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# Environmental Survey and Quality Control Tests of X-RAY Diagnostic Facility of Hospitals in Iraqi Kurdistan Region

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**Abstract**

**Background:** Medical x-ray exposures have the largest man made source of population exposure to ionizing radiation in different countries. Recent developments in medical imaging have led to rapid increases in a number of high dose x-ray examinations performed with significant consequences for individual patient doses and for collective dose to the population as a whole. It is therefore important in each country to make regular assessments of the magnitude of these large doses.

**The aims** of this study to Environmental monitoring and quality control test of X-ray facilities of Kurdistan region hospitals was carried out.

**Methods:** Data on the number of diagnostic procedures using x-ray examination in year 2010- 2011 in four governmental hospitals. The **palm RAD 907** measures the rate of the x-ray radiation. Questionnaires were also used to elicit information from the most senior personnel of the hospital.

**The results** show that the facilities for safety were grossly inadequate and the dose rates of **11.75**µSv/hr and **10.48µSv/hr** were recorded at Place for standing radiographic respectively. The dose rates at the Behind x-ray door room at least **3.123µSv/hr** indicating higher health risk to the visitors and personnel at the hospital. However, recommendations on how to improve on the safety of the all staff of the X-ray unit, patient and personnel were sent to the management of the X-ray unit of the hospital.

**Keywords:** Radiation Protection, Dosimeters, X-Ray and Health risk.

## Introduction

Monitoring of radiation doses received by staff in radio-diagnostic centre is of great importance to the radiographers in their effort to protect themselves, patients and the general public from the untoward effect of excessive radiation. It is clearly sensible for those involved in the use of ionizing radiation in diagnostic radiology to have an appreciation of the possible risks involved {1}. Diagnostic x-rays are the largest man made sources of radiation exposure to the population, contributing to about 14% of the total annual exposure worldwide from all sources. Although diagnostic x-ray provides great benefits, its use carries some risk of developing cancer {2}.

Patients and medical personnel's receive various doses of ionizing radiation from both naturally occurring and man made sources. The level of doses received depends on the occupation, level of radiation in the environment and where an individual lives. Depending on where an individual lives, most people receive an exposure in the range of **1mSv Rem per year** from cosmic radiation from outer space and from naturally occurring isotopes in the ground, air, food and water. Nevertheless, X-ray examinations are common place and contribute by far the largest man made source of ionizing radiation exposure for the population {3}.

More than ever before, in the recent times, there has been a constant increase in the number and frequency of X-ray examinations {4} because of the increase in availability of the X-ray facilities in developing countries. In Kurdistan region, almost every state owned hospitals has at least an X-ray unit. The Teaching hospital and medical centers have between two and four X-ray units. The private hospitals have at least an X-ray unit. In some Teaching hospitals (THs) and private hospitals there are Computer Tomography (CT) units.

The dosimeter readings are kept as records for every staff for the purpose of evaluating their radiation history and possible risks involved. The records help in improving radiation protection practices in clinical settings. At the Washington State University, employees who have not had a radiation monitoring badge before must apply for and receive one before starting work involving radiation exposure {5}.

Meanwhile, in the Nigeria hospitals which spread The contributes certain doses of ionizing radiation to the existing background radiation dose level. Due to the fact that radiation does not respect nationality, experience and professionalism, it is expected that workplace be monitored at a frequency that will ensure safe working conditions {6}.

The purpose of a radiation monitoring programmed is to identify all sources of radiation exposure within an operation area, to assess the level of radiation exposure of the employee and members of the public so that timely detection of changes in radiation parameters which may lead to increased exposures, and to produce sufficient information for optimization purpose {7}.

In the past in Nigeria, the responsibility of monitoring facilities using ionizing radiation and the environmental test of the facilities rested solely on the Federal Radiation Protection Service (FRPS), earlier survey reported in another place showed that out of the 22 hospitals in 8 states 9.1% have never used any dose monitoring device and 9.1% have never calibrated their equipment. Also, 81.8% have never calculated the dose to the patient as required by international regulatory bodies, while many hospitals have never carried out any quality control (QC) test of their facilities. And in most cases environmental monitoring has never been carried out {8}. Exposure to ionizing radiation is most strongly associated with leukemia and cancer of the thyroid, breast and lung. An association has been reported at the absorbed dose of less than 0.2Gy {9}.

The risk of developing cancer, however, depends to some extent on age at exposure, level of exposure (dose received). Moreover, the risk of carcinogenesis is generally greater for children than the adults and the genetic consequence of doses to the gonad in pediatric patients are also higher than in adults {10}. Additionally, some evidence suggests that lung cancer risk may be most strongly related to exposure of latter age in life. Relationship between radiation exposure and cancer of the salivary gland, stomach, bladder, ovary, colon, central nervous system (CNS) and skin have been reported usually at dose greater than 1Gy {11,12}.

## Materials and Methods

The environmental monitoring in this study was carried out using calibrated radiation monitor device **palm RAD 907 Fig. 1**. Questionnaires were also used to elicit information from the most senior personnel of the hospital. The study was carried out at the X-ray unit of the Kurdistan Region hospitals. The palm RAD 907 measures the rate of the following types of nuclear radiation (Alpha, Beta, Gamma & X-radiation).


Fig. [1]: palm RAD 907

**Results & Discussion**

The finding of our survey is appalling considering the importance of radiation monitoring to radiography practice. Determining radiation dose received by personnel will ensure reduction of untoward biological radiation effects. Radiation exposures in medical practice are usually no accidental and protection is usually geared towards reducing stochastic effects, which likelihood is determined by the magnitude of the absorbed dose {13}.

Table [1] shows the X-ray machine specific data. The data show that the X-ray machine is manufactured more than 15 years ago and all machines is working electronic except one of them worked by hand.

Table [2, 3, 4, and 5] indicates the measured dose rate value in μSv/hr at different hospitals and location within and around the X-ray room. The measured values here show that the dose rate measured at five different points was far above the **background dose rate**. The dose rate measured at the patient waiting room was far above the background radiation dose rate, while the exposure of the patients was going on.. This high dose rate could mean a higher health risk to the unsuspecting supportive personnel such as nurses, hospital attendants and the visitors. Such dose rate at the reception could pose more serious problem to a pregnant personnel who is expected to have a dose limit of 2 mSv to the surface of her abdomen (the fetus). Recommendation of the International regulatory body stipulates that pregnant radiation workers should not work in areas where there is a risk of getting more than 30% of the allowed whole body limits for radiation workers. In addition, pregnant personnel should not be allowed to work in fluoroscopy, theatre radiography, mobile X-ray units or interventional radiography.

Table 6 [A&B] shows the general observation in terms of facilities for radiation safety within and around the X-ray machine. The results indicate that the door that leads to the X-ray room was not efficiently lead lined; this inadequacy could have led to the high dose rate at the reception and patient waiting area. The results also show that the cubicle is not efficiently lead lined. Interlock was not provided for the door and the door could not close automatically during the exposure to prevent intruders. It is necessary to note that controlled access to areas where radiation exposure may be taking place is required. It is also evident from table 6 that hazards warning light and personnel monitoring (TLD badges) were not provided. In addition, qualify radiographer was not available and log books for keeping records of radiation protection activities in the unit were not available. The lead apron required to be worn by the radiographer during exposure was visibly missing. It therefore, implies that in the X-ray unit of the hospital, the issue of safety of personnel and patients are not adequately taken into consideration. Apparently the preoccupation of the management and the personnel was the image quality at the expense of patient health risk. This trend is an indication that the principle of as low as reasonably achievable (ALARA) principle was not adopted in the hospital.

The quality control test of X-RAY machine is done at least one year, the quality control test (test of accuracy, consistency and reproducibility). The test for kVp accuracy, kVp consistency and timer accuracy were outside the acceptable limit. This inconsistent nature of the kvp could have adverse effect on the image contrast and leads to repeated exposure of the patient. Since the length of exposure affects the total quantity of radiation (mAs) emitted from an X-ray tube, therefore an accurate exposure timer is essential for good radiographic imaging. The quality control tests for CT-Scan at least three months, the results of QA passed examination because our protocol is good.

Patient doses for the same examination are known to vary widely between countries and even between hospitals in the same country, so estimates of national mean doses based on just local or foreign data will not be very reliable {14,15}.

More importantly, qualified radiographer, darkroom operators and medical physicist were not available to carry out the necessary procedures and to look into the safety report of the activities of the hospitals. Available data indicate that, the X-ray centre has never employed the services of Radiation Protection officer and Medical Physicist whose role are very important in diagnostic radiology.

In this study we have undertaken the quality control test and environmental monitoring of the facilities of X-ray unit of **Kurdistan region** hospital. The quality control test obtained fall short of the required standard of International Commission on Radiological Protection (ICRP) and National Council on Radiation Protection (NCRP). In addition, facilities for the safety of both the public and personnel were grossly inadequate.

Based on the recommendation of these findings and the follow-up studies, general overhauling of the facilities has since commenced. Recommended safety and radiation monitoring materials have been put in place. Moreover new X-ray machine has been ordered.

**Table 1: X-Ray Machine information**

| Name of hospital | Number Room. | Machine name | Made from | Type Of machine | work | tube |
|---|---|---|---|---|---|---|
| Rizgary | 1,3,5,6,7&8 | Siemens | Germany | Const. | electronic | Standard |
| | 2&4 | shimadzu | japan | Const. | electronic | Standard |
| | | | | | | |
| Emergency | 1&2 | Silhouette | USA | Const. | electronic | Standard |
| | | | | | | |
| Raparin | | Siemens | Germany | Const. | electronic | Standard |
| | | | | | | |
| Hawler | 1 | IM5 | Italy | Const. | electronic | Standard |
| | 2,3,4,5,6,8&9 | Siemens | Germany | Const. | electronic | Standard |
| | 7 | shimadzu | japan | Const. | By hand | Standard |

**Table 2: Dose rate measured at different location in Hawler Teaching hospital**

| Hospitals & NO. of rooms | Point of interest | Description | Dose rate μSv/ hr |
|---|---|---|---|
| 1- Hawler Teaching Hospital Room No. 6 | • Place for standing radiographic<br>• Behind x-ray door room<br>• Behind direct x-ray room<br>• Cleaning room<br>• Place for waiting patient | Head | 0.305<br>0.143<br>0.120<br>0.088<br>0.099 |
| 2- Hawler Teaching Hospital Room No. 1 | • Place for standing radiographic<br>• Behind x-ray door room<br>• Behind direct x-ray room<br>• Cleaning room<br>• Place for waiting patient | Chest and Service | 0.117<br>3.123<br>0.083<br>0.123<br>0.083 |
| 3- Hawler Teaching Hospital Room No. 5 | • Place for standing radiographic<br>• Behind x-ray door room<br>• Behind direct x-ray room<br>• Cleaning room<br>• Place for waiting patient | limbs | 0.125<br>0.7<br>0.077<br>0.095<br>0.077 |
| 4- Hawler Teaching Hospital Room No. 8 | • Place for standing radiographic<br>• Behind x-ray door room<br>• Behind direct x-ray room<br>• Cleaning room<br>• Place for waiting patient | Vertebra & KUB, abdomen | 10.48<br>0.185<br>0.172<br>Closed<br>0.095 |
| 5- Hawler teaching Hospital Room No. 9 | • Place for standing radiographic<br>• Behind x-ray door room<br>• Behind direct x-ray room<br>• Cleaning room<br>• Place for waiting patient | Colored | 1.0<br>0.924<br>0.712<br>Closed<br>0.924 |
| 6- Hawler teaching hospital Room No. 7 | • Place for standing radiographic<br>• Behind x-ray door room<br>• Behind direct x-ray room<br>• Cleaning room<br>• Place for waiting patient | Knee joint, pelvic | 0.089<br>0.098<br>0.078<br>0.077<br>0.098 |

***Background Dose rate: 0.1-0.2 μSv/ hr**

**Table 3: Dose rate measured at different location in Emergency hospital**

| Name of Hospitals | Point of interest | Description | Dose rate µSv/ hr | |
|---|---|---|---|---|
| | | | Vertical | horizontal |
| Emergency Hospital | • Place for standing radiographic<br>• Behind x-ray door room<br>• Behind direct x-ray room<br>• Cleaning room<br>• Place for waiting patient | All parts of the body | 0.3<br>0.293<br>0.251<br>0.191<br>0.251 | 0.2225<br>0.131<br>0.0915<br>0.142<br>0.131 |

**Table 4: Dose rate measured at different location in Raparin Hospital**

| Name of Hospitals | Point of interest | Description | Dose rate µSv/ hr |
|---|---|---|---|
| Raparin Hospital | • Place for standing radiographic<br>• Behind x-ray door room<br>• Behind direct x-ray room<br>• Cleaning room<br>• Place for waiting patient | All parts of the body | 0.674<br>0.119<br>0.137<br>0.99<br>far |

**Table 5: Dose rate measured at different location in Rezgary hospital**

| Hospitals & NO. of rooms | Point of interest | Description | Dose rate µSv/ hr |
|---|---|---|---|
| 1- Rizgary Hospital Room No. 2 | • Place for standing radiographic<br>• Behind x-ray door room<br>• Behind direct x-ray room<br>• Cleaning room<br>• Place for waiting patient | Vertebra and barium | 0.160<br>0.095<br>0.143<br>0.155<br>0.117 |
| 2- Rizgary Hospital Room No. 3 | • Place for standing radiographic<br>• Behind x-ray door room<br>• Behind direct x-ray room<br>• Cleaning room<br>• Place for waiting patient | Chest and orthopedic | 0.401<br>0.161<br>0.131<br>Far<br>0.161 |
| 3- Rizgary Hospital Room No. 1 | • Place for standing radiographic<br>• Behind x-ray door room<br>• Behind direct x-ray room<br>• Cleaning room<br>• Place for waiting patient | urinary | 11.75<br>0.203<br>0.197<br>far<br>0.203 |
| 4- Rizgary Hospital Room No. 4 | • Place for standing radiographic<br>• Behind x-ray door room<br>• Behind direct x-ray room<br>• Cleaning room<br>• Place for waiting patient | Abdomen&pelvic | 0.179<br>0.077<br>0.113<br>Far<br>0.119 |

**Table 6(A): General observation of Radiation Protection tools.**

| Name of hospital | Number Room. | Lead dress for radiographic | | Paws | | Lead dress for patient | | Glass lead | | Room light |
|---|---|---|---|---|---|---|---|---|---|---|
| | | using | Non using | using | Non using | using | Non using | excise | Not excise | |
| Rizgary | 1 | * | | | * | | * | | * | Good |
| | 2 | * | | | * | * | | * | | Good |
| | 3 | | * | | * | | * | | * | Good |
| | 4 | | * | | * | | * | * | | Good |
| Emergency | 1 | | * | | * | | * | * | | Good |
| Emergency | 2 | | * | | * | | * | * | | Good |
| Raparin | | | * | | * | * | | * | | Good |
| Hawler | 1 | | * | | * | | * | * | | Good |
| | 2 | | * | | * | * | | * | | Good |
| | 3 | | * | | * | * | | * | | Good |
| | 4 | | * | | * | * | | * | | Good |
| | 5 | | * | | * | | * | * | | Good |
| | 6 | | * | | * | | * | * | | Good |

**Table 6(B): X- Ray rooms information:**

| Name of hospital | Number Room. | Room dimension/ cm | Width of wall/cm | Number of window | Number of door | diaphragm |
|---|---|---|---|---|---|---|
| Rizgary | 1 | | | | | |
| | 2 | 650 x 550 | 10 | 0 | 4 | 0 |
| | 3 | 480 x 450 | 45 | 0 | 1 | 1 |
| | 4 | 660 x 540 | 10 | 0 | 2 | 0 |
| | 5 | 660 x 540 | 10 | 0 | 2 | 2 |
| Emergency | 1 | 600 x 360 | 35 | 0 | 1 | 1 |
| Emergency | 2 | 600 x 360 | 35 | 0 | 1 | 1 |
| Raparin | | 600 x 450 | 55 | 0 | 2 | 1 |
| Hawler | 1 | 570 x 480 | 60 | 1 | 1 | 0 |
| | 2 | 650 x 550 | 10 | 0 | 4 | 0 |
| | 3 | 480 x 450 | 45 | 0 | 1 | 1 |
| | 5 | 540 x 480 | 60 | 0 | 1 | 1 |
| | 6 | 720 x 480 | 60 | 2 | 1 | 1 |
| | 7 | 600 x 450 | 50 | 1 | 1 | 0 |
| | 8 | 600 x 570 | 50 | 1 | 1 | 0 |
| | 9 | 600 x 570 | 50 | 1 | 1 | 1 |

## References

[1]. International Commission on Radiological Protection; Recommendations of the International Commission on Radiological Protection (ICRP) publication 60. Ann ICRP 1991, 1-3.
[2]. Health Risks of Low Level Radiation Exposure. Indian Journal of Nuclear medicine 2005;20(2):
[3]. Mahogora W.E and Nyanda A.M; The potential for reduction of radiation doses to patients undergoing some common X-ray examination in Tanzania. Radiation protection Dosimetry 381 – 384 (2000)
[4]. Mallam S.P, Akpa M.D, Oladipupo M.D and Sa'id, A. Reappraisal of existing expressions for estimating Radiation output from Diagnostic X-ray machine. Nigerian Journal of physics 16 (2); 30.(2004)
[5]. Washington State University. Safety policies and procedures manual on radiation safety, 2000.
[6]. Elegba, S.B. Keynote address on Radiation safety officers in diagnostic and interventional Radiology. University of Ibadan Nigeria (2006).
[7]. Olowookere, C.J Obed, R.I. Adefisoye, P.A. Vincent U.E. Medical Physicist: Missing component of Nigerian Radiological Crew. Journal of Scientific and Industrial Studies,7 (1), 2009: 110-117.

[8]. OLUWAFISOYE P.A, OLOWOOKERE C.J. OBED R.I. EFUNWOLE H.O and AKINPELU J.A; Environmental survey and Quality control testes of x-ray in a large Nigerian hospital International Journal of Research and Reviews in Applied Sciences volume 1, Issue 2(November 2009).

[9]. Bhatai, S; Sather, H.N. Pabustan, O.B, Trigg, M.E, Gaynon, P.S and Rabison, L.L. Low incidence of second neoplasm's among children diagnosed with acute lymphoblast leukemia after 1983. Blood 99(12): 4257 – 64.

[10]. Ware, D.E, Huda, W, Mergo, P.J and Litwiller, A.L. Radiation effective dose to patients undergoing Abdominal C T examination Radiology; 210: 645 – 650. (1999)

[11]. National Occupational Health and Safety Commission. Recommendation for limiting exposure to ionizing radiation. Radiation health series 39 (1995) NOHSC: 3022

[12]. Licher, M.D; Karagas, M.R, M.H, L.A Spencer S.P, stukel, TA. Greenburg, E.F. therapeutic ionizing radiation and incidence of basal cell carcinomal and squamous cell carcinoma. The New Hamsphire skin cancer study Group. Arch Dematol 136 (80): 1007 2000)

[13]. Rosenbloom, M., Theoretical background to radiation protection. In: P. Mayles, A. Nahum and J.C. Rosenwald, (Eds). Handbook of radiotherapy physics: theory and practice. Florida, USA: Taylor and Francis Group. (2007).

[14]. European Commission. European Guidance on Estimating Population Doses from Medical X-ray Procedures. Radiation Protection 2008;154.

[15]. Daniel Admassie1, Seife Teferi1, Kalkidan Hailegenaw1Collective radiation dose from diagnostic x-ray examinationin nine public hospitals in Addis Ababa, Ethiopia . Ethiop. J. Health Dev. 2010; 24(2).