Use of Medical X-Ray Diagnostic Units in Iraq

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Abstract

The medical use of X-rays represents a major source of population radiation exposure. A special consideration is given to assess the genetically significant dose due to diagnostic radiology.

All medical institutions, hospitals, private physicians and dentists in Iraq, were visited to record: the number and type of X-ray units, the frequency and kind of X-ray diagnostic examinations and number of workers in such units. In addition the protection of the workers from the radiation and the services of personnel monitoring were also observed.

It was found that, up to the end of 1972, there are 407 X-ray units, all over the Republic used for whole body medical roentgenodiagnosis and 146 X-ray units for dental radiography, carrying out more than 4×10^6, and 15×10^4 examinations per year, respectively.

The study gives a clear map of the distribution of the X-ray units in the different parts of the country and can be used as a guide for future radiological health programs. It might also serve as a model for radiation survey and inspection. Also , the figures could be useful in the estimation of the annual genetically significant dose received by the 10 million Iraqis from exposure to diagnostic X-rays.

Introduction

X-ray diagnosis in the application must be used only when highly specifically indicated. The radiation dose received on an individual ground varies with the examination used, the number of exposures during their reproductive period of life and the techniques used.

Diagnostic X-rays started to be used for medical purposes in Iraq since 1917/ 1 /. No scientific measures, concerning protection of personnel and patients were taken until 1972 when a highly specialized committee was established to study this problem.

A legalized regulations were issued by this committee applying what the ICRP suggested for radiological protection and permissible doses / 2-3 /.

Therefore in respons to the need of radiological health program for an effective method of surveying of all radiation sources, the Radiation Control Board requested all medical institutions and hospitals, to register radiation sources and give full details of thier uses.

The survey covered approximately 99% of the radiation machines, which constitute the subject of this paper for the year 1972.

Materials and Method

Regulations were issued restricting the sale and import of diagnostic X-ray films or any spare parts without permission. Such permission is now given only after a visit to the X-ray machine in order to record the number and type of the unit, the frequency and type of X-ray examinations performed, output measurements at various tube voltages and the different age groups of the patients of both sexes. In addition, the protection of the workers from the radiation and the services of personnel monitoring were also observed.

With regard to the dose measurements, skin dose estimation either of the critical organs was made directly on patients during different types of X-ray examinations. Film badges type E.R.P. 30 Black Spot, such as personnel monitoring film badge with kodak radiation-monitoring films were used for these measurements for practical reasons and availability. The contribution of radiography to gonadal dose is a complex function of applied peak kilovoltage, tube traget to skin distance, volume of the tissue in the primary beam, the sex and age of the patient / 4 /.

The dose received by gonads in 70 patients exposed to radiation for diagnostic purposes was calculated. The genetically significant dose was obtained from the following formula / 5 / :

$$D = \frac{\sum_j \sum_k \left(N_{jk}^{(F)} W_{jk}^{(F)} d_{jk}^{(F)} + N_{jk}^{(M)} W_{jk}^{(M)} d_{jk}^{(M)} \right)}{\sum_k N_k^{(F)} W_k^{(F)} + N_k^{(M)} W_k^{(M)}}$$

where

D = (annual) genetically significant dose.

N_{jk} = (annual) number of individuals of age-class k, subjected to class j exposure.

N_k = total number of individuals of age-class k.

W_{jk} = future number of children expected by an exposed individual of age-class k subsequent to a class j exposure.

W_k = future number of children expected by an average individual of age-class k.

d_{jk} = gonad dose per class j exposure of an individual of age-class k.

(F) and (M) denote "female" and "male" respectively".

Results

A. Number of machines and area distribution :

A total number of 553 X-ray machines were used in Iraq for diagnostic purposes (Table I), 407 conventional X-ray units are used for general diagnostic medical purposes, the remaining I46 units are used only for dental purposes. Some of these machines are quite old (since I934).

30.5% of the conventional X-ray machines are found in private clinics, while in the case of dental X-ray machines the number of the machines in the private clinics were higher than the governmental machines (53.3% of the total dental machines).

With regard to the area distribution, Baghdad(the capital) has the higher number of machines; Basrah came the next and Nineva came the third. Other provinces are more or less similar in the number of the X-ray machines used.

Table 2. shows the different firms of both conventional and dental machines used in Iraq. Since there are approximatly I0 millions inhabitants in Iraq at the end of I972 /6/, it means that the average is I medical diagnostic X-ray machine for each 25×10^3

inhabitants and I5 dental X-ray machines for each million inhabitants.

Table I. Distribution of X-ray machines by Goveronarates (Muhafadha).

Muhafadha	Inhabitants %	Diagnostic Public	Diagnostic Private	Diagnostic Total	Dental Public	Dental Private	Dental Total
Duhok	II.I	4	-	4	I	-	I
Nineua		I8	9	27	6	5	II
Arbil	4.5	I2	2	I4	I	-	I
Kirkuk	5.9	I3	6	I9	2	3	5
Sulaimaniye	4.7	II	3	I4	3	-	3
Diyala	4.5	9	I	I0	I	-	I
Baghdad	25.5	I07	79	I86	29	53	82
Al-Anbar	3.9	II	I	I2	2	-	2
Babylon	5.7	II	2	I3	I	2	3
Karbala	4.2	II	4	I5	4	3	7
Al-Kadisiye	6.8	9	2	II	I	I	2
Al-Mouthana		5	I	6	I	-	I
Wasut	4.2	7	2	9	2	-	2
Thecare	6.4	9	I	I0	4	3	7
Measan	4.3	I2	I	I3	3	I	4
Basrah	8.4	34	I0	44	7	7	I4
Total	I00	283	I24	407	68	78	I46
		69.5%	30.5%	I00.6%	46.%	53.4%	I00%

Table 2. Distribution of X-ray machines in Iraq by manufacturers

Manufacturer	Diagnostic Public	Diagnostic Private	Diagnostic Total		Dental Public	Dental Private	Dental Total	
Siemens	53	46	99	24%	6	7	I3	9%
Philips	48	30	78	I9	I	7	8	5
General Electric	29	I0	39	I0	II	-	II	8
Generay	83	-	83	20	-	-	-	
Watson	30	7	37	9	-	-	-	
Tur	29	6	35	9	-	-	-	
Explor	-	-	-		-	29	29	20
Kavo	-	-	-		24	-	24	I6
Honda	-	-	-		II	-	II	8
Ritter	-	-	-		I	5	6	4
Other Types	8	I5	23	6	6	25	3I	2I
Unknown	3	I0	I3	3	8	5	I3	9
Total No.	283	I24	407		68	78	I46	
%	69.5	30.5	I00		46.6	53.4	I00	

B. Number of X-ray Examinations :

In the estimation the number of radiographs taken during fluoroscopic examinations were included in the list under radiography and one examination means one exposure. All types of examination concerning radiography and fluoroscopy were classified to I0 forms as shown in Table 3, which also illustrates details regarding the age, sex and area examined in a total number of one thousand patients examined in different diagnostic X-ray machines except

mass miniature radiographies and dental, because it was difficult to know the sex of patients in these last two types of examinations.

Table 3. Frequency in thousand of diagnostic examinations by age, sex and type examination.

Type of Examenation	0-15 years M	0-15 years F	16-20 years M	16-20 years F	21-30 years M	21-30 years F	31-45 years M	31-45 years F	46-50 years M	46-50 years F	50- years M	50- years F	Total M	Total F	Total %
Hands	I2	5	5	I	I5	3	3	3	3	I	I	3	39	I6	5.5
Head&Neck	I2	25	I0	I2	37	27	I3	22	3	3	8	I7	83	I.6	I8.9
Feet	7	3	2	7	5	7	7	3	5	I	I	I	27	22	4.9
Chest	25	25	5	32	27	35	23	37	I5	I0	32	8	I27	I47	27.4
VertebralCol.	3	3	3	I0	22	7	I7	7	5	7	I2	7	62	4I	I0.3
Gall Blader	I	I	I	I	3	3	I	5	I	5	I	I	8	I6	2.4
Stomach	I	I	3	I5	32	25	25	22	7	8	I2	5	80	76	I5.6
Urinary Tr.	I5	2	8	I0	I7	I8	II	I3	2	II	3	6	56	60	II.6
Belvis	3	3	I	3	I	5	I	I	I	I	2	I	9	I4	2.3
Bregnancy	-	-	-	5	-	5	-	I	-	-	-	-	-	II	I.I
Total M	79		38		I59		I.I		42		72		49I		I000
Total F		68		96		I35		II4		47		49		509	
%	I4.7		I3.4		29.4		2I.5		8.9		II.I		49.I	50.9	I00%

27.4% of the total examination in Table 3 were performed for chest X-ray examination, while the head and neck X-ray examination came to be second in frequency(I8.9%), stomach and the surrounding organs(gall bladder and liver) constituted about I8% of the total X-ray examination done. Pelvis X-ray diagnosis constituted about3.4% of the total X-ray tests. The urinary tract X-ray diagnostic tests constituted II% of the total examinations.
With regard to age grouping, Table 3 shows that I4.7% of the test were done on patients under the age of I5 years of both sexes. While I3.4% of the tests were done on patients between I6-20 years old .

The age group 2I-45 years which constitute the active reproduction age specially in women, reached 5I.9% of the total number examined in this table . With respect to the other older age groups, it appears that a relatively small percentage of patients were examined. Regarding the total male to female ratio of the one thousand patients examined in this work, the ratio was nearly one. The official census of the population indicates that there are 5.073,600 males and 5,000,600 females in Iraq at the end of I972/6/.

The total number of radiographic examinations was $4.2 \times I0^6$ diagnostic examinations. Nearly 2I% them were mass miniature radiographies. While the annual total number of dental X-ray examination was about $I50 \times I0^3$ examinations. The astimation shows that the patients performed in average 2.2 examinations each visit. Therefore it appeared that thefrequency is 2 persons from I0 inhabitants were undergone diagnostic examinations yearly. Morever, about I5 persons out of I000 had dental X-ray examinations annually.

Table 4a showes the total number of X-ray examinations done on different parts of the body of both sexes and the gonad dose measured from each particular examination.

The man-rad/year received, was the highest in performing the abdomination, which is in the rahge of $7.8 \times I0^5$ man-rad/year. The mass chest X-ray miniature constituted the second man-rad/year received. Other clinical examinations gave a significant decrease in man-rad/year dose in comparison with the above mentioned diagnostic tests. The total man-rad/year for all types of

examinations 8 x 10^5 man-rad/year.

Table 4a. Total gonad dose in man-rad due to examinations of both sexes (Figures are taken 1000 exm.per year).

Type of Examination	Male		Female		Total	
	No.exm.	gonad dose man-Rad	No.exm.	gonad dose man-Rad	No.exm.	gonad dose man - rad
Mass miniature					820	2.700
Extremities	225	0.220	129	0.130	354	0.350
Head& Neck	282	0.280	360	0.360	642	0.640
Chest	423	0.860	500	1.000	932	1.860
Abdomen	731	329	741	445	1472	774 99%
Dental					150	0.300
Total	Gonadal dose 779.85 x 10^3 man-rad/year.					

Table 4-b represents the genetically significant dose received by both sexes of the Iraqi population.It is apparent that the dose received from the use of the dental machines is significantly smaller than the dose received from the conventional X-ray diagnostic procedure.The calculation of the annual genetically significant dose resulted in a value of 52 m rad for 1972.

The accuracy of this result is probably of the order of 60%. The number and technical data for measurements are reported by the author in a separate paper/7/.

Table 4b. Genetically signigicant dose by sex (mrad/person per year).

Sex	Type of exam.		Total G.S.D. mrad/year	%
	Diagnos.	Dental		
	mrad /year			
Male	25.62	0.15	25.77	49.65
Famale	26.03	0.15	26.18	50.35
Total	51.65	0.30	51.95	100

Discussion

There is no general standard system to distribute the X-ray machines over the different parts of Iraq.But one can make his own conclusion from table I,which reflects the relation between the density distribution of the population and the X-ray units.The relatively high number units of (45.7% and 56.1%)of the total conventional diagnostic and dental units respectivly in Baghdad area is due to the number or its inhapitants (25.5% of the total population of the country) and the same situation is true in Basrah and Nineva.Another reason for this distribution may be attributed to the preference of most doctors to live and work in large cities.One the other hand,wherever the official numbers of units are high,the number of private units are high too.This may be due to the permission is given only to specialist doctors in radiological fields to possess X-ray units in private clinics. This permission is given to any dentist.It is found that the private specialists in medical radiology themselves are mainly the official ones.Sometimes specialists with high qualification in other fields might be granted a permission too.

A total number of 407 conventional X-ray machines performing an annual frequency of 420 X-ray examinations per 1000 persons. This figure of examinations is similar to the figures obtained in many other countries which had carried out comprehensive survey /5/ while our number of instalations per 1000 of total populations are less.From Table 2 it is shown that there are only 6 firms

which supplied about 90% of the conventonal units and 7 firms supplied about 70% of the dental X-ray machines.This situation makes it easy for detestimation of the dose received from all machines. The average operating peak kilovoltages has been found to be 70 KVP in conventional machines and (50-60).KVP in dental.

Data of Table 3 included sex categories by sex and age .Each category encompassed the types of examinations.It seams that 20% of the total patients are less than 30 years old.The last percentage of patient is to be considered when discussing genetic effects.

The abdominal(stomch,vertebral column,gall bladder and urinary tract)examinations which comprised 33.7% of all the examinations,give exposure values representing about 99% of the average gonadal exposure as shown in Table 4a.In estimation of genetically significant dose,the individual gonad dose is weighed with a factor taking in to account the future number of children expected.However the total gonadal dose is about 780 x 10^3 man-rad/year,the genetially significant dose resulted is 52 mrad/year which is a high figure in comparison to that of other countries having frequencies between 8 and 44 mrad/year/4,5,8,9/. However,this dose is still below the dose recommended by ICRP, which is 5 rem over a period of 30 years.

Conclusions

I.The study gives a clear picture of the X-ray unit distribution in different parts of Iraq,which is somewhat satisfactory.

2.The annual number of radiographic examinations is expected to be soon more than 5 x 10^6. It is thought advisable to start a local film production.As long as films are,for the time beeing, imported,this study will help very much in the estimation of the annual need of these films.

3.Since the genetically significant dose (52 mrad/year)is higher than that in other countries,beside that we have no data for the past years about the number of diagnostic X-ray examinations per year,it seams that there is an urgent need for the reduction of the annual genetically significant dose from X-ray examinations, although very few people are being exposed.

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