ray diagnostic examinations for chest, skull and lumbar spine at the two hospitals.

For skull AP and lumbar spine AP for both hospitals, the result obtained show a clear difference between the two hospitals. This difference may be due to the different technical factors used in **Table 3** and **Table 4**.

So (QA) Programme organized on a central basis can be a useful instrument to reach every hospital, with the aim of improving and optimizing the radiological practice.

References

[1] ICRP (1977) Recommendations of the International Commission on Radiological Protection Publications 26. Pergamon, Oxford.

[2] European Union (1997) On Health Protection of Individuals against the Dangers of Ionizing Radiation to Medical Exposure. Council Directive 97/43/Euratom. Official Journal of the European Union No L 180, 22-27.

[3] Kyriou, J.C., Newey, V. and Fitzgerald. M.C. (2000) Patient Doses in Diagnostic Radiology at the Touch of a Button. The Radiological Protection Center, St. George's Hospital, London.

[4] (1999) Guidelines on Patient Dose to Promote Optimisation of Protection for Diagnostic Medical Exposures. Documents of the NRPB, Vol. 10, No. 1, National Radiological Protection Board.

[5] EC (1996) European Guidelines of Quality Criteria for Diagnostic Radiographic Images. EUR 16260 EN. European Commission.

[6] EC (1999) Guidance on Diagnostic Reference Levels (DRLs) for Medical Exposures. Radiation Protection 109, Directorate-General, Environment, Nuclear Safety and Civil Protection, European Commission.

[7] Suliman, I.I., Abbas, N. and Habbani, F.I. (2007) Entrance Surface Doses to Patients Undergoing Selected Diagnostic X-Ray Examinations in Sudan. *Radiation Protection Dosimetry*, **123**, 209-214. http://dx.doi.org/10.1093/rpd/ncl137