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An investigation of radiological assurance of administrators and inspectors because of CT filter radiation spillage

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Abstract

Rate of radiation leakage from the CT-Scan rooms was measured for 10 public hospitals in Iraqi Kurdistan, using radiation survey dosimeter. Annual exposure dose was considered as a main factor to asses risks of that leakage on the health of operators and auditors. Average leakage dose was measured at the control room, table of operators, the main doors, and waiting hall. Average time of exposure for the years of 2009, 2010, and 2011 were evaluated through the data of the statistics unit in each hospital. Knowledge of recent trends in the radiation dose from CT examinations and their distribution for the Iraqi Kurdistan hospitals provides useful guidance on where best to concentrate efforts on patient and operator dose reduction in order to optimize the protection of the patients and operators in a cost-effective manner. The results show that the range of exposed dose by the operators and auditors depended on the rate of leakage dose and the time of exposure. The largest and smallest amount of annual radiation dose received by the operators was in the Hawler Teaching Hospital (51.55±67.189 µSv) in Erbil, and Shahid Aso Hospital (0.222±0.061 µSv) in Sulaimaniyya, respectively. On the other hand, the largest and smallest amount of annual radiation dose received by the auditors was in the Azady Hospital (469.884±283.1 µSv) in Duhok, and Shorish Hospital (0.324±0.18 µSv) in Sulaimaniyya, respectively. Hence, the much increased contributions of CT procedures to the Kurdistan region population dose indicate an urgent need to develop radiation protection and optimization activities for these high dose procedures to the low and accepted levels.

Keywords: Computed tomography, radiological protection, leakage of radiation, Iraqi Kurdistan.

INTRODUCTION

Computed topographic (CT) scanner is widely used in lung, abdomen, and head. It is considered as the largest man made sources of radiation exposure to the population. Early radiation effects usually are related to a significant fraction of cell loss, exceeding the threshold for impairment of function in a tissue (Rydberg et al., 2000). The basic principles of using CT X-ray source are tightly collimated to interrogate a thin "slice" through the patient. The source and detectors rotate together around the patient, producing a series of one-dimensional projections at different angles (David and Eric, 2007).

Radiation which escapes from the X -ray tube housing through places other than the desired X-ray window is considered as a leaked radiation. The leaked radiation increases the dose of the patient and their surroundings and increases the scattered projection measurements though it does not contribute to the information carrying the primary radiation. In conventional computed tomography (CT) scanners, leakage radiation is found to be on the order of 1.5-5 myriads per scan at one meter from the scanner centre using standard scan technique factors (400 mAs, 140 kVp with a body phantom in place

Figure 1. Survey radiation dosimeter used to measure rate of exposure (µSv/h). (µSv/h).

(David and Eric, 2007; Annals of the ICRP, 2011). The actual leakage radiation depends on the system, the tube output and the presence of scattering material (such as a patient) within the gantry. Legislation in different countries restricts the leakage radiation at one meter distance from the tube when operating at maximum high voltage and corresponding tube current (Annals of the ICRP, 2011; Sasa et al., 2003).

Knowledge of recent trends in the radiation dose from CT-scan examinations and their distribution for the Iraqi Kurdistan hospitals provides useful guidance on where best to concentrate efforts on patient and operator dose reduction in order to optimize the protection of the patients and operators in a cost-effective manner.

The population of Iraqi Kurdistan is exposed to ionizing radiation from a number of natural and man-made sources. Since their discovery at the turn of the last century, the use of X-rays to see inside the body, without recourse to more invasive techniques, has been of enormous benefit in the safe and effective diagnosis of a multitude of diseases and injuries. Medical imaging technology has evolved rapidly, particularly over the last 10 years (since 2003). Not only has technology developed and the sensitivity of imaging devices increased, but, radiation protection has received increasing attention in diagnostic radiology in Iraq (National Council on Radiation Protection and Measurements, 1993; Towards a Strategy for Cancer Control in The Eastern Mediterranean Region, 2009).

In this research, the results of a recent survey of the frequency of CT-scan examinations in Iraqi Kurdistan hospitals and contemporary data on the radiation doses typically received by patients and operators are used to assess trends in the extent and the pattern of the population exposure.

The relationship between radiation exposure or dose and risk is age and gender specific due to latency effects, differences in tissue types and sensitivities, and differences in average life spans between genders**.** These relationships are estimated using the double detriment life-table methodologies recommended by the NCRP (2000) (National Council on Radiation Protection and Measurements, 1993) and more recent radiation epidemiology information (Preston and Shimizu, 2003; Cucinotta et al., 2006).

RESEARCH METHODOLOGY

To estimate the annual exposure dose from all CT-Scan examinations, information is required on the annual frequency and mean effective dose for each type of examination. A recent survey (statistical unit in each hospital was used to perform the survey) of the frequency of CT-Scan examinations in each hospital in Iraqi Kurdistan was used to provide the information on the annual numbers of CT-Scan examinations. This contains data collected in the period from 2009 to 2011 covering about 4 types of radiograph and 60000 types of CT-Scan examination.

Survey radiation dosimeter (Figure 1), which is a digital dosimeter Inspector Ext., version 2.1, model: 2-0033-10, S/N: 8307-019, was used to measure the rate of exposure (µSv/h) of leakage radiation from the CT-Scan rooms. It was made by RCTEM INDUSTRIES C€, and is a portable radiation survey meter with external probes for all kinds of radiation. Its internal detector has a measuring range from 0.5 to 1100 µSv/h, with a background check of <0.104 µSv/h.

Ten public hospitals were selected from the Governorates of Erbil (Arbil), Dohuk, and Sulaimaniyya in Iraqi Kurdistan regions (Figure 2). Average leakage dose was measured annually for each hospital for the positions of: control room, table of operators, the main doors, and waiting hall. The data (number of cases/ year) were got from the statistic unit of each hospital. Data analysis for the annual exposure dose was done for each position, though background radiation dose was taken into account.

RESULTS AND DISCUSSION

Leakage radiations were surveyed and estimated from the CT rooms inside the public hospitals of Iraqi Kurdistan. Risks of leakage on the operator"s health were evaluated according to the time of exposure per year,

Figure 2. Sketch map of the area under study.

Table 1. Exposed average dose by the operators per year for each hospital through a control room (operators" table and the indoor window of the CT room).

Governorate	Hospital name	Average leakage (µSv/h)	Real time of exposure (h/year)	Average case per year	Average of annual exposure dose (µSv)
Erbil (Capital)	Rizgary	0.235±0.191	30.491	7318±60.811	7.18±5.823
	Raparin	0.222±0.277	13.379	3211±341.11	2.966±3.705
	West Emergency	0.0842±0.005	8.587	2061±110.2	0.722±0.0429
	East Emergency	2.036±2.515	18.42	4421±332.76	37.503±46.326
	Hawler Teaching	1.9856±2.588	25.962	6231±341.92	51.55±67.189
Dohuk	Azady	0.311±0.1225	23.466	5632±321.76	7.288±2.874
	Emergency	0.235±0.192	17.758	4262±224.33	4.182±3.41
Sulaimaniyya	Shahid Aso	0.052±0.0142	4.287	1029±102.44	0.222±0.061
	Shorish	0.126±0.108	8.791	2110±111.41	1.109±0.95
Common information	1) Maximum dose for the abdomen scans has been used for the present study. 2) Time of staff"s exposure variable from 5 h per day to 10 h per day. 3) The thickness of the lead shielding of the door is around 2.5 mm. 4) Measurement process in the CT-Scan room inside Western Emergency Hospital is within 24 h.				

and the results are listed in Table 1. Average exposed dose by the operators per year for each hospital was measured through a control room (operator"s table + indoor widow of CT room). The public Hawler Teaching

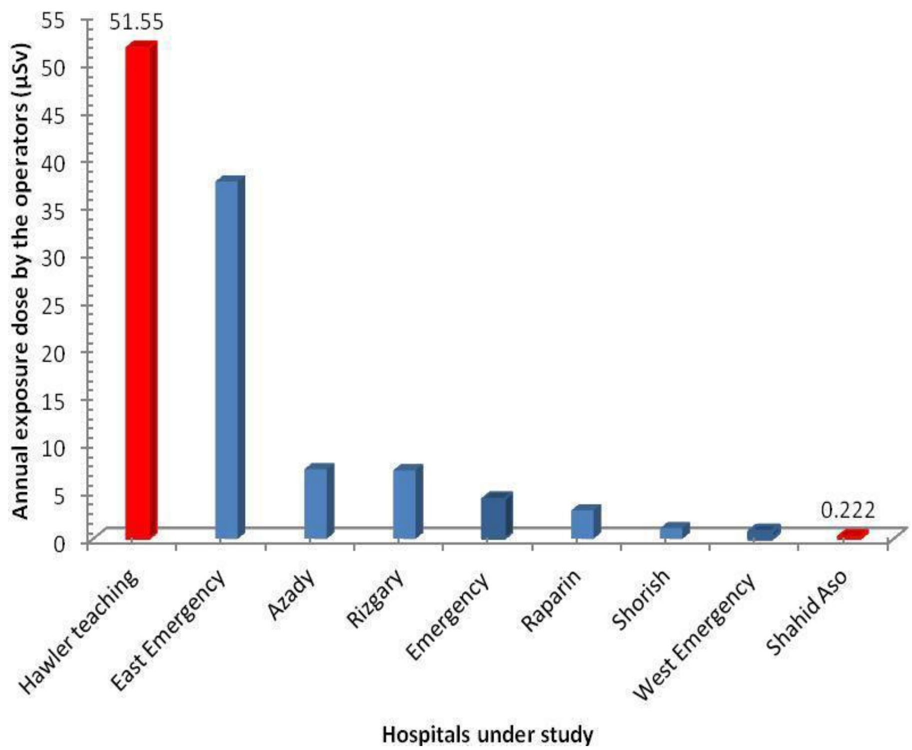

Figure 3. Amount of annual exposure dose inside the operators control room of CT Scan for Iraqi Kurdistan hospitals.

Hospital in Erbil city (capital of Iraqi Kurdistan) poses more danger to operator‟s health (51.55±67.189) µSv/yr, due to bad machine (its calibration is not more than 1 year) and the design of shield with adequate attenuation to achieve the required (or acceptable) dose equivalent (rate) limitation (or ALARA) not acceptable. On the contrary, the Shahid Aso Hospital in Sulaimaniyya city was safer than the other hospital (0.222±0.061) µSv/yr (Figure 3). This is because the shielding and protection systems of this hospital are perfect and acceptable with the international standard. In addition, the time of exposure (hour per day) was adequately comfortable (5-6 h/day).

Risks of radiation leakage on the health of auditors and any other workers that have taken rest or waited behind the outdoor gate of the CT rooms were evaluated too. Essentially, the evaluation of that depended on the time of exposure per day and per year. Evaluation of the risks listed in Table 2 depended on the assumption of the time of exposure as equal to 2 min per day (12 h/yr) (Note: this was assumed for 7 auditors, and it was the minimum exposed time for the auditors). Annual exposed dose by the auditors per year for each hospital was measured through waiting halls.

Azady Hospital in Duhok city was very much higher and more dangerous to auditor‟s health (469.884±283.1 µSv/yr) than the other hospitals. This is because of the engineering design of the shield (outdoor) and the unacceptable location of the CT room (it was in contact with the waiting hall). However, most of the staff have no experience about the risks of the scatterings of radiation on the auditors‟ (combining persons) health. So, places of the combined persons have not been well protected by management of the hospitals. On the other hand, Shorish Hospital in Sulaimaniyya city was safer than the other hospital (0.324±0.18 µSv/yr) (Figure 4). This is because the shielding and protection systems for the auditors (waiting hall) of this hospital are well protected.

The results show that the hospitals of Sulaimaniyya are safer as regards the health of the operators and the auditors than the other hospitals of Erbil and Duhok, relatively.

CONCLUSION

Radiation leakage from the CT-Scan rooms was measured for 10 public hospitals in Iraqi Kurdistan, using radiation survey dosimeter for years 2009-2011. Risks of the radiation leakage on the health of operators and auditors were assessed. It was found that the leakage dose rate varied from one hospital to another, and it depended on the time of exposure (case/day), though risks of the leakage was clearly observed through the outdoor gate (place of auditor‟s wait). Generally, hospitals of Sulaimaniyya governorate were

Table 2. Exposed average dose by the auditors per year (2 min/day exposure time: 12 h/year) for each hospital through the waiting halls (out door of the CT- scan room/behind the door of the CT room).

Governorate	Hospital name	Average leakage (µSv/h)	Average case per year	Average of annual exposure dose (µSv)
Erbil (Capital)	Rizgary	18.943±14.793	7318±60.811	227.32±177.52
	Raparin	3.127±3.479	3211±341.11	37.524±41.74
	West Emergency	3.959±3.303	2061±110.2	47.508±39.63
	East Emergency	0.1832±0.087	4421±332.76	2.1984±1.044
	Hawler Teaching	2.314±0.727	6231±341.92	27.768±8.724
Dohuk	Azady	39.157±23.591	5632±321.76	469.884±283.1
	Emergency	24.793±18.943	4262±224.33	297.51±227.32
Sulaimaniyya	Shahid Aso	0.467±0.405	1029±102.44	5.604±4.86
	Shorish	0.027±0.015	2110±111.41	0.324±0.18
Common information	1) Maximum dose for the abdomen scans has been used for the present study. 2) The thickness of the lead shielding of the door is around 2.5mm. 3) Measurement process in the CT-Scan room inside Western Emergency Hospital is within 24 h. 4) Time of auditors„s exposure considered by 2 min per day (12 h/yr).			

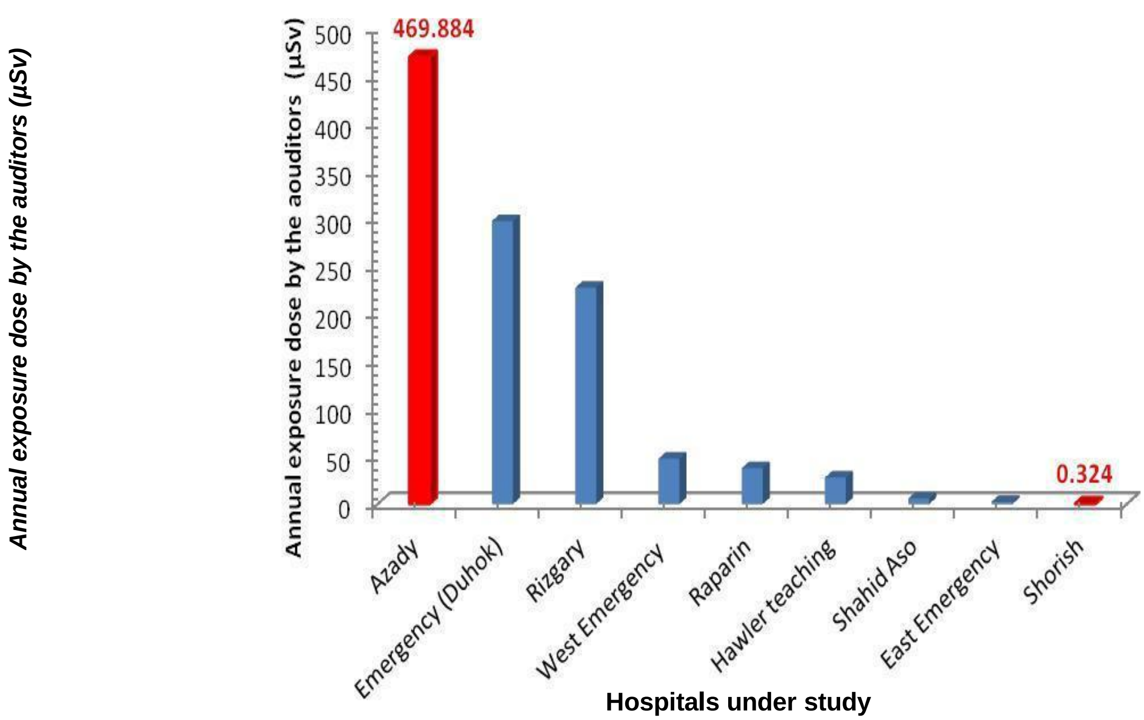

Figure 4. Amount of annual exposure dose (µSv) of the auditors inside a control room of Iraqi Kurdistan hospitals

safer as regards the health of operators and auditors than the hospitals of Erbil and Duhok governorates.

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