Measuring of radiation levels in radiology departments at Libyan Hospitals

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Abstract

Abstract.
Aims: This work aims to measure and monitor the exposure levels for staff and patients in the radiology departments at Tripoli University Hospital and Central Tripoli Hospital.
Materials and Methods: radiation survey was carries out using Szintomat 6134A Geiger counter survey meter for the diagnostic and therapeutic radiology departments at the Tripoli University Hospital and using the RADOS RDS-120 ionising radiation meter for the diagnostic and therapeutic radiology departments at the Tripoli Central Hospital.
Results: The radiation survey's results were within 0.05 µSv/hr and 0.10 µSv/hr at Tripoli University Hospital and Central Tripoli Hospital, respectively; which are too low and within the levels of radiation background.

I. INTRODUCTION

Ionisaing radiation is the radiation that capable to produce ionisaing to the matter. The exposure to the ionsiaing radiation that exceeds dose limits might leads to very dangerous diseases such as cancers and death. Therefore, the NRC (Nuclear Regulatory Commission) in 2011 and the ICRP (International Commission on Radiological Protection) in 2007 provided the recommendation of dose limits for staff and public [1]. The radiation dose limits aim to reduce the risk of random, genetic and inevitable effects resulting from exposure to radiation.

Radiation exposure to humans can be generally classified as internal and external exposure. For instance, sealed sources, which are unlikely to cause internal exposure, are used almost exclusively in radiotherapy. External exposure monitoring refers to measuring of radiation levels: in and around work areas, around radiotherapy equipment or source containers and equivalent doses received by individuals working with radiation. However, radiation monitoring is carried out: to assess workplace conditions and individual exposures, to ensure acceptably safe and satisfactory radiological conditions in the workplace, and to keep records of monitoring, over a long period of time, for the purposes of regulation or good practice.[2]

Radiation monitoring instruments are used both for area monitoring and for individual monitoring. The instruments used for measuring radiation levels are referred to as area survey meters (or area monitors) and the instruments used for recording the equivalent doses received by individuals working with radiation are referred to as personal dosimeters (or individual dosimeters). All instruments must be calibrated in terms of the appropriate quantities used in radiation protection. [2]. In this research area monitoring for some radiology department in Tripoli is studying.

II. MATERIALS AND METHODS

A. Radiation Survey

The radiation survey was carried out using Szintomat 6134A Geiger counter Survey meter (Figure 2.1); which is sensitive for radiation of (25 KeV-1.3 MeV), for the Synergy linear accelerator, Cobelt-60 machine and Oncentra conventional simulator available in the department of therapeutic radiology at the Tripoli University Hospital (TUH). In addition, the radiation survey was performed for the department of diagnostic radiology including: X-ray, Computer Tomography (CT), fluoroscopy, and mammography units, and for the department of nuclear medicine, including hot-lab, Gamma Camera, Cyclotron, and PET-CT (Positron Emission Tomography – Computed Tomography) units. Figures 2.3-2.8 illustrate the setup for some of the radiation survey processes and the radiation generators those were the radiation survey was performed for them. However, the radiation survey was performed when the radiation generators were ON and OFF, but the radiation

Fig. 2.1: Szintomat 6134 A

Fig.2.2. RADOS RDS-120 Survey meter

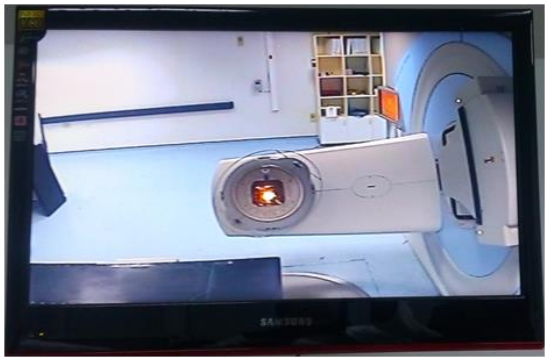

Fig. 2.4: shows the Synergy's gantry position during the radiation survey procedure (taken from the camera), which is the position at which the primary radiation is face to face to the control console.

Fig. 2.5: illustrates the radiation survey procedures for the dentist X-ray devise

Fig. 2.3: shows radiation survey for Oncentra simulator at TUH

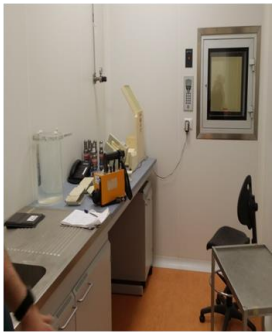

Fig. 2.7: demonstrates the radiation procedure for PET-CT machine at TUH.
Fig. 2.8: Demonstrates survey process inside the hot-lab; the room where the radiopharmaceutical is prepared, at UTH

generators in the department of nuclear medicine, was OFF only because the department was not working from a while.

The radiation survey was also carried out using RADOS RDS-120 ionising radiation meter at the Central Tripoli Hospital (TCH) for the Coblet-60 and the conventional simulator machines in the department of therapeutic radiology. In addition, the radiation survey was performed for the departments of diagnostic radiology including: X-ray, Computer Tomography (CT) and fluoroscopy units.

III. RESULTS

B. Radiation Survey

The results of radiation survey that was carried out in the gastroenterology, therapeutic and diagnostic radiology and gastroenterology departments at the Tripoli University Hospital are illustrated in the tables 3.1 and 3.2. The highest effective dose rate registered in the CT unit at the TUH was 0.15 µSv/hr; at the control room's window. The rest of the survey meter's readings were equal to the radiation background levels, either the CT was ON or OFF including the area at the CT- room door; where the technicians were complained of a problem of unlocked properly door, the effective dose rate at this area was within 0.03 µSv/hr.

the central X-ray and Fluoroscopy departments at the TUH were within the background range to within 0.05 µSv/hr when the radiation generators ON and OFF. Though, the effective dose rate under the X-ray tube in the dentist OPD was very weak; within 0.20 µSv/hr.

The highest effective dose rate registered in the department of nuclear medicine at the TUH was within the background; of 0.04 µSv/hr. the entire survey was performed while the radiation generators were OFF, because the entire department was not functioned from several years.

Regarding to the department of therapeutic radiology at the TUH, the results of the radiation survey carried out for the Oncentra simulator, the Synergy linear accelerator (of photon energy potentials of 6 MV and 10MV and electron energy potentials of 4MeV-18MeV) were within the background, where the highest effective dose rates were 0.05 µSv/hr and 0.08 µSv/hr for the linear accelerator and Oncentra simulator, respectively.

The results of the radiation survey that carried out in the departments of the diagnostic and therapeutic radiology in the TCH are summarized in the tables 3.3-3.5. The irradiation time for the survey process for Co-60 and simulator was 10 minutes.

The results for the X-ray, CT, simulator and fluoroscopy units at CTH demonstrated the highest effective dose was 1.57 µSv/hr; registered for the fluoroscopy unit, at TCH, in the place where a physician stands. Nevertheless, there is a window in the simulator room

opens to the street, the highest effective dose rate at the street was 0.10 µSv/hr; several gantry angles were examined to include primary and scattered radiations.

Regarding the survey results for the Co-60, the effective dose rates recorded were within 0.10 µSv/hr at the areas of present staff and patients. However, two high effective dose rate values were recorded of 2.02 µSv/hr and 4.47 µSv/hr; both were at the right and left sides of the door, almost infront of the scattered radiation and nobody presents at these points. In addition, at the head of Co-60 machine at the source house, the survey meter recorded very high effective dose rate of 13 µSv/hr; as it is expected. That is why it is always been recommended to do not stand under the source house.

TABLE 3.1: RADIATION SURVEY RESULTS FOR DIAGNOSTIC RADIOLOGY DEPARTMENTS AT TRIPOLI UNIVERSITY HOSPITAL

Department of diagnostic radiology at TUH				
Units	*Room(position of the survey)*	***Notes***	Radiation off (Background) (µSv/hr)	Radiation on (µSv/hr)
CT-Imaging Unit	Entrée of corridor that leads to CT- room		0.05	0.05
	Inside the CT-room, around the CT devise		0.04	
	On the window's glass of the control room			0.15
	At the CT-room' door, which used to enter the patient; presents at the end of the previous corridor	Technicians were compliance, the door was not close properly. The door does not present at waiting area of patients and relatives		0.03
	Waiting room		0.03	0.03
X-ray Imaging (Central X-rays)	Entrée of corridor that leads to CT- room		0.05	0.05
	Inside the CT-room, around the CT devise		0.04	
	On the window's glass of the control room			0.15
	At the CT-room' door, which used to enter the patient; presents at the end of the previous corridor	Technicians were compliance, the door was not close properly. The door does not present at waiting area of patients and relatives		0.03
	Waiting room		0.03	0.03
Fluoroscopy	Control room' behind the protection barrier	Imaging was for a child using the barium contrast	0.02 - 0.05	0.02 - 0.05
Department of diagnostic radiology at TUH				
Units	*Room(position of the survey)*	***Notes***	Radiation off (Background) (µSv/hr)	Radiation on (µSv/hr)
ER X-ray imaging	Not functioned			
ER X-ray imaging	Not functioned			
OPD X-ray imaging unit	Not functioned			
Dentist OPD	Treatment room		0.05	
		Under the x-ray tube (Figure 2.5)	0.05	0.20
			0.05	0.04
		Touched to the x-ray room	0.05	0.04
	Room Entree		0.02	
catheterization	Inside the room		0.05	0.05
	Control room		0.05	0.05
			0.05	0.05

TABLE 3.2: RADIATION SURVEY RESULTS FOR GASTROENTEROLOGY, NUCLEAR MEDICINE AND THERAPEUTIC RADIOLOGY DEPARTMENTS AT TRIPOLI UNIVERSITY HOSPITAL

Department of Gastroenterology at the TUH				
Units	*Room(position of the survey)*	***Notes***	Radiation off (Background) (µSv/hr)	Radiation on (µSv/hr)
Fluoroscopy	X-ray room		0.05	0.05
	Fluoroscopy room (147)		0.05	0.05
	Fluoroscopy room (143)		0.05	0.05
Department of Therapeutic radiology at the TUH				
Units	*Room(position of the survey)*	***Notes***	Radiation off (Background) (µSv/hr)	Radiation on (µSv/hr)
Linear accelerator (Synergy)	Inside the linac's banker, close to the linac head		0.05	
	Inside the linac's banker, at the corridor; at the mazz		0.05	
	At the control room, faced the primary radiation	Figure (2.4)	0.05	0.03
	At the door			0.08
	At the waiting room			0.04

Units	Department of Gastroenterology at the TUH			
	Room(position of the survey)	***Notes***	Radiation off (Background) (µSv/hr)	Radiation on (µSv/hr)
Simulator	At control room, infront of the simulator's door that is opened in the control room	Operation setup was 75 kV, 4.8 mA	0.05	
	Inside the room, over the couch and direct under the x-ray tube		0.05	
Co-60	at source house	The Co-60 source was passed more than three half lives at the time of survey. It is not used for the clinic anymore from the while	0.05	
	Control room		0.05	

Units	Department of Nuclear Medicine at the TUH			
	Room(position of the survey)	***Notes***	Radiation off (Background) (µSv/hr)	Radiation on (µSv/hr)
Gamma-Camera	Inside the room and on the couch	All department's units are not working from several years	0.02	
	Control room		0.02	
	Hot Lab (using Mo-Tc^{99m} Generator)		0.02	
	reception		0.02	
PET-CT	Hot lab for cyclotron	All department's units are not working from several years	0.04	
	Cyclotron		0.04	
	At corridors		0.04	
	Imaging Room		0.04	
	Control room		0.02	
	Direct at the PET-CT's head		0.04	

Table 3.3: Radiation survey results for the therapeutic radiology department at Tripoli Central Hospital

Units	Department of Therapeutic radiology at the TUH			
	Room(position of the survey)	***Notes***	Radiation off (Background) (µSv/hr)	Radiation on (µSv/hr)
Simulator	In the front of the room's window, at the street,	Setup: 80 Kv, 100 mAs, 500 ms, 0º gantry; common using setup	0.1	0.1
		Setup: 80 Kv, 100 mAs, 500 ms, 90º gantry	0.1	0.1

Simulator	Department of Therapeutic radiology at the TUH (Simulator Unit)			
	Room(position of the survey)	***Notes***	Radiation off (Background) (µSv/hr)	Radiation on (µSv/hr)
	In the front of the room's window, at the street,	Setup: 80 Kv, 100 mAs, 500 ms, 270º gantry; common using setup	0.1	0.06
	At the control room, at the operator's place	Setup: 90 Kv, 100 mAs, 500 ms, 0º gantry; uncommon using setup	0.1	0.1
	At the simulator's door that opens at the control room	Setup: 90 Kv, 100 mAs, 500 ms, 0º gantry; uncommon using setup	0.1	0.1
	At the corridor, where the control room opens; patients staff and relative can be exist in it	Setup: 90 Kv, 100 mAs, 500 ms, 0º gantry; uncommon using setup	0.1	0.1
	At the control room, at the operator's place	Setup: 90 Kv, 100 mAs, 500 ms, 90º gantry; uncommon using setup	0.1	0.1
	At the simulator's door that opens at the control room	Setup: 90 Kv, 100 mAs, 500 ms, 90º gantry; uncommon using setup	0.1	0.1
	At the corridor, where the control room opens; patients staff and relative can be exist in it	Setup: 90 Kv, 100 mAs, 500 ms, 90º gantry; uncommon using setup	0.1	0.1
	At the control room, at the operator's place	Setup: 90 Kv, 100 mAs, 500 ms, 270º gantry; uncommon using setup	0.1	0.1
	At the simulator's door that opens at the control room	Setup: 90 Kv, 100 mAs, 500 ms, 270º gantry; uncommon using setup	0.1	0.1
	At the corridor, where the control room opens; patients staff and relative can be exist in it	Setup: 90 Kv, 100 mAs, 500 ms, 270º gantry; uncommon using setup	0.1	0.1

Table 3.4: Radiation survey results for therapeutic radiology department at Tripoli Central Hospital

Units	Department of therapeutic radiology at TCH			
	Room(position of the survey)	***Notes***	Radiation off (Background) (µSv/hr)	Radiation on (µSv/hr)
Cobelt-60	at source house		**13.0**	
	at the cross hair for the collimator		**0.10**	
	At the storage that exist beside the Co-60 banker and at point infront of the collimator	gantry angle = 90º, so the primary radiation faced the storage		2.02
	At the Co-60 room's door, at the point present on the left side of the door	gantry angle = 90º, so the primary radiation is faced to the storage, therefore it is fare from measurement point at the door.		0.10
	At the Co-60 room's door, at the point present on the right side of the door	Gantry angle = 90 º, so the primary radiation faced to the storage. The measurement point is in the path of scattered radiation		4.47
	At the control room, at the area of operator's setting	Gantry angle = 90 º; so the primary radiation faced the storage and in parallel to operator's setting area		0.10
	Technicians' room, which is behind the storage. (fare from the Co-60 banker)	Gantry angle = 90 º; so the primary radiation faced the storage, then technician's room		0.10
	Patients' waiting room, which exists behind technicians' room. (fare from the Co-60 banker)	Gantry angle = 90 º; so the primary radiation faced the storage, then this room		0.10
	In the storage, that exists beside the Co-60 banker.	Gantry angle = 270 º, so the radiation in the opposite direction of the storage		0.10

Units	Department of therapeutic radiology at TCH			
	Room(position of the survey)	***Notes***	Radiation off (Background) (µSv/hr)	Radiation on (µSv/hr)
Cobelt-60	At the Co-60 room's door, at the point present on the left side of the door	Gantry angle = 270º		0.67
	At the Co-60 room's door, at the point present on the right side of the door	Gantry angle = 270º		4.09
	At the control room, at the area of operator's setting	Gantry angle = 270º		0.10
	Technicians' room, which is behind the storage. (fare from the Co-60 banker)	Gantry angle = 270º		0.10
	Patients' waiting room, which exists behind technicians' room. (fare from the Co-60 banker)	Gantry angle = 270º		0.10
	Faced the Co-60 head, at the street	Gantry angle = 270º		0.10

Table 3.5: Radiation survey results for diagnostic radiology departments at Tripoli Central Hospital

Units	Department of therapeutic radiology at TCH			
	Room(position of the survey)	***Notes***	Radiation off (Background) (µSv/hr)	Radiation on (µSv/hr)
CT Imaging unit	Inside the CT room	Devise is not functioned	0.10	
	At the Corridor		0.10	
X-ray Imaging (Central X-rays)	Inside the X-ray room	Using 63 kV, 30 mAs, 37.8 ms (the common set-up)	0.10	
	Inside the X-ray room and behind the protection barrier			
	Infront the room's door		0.1	
	Inside the X-ray room and behind the protection barrier	Using 85 kV, 80 mAs, 136 ms (uncommon set up, just for this test)	0.1	
	Infront the room's door		0.1	
	At the corridor	It is CT's corridor	0.1	
Fluoroscopy	At a physician's position	Setup used: 95 Kv, 95mAs; Abdominal case	0.05	1.57
	At 1m from a patient's place		0.05	0.51
	At the room's door		0.05	0.17
	Control room; behind the protection barrier		0.05	0.08
	At the Corridor		0.05	

I. Conclusion

Th is research aims to evaluate the exposure level for staff and public in the radiology and therapeutic radiology at TUH and TCH by performing radiation survey. The results demonstrate that effective dose rates recorded were very weak of maximum of 0.10 µSv/hr, which is within the radiation background levels and less than the annual dose limit of 6.2 mSv as been recommended by ICRP and NRC [1]. That means the radiation protection system followed at the TUH and TCH was followed properly. In addition, the low effective dose rate registered for the Co-60 unit at TCH approves that there is no leakage in gamma-ray.

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