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DOSE SURVEY OF PEDIATRIC AND ADULT PATIENTS IN SUDAN

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ABSTRACT

A survey of radiation doses to children and adults from diagnostic radiography has been carried out in seven hospitals in Sudan. In four hospitals only pediatric examinations were studied. In two hospitals only adult patients were recorded and in one hospital both kinds of patients (pediatric and adults) were evaluated. For pediatric patients only chest x-ray examination was evaluated and children were divided according to age ranges: from (0-1) and (1-5) years for chest AP only and from (5-10) and (10-15) for chest PA. For adult patients the examinations were chest AP and PA, abdomen AP and skull AP and PA. Entrance Surface Dose (ESD) and the Effective Dose (E) were calculated using the DoseCal software. The mean ESD for children, measured in μGy, ranged from (45-53) and (53-56) for (0-1) and (1-5) years, respectively and from (55-71) and (68-85) for (5-10) and (10-15) years, respectively. In two of the pediatric hospitals the mean ESD values were greater than the CEC Reference Dose Levels. In Elbulk and Sinar hospitals the values ranged from 167-261 and 186-308 μGy for the age ranges (0-1) and (1-5) respectively and 167-194 and 279-312 μGy for the age ranges of (5-10) and (10-15) respectively. For adult patients the ESD and E dose values evaluated in Alfisal hospital presented values comparable with the CEC Reference Dose Level. However for Alshorta hospital the values were higher for the chest AP and PA with results for ESD 0.446 and 0.551 mGy respectively.

INTRODUCTION

Quality Assurance Programs (QAP) in diagnostic radiology are nowadays a legal requirement all over the world and should be implemented in radiology departments of hospitals and clinics. A QAP should include the patient's dose evaluation[1] as one of the most relevant items to be assessed, along with image quality. The main goals of a QAP are to improve the diagnostic information and to reduce the patient dose to a minimum; the ALARA principle[2]. Quality Assurance in pediatric radiology is even more important, since it is known that children are more sensitive to radiation than adults[3]. Therefore, closer attention should be paid to improve the diagnostic information, reducing the child's doses as much as possible.

In Sudan, the National Assembly in 1996 issued the Sudan Atomic Energy Commission (SAEC) Act. Under this Act, a policymaking Board was established by the Council of Ministers. The SAEC Board, within its mandate, established the Regulatory Authority Radiation Protection Technical Committee (RPTC). It is a national committee responsible for the development of the radiation protection legal framework, licensing procedures, policy making and approving inspections. In Sudan, as well as in most countries, QAP are mandatory in diagnostic radiology departments.

This study aims at evaluating Entrance Skin Dose (ESD) and Effective Dose (E) in AP and PA projections for chest X-ray examinations, for pediatric patients and chest AP and PA, skull AP and PA and Abdomen AP for adult patients in seven Sudanese hospitals. It is expected that this work will contribute to the improvement of diagnostic information and to the reduction of patient's dose.

MATERIALS AND METHOD

Dose measurements were performed in 7 hospitals in Sudan namely: Ahmed Gasim, Khartoum, Omdurman and Elbulk in Khartoum city and Sinar hospital out side of Khartoum city for pediatrics and Khartoum, Elshorta and Elfisal hospitals for adult patients. Data were collected during a period of 6 months (September 2004 – February 2005). The dose values were obtained with the use of the DoseCal software that provides Entrance Surface Dose (ESD), E (Effective Dose). This software has been successfully used to perform patient doses[4] in previous publications. The software, which uses manually entered tube output values and exposure parameters and patients data, 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. The necessary information provided to the DoseCal includes exposure details such as: room number, tube identification, type of examination, projection, focus-to-skin distance (FSD), kV and mAs, together with the patients details such as: age, sex and weight.

The ESD and ED was calculated according to the following equation:

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

$$ED = ESD \times Cf(ED) \qquad (2)$$

where:

S is the standard output factor in $\left(\frac{mGy}{mAs}\right)$ *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, B is the backscatter factor and Cf(ED)is NRPB factor used to convert the ESD to ED, which is almost 10% of ESD .*

RESULTS AND DISCUSSION

Tables 1 and 2 shows, the statistical results of ESD and E dose for pediatric patients in five Sudanese hospitals. The results that are above the recommend ESD limits according to NRPB 1999[5], Reference Dose Levels (RDL) are printed in bold characters. The recommend limits for children are: 50 μGy for newborns and 1 yr old children, 70 μGy for 5 yr olds and 120 μGy for 10 yr old children.

Table 1 - ESD and mean E for AP projection and age range 0-1 and 1-5 years for the five pediatric hospitals in Sudan.

Age		A. Gasim	Khartoum	Omdurman	Elbluk	Sinar
0-1 year	ESD(μGy)					
	Mean	45.25	53.16	**45.5**	**167.44**	**260.5**
	SD	0.0527	0.05	21.94	0.52	56.86
	Min	45.2	53.1	22.5	167	192
	Max	45.3	53.2	77.9	168	325
	Median	45.2	53.2	51.8	167	255
	E (μSV)	7.46	8.66	6.54	31.67	46.05
1-5 years	ESD(μGy)					
	Mean	56.31	53.33	**82.39**	**168.8**	**307.6**
	SD	14.08	0.0097	29.60	0.421	88.74
	Min	45.4	53.2	60	168	185
	Max	72.8	53.35	155	169	405
	Median	45.4	53.33	68.6	169	313.5
	E (μSV)	7.17	7.15	10.78	25.1	44.51

Table 2 - ESD in (μGy) and mean E in (μSv) for PA projection and age range 5-10 and 10-15 years for the five hospitals in Sudan

Age		A. Gasim	Khartoum	Omdurman	Elbluk	Sinar
5-10 year	ESD(μGy)					
	Mean	71.58	55.54	59.56	**166.8**	**194.4**
	SD	0.36	2.48	28.13	0.42	18.88
	Min	71.16	52.6	23.7	166	154
	Max	71.9	57.6	104	167	217
	Median	71.8	57.4	66.65	167	197
	E (μSV)	5.27	4.41	5.1	16.22	17.83
10-15 year	ESD(μGy)					
	Mean	73.36	85.43	68.31	**279**	**311.6**
	SD	4.30	3.33	18.91	0	53.09
	Min	72	80.6	43.7	279	225
	Max	85.6	87.5	86.6	279	398
	Median	72	87.5	72.1	279	313
	E (μSV)	5.37	5.44	5.26	18.71	25.75

The Minimum, maximum and the mean of ESD for the adult patients for the chest PA compared with RDL are shown in figure 1. However, for Alshorta hospital it is 0.5mGy while for Khartoum hospital is 0.30 mGy. It can be seen that the mean ESD for Alshorta hospital is greater than the recommended RDL. Figures 2 and 3 show the mean ESD for abdomen AP and skull AP. It can be seen that for the three hospitals the values are lower than the RDL.

Figure 1: the minimum, maximum and mean of ESD for chest in PA projection in the three hospitals compared with RDL.

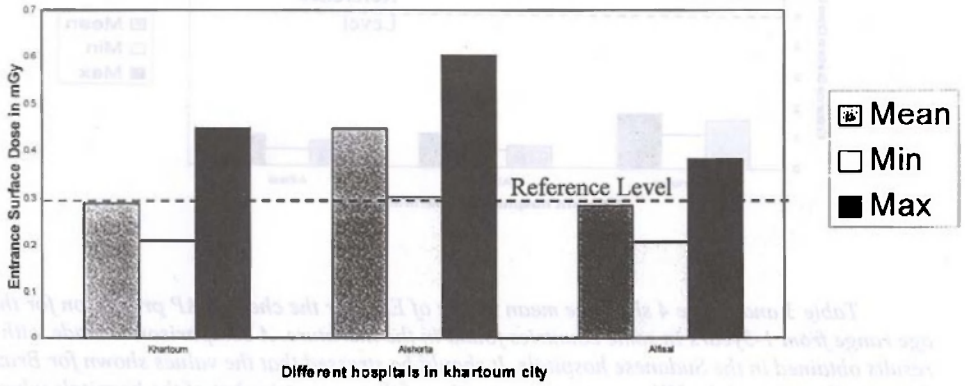


Figure 2: minimum, maximum and mean of ESD for abdomen AP projection in the three hospitals compared with RDL.

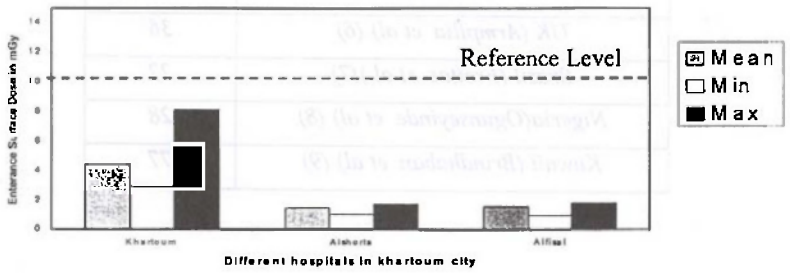


Figure 3: minimum, maximum and mean of ESD for skull in AP projection in the three hospitals compared with RDL

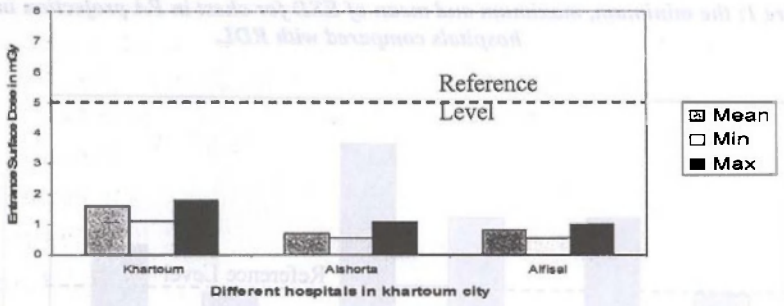
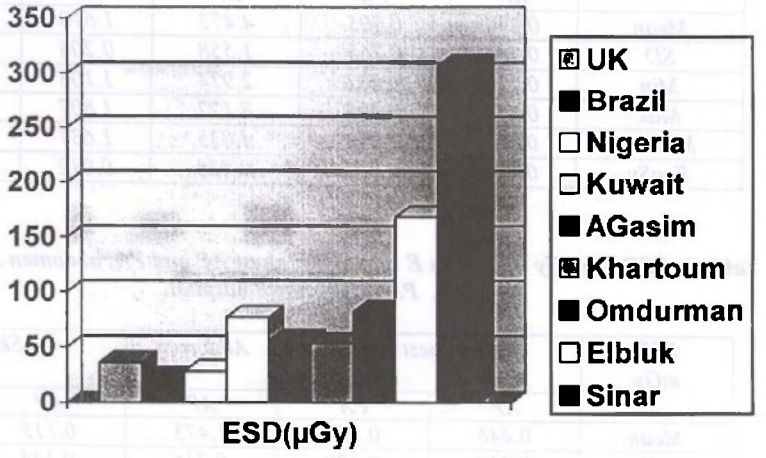


Table 3 and figure 4 show the mean values of ESD for the chest in AP projection for the age range from 1-5years in some countries found in the literature. A comparison is made with results obtained in the Sudanese hospitals. It should be stressed that the values shown for Brazil, Nigeria, Kuwait and the UK are not representative of these countries but of the hospitals where the evaluation was performed.

Table 3: Mean ESD for chest x-ray AP projection (1-5year) in some countries

Countries	*ESD(μGy)*
UK (Armpilia et al) (6)	*36*
Brazil (Freitas et al)(7)	*22*
Nigeria(Ogunseyinde et al) (8)	*28*
Kuwait (Brindhaban et al) (9)	*77*

Fig 4: the Mean ESD for chest x-ray AP projection (1-5) year in Sudanese hospitals and other countries.



The statistical results of ESD in m Gy and the E in m Sv obtained to the adult patients for the chest AP and PA, abdomen AP and skull AP and PA are presented in tables 4, 5 and 6 for Khartoum, Alshorta and Alfisal hospitals respectively.

Table 4:ESD in m Gy and mean E in mSv for chest AP and PA, abdomen AP and skull AP, PA for Khartoum hospital.

ESD mGy	Chest		Abdomen	Skull	
	AP	PA	AP	AP	PA
Mean	0.290	0.303	4.472	1.610	1.724
SD	0.740	0.765	1.558	0.206	0.110
Min	0.210	0.202	2.974	1.108	1.569
Max	0.448	0.494	8.122	1.807	1.880
Median	0.261	0.293	4.035	1.631	1.712
E mSv	0.037	0.025	0.528	0.012	0.010

Table 5: ESD in m Gy and mean E in mSv for chest AP and PA, abdomen AP and skull AP, PA for Alshorta hospital.

ESD mGy	Chest		Abdomen	Skull	
	AP	PA	AP	AP	PA
Mean	0.446	0.551	1.473	0.715	0.833
SD	0.119	0.129	0.216	0.144	0.147
Min	0.302	0.363	0.978	0.570	0.639
Max	0.602	0.726	1.693	1.073	1.036
Median	0.483	0.507	1.560	0.724	0.804
E mSv	0.070	0.053	0.172	0.006	0.005

Table 6: ESD in m Gy and mean E in mSv for chest AP and PA, abdomen AP and skull AP, PA for Alfisal hospital.

ESD mGy	Chest		Abdomen	Skull	
	AP	PA	AP	AP	PA
Mean	0.238	0.266	0.150	0.842	0.966
SD	0.058	0.030	0.269	0.131	0.128
Min	0.207	0.206	0.934	0.560	0.841
Max	0.384	0.301	1.810	1.010	1.270
Median	0.286	0.265	1.510	0.882	0.919
E mSv	0.044	0.025	0.174	0.007	0.006

It can be seen that wide variations have been reported among the sudanese hospitals. For chest AP the ESD varied from 0.29 mGy to 0.446 mGy. The reasons for these variations can be accounted for training and skill of the staff as well as equipment performance. For skull PA in Khartoum hospital the mean ESD is 1.724 mGy whilst for Alshorta hospital is only 0.833 mGy.

CONCLUSIONS

Large doses were found in Sinar and Elbulk pediatric hospitals. The reasons could be the performance of the equipment, the radiographic techniques use and the training and skill of the staff. After the implementation of the QAP in Khartoum hospital the ESD for pediatric patients was decreased by 80 % as compared to a previous publication[13].

We can conclude that a lot can be done to reduce doses in radiology in Sudan and that it is a special concern the pediatric department. if a QAP was implemented on a regular basis. X ray equipment properly calibrated, with a good maintenance schedule, correct processing conditions, adequate screen-film combination, using an intensifying screen and technicians well trained are among the most important items to be considered. It is also of great importance to instruct physicians about the basic principals of radioprotection so that they would be aware of the correct methods to reduce radiation risks in infants and adults.

Absolute values of the E are relatively low in all hospitals for pediatrics and adults patients except Sinar and Elbuluk Hospitals.

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