Radiation Exposure to Nuclear Medicine Technologists During Different Diagnostic Techniques

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Abstract: Nuclear Medicine is being widely used, now a days, for different diagnostic purposes. The present study was planned to find out the radiation exposure to nuclear medicine technologists from radioactive patients who have gone through different diagnostic techniques. This study was carried out at Punjab Institute of Nuclear Medicine (PINUM), Faisalabad (Pakistan). In order to carry out this activity, data was collected from the nuclear medicine diagnostic techniques i.e., heart scans (Rest and Stress MIBI), bone scans, renal scans, liver scans, thyroid scans and Thallium heart scans. The radiation exposure was recorded using pen dosimeter (Arrow-Tech W138) having range 0-200mR. Heart scan (Stress MIBI) was taken as standard as it showed maximum exposure (0.584 mR) and equivalent dose corresponding to this exposure (5.85μSv) amongst all scans.

Keywords: Radiation exposure, Equivalent doses, Nuclear medicine technologists, Dosimeters, Gamma camera.

INTRODUCTION

Health and Medical Physics has introduced a number of safe, non-invasive and cost-effective nuclear medicine diagnostic techniques so far in the Nuclear Medicine departments to diagnose different diseases and therefore, have assisted the physicians and surgeons more accurately in radiotherapy. Radiations cause a number of different chemical and physical changes in the target material exposed to these radiations [1-5]. Therefore, the potential benefit-risk ratio from these nuclear medicine techniques should be well known to the referring clinicians, radiologists, cardiologists, nuclear medicine technologists and to some extent to the patients too [6]. The patients referred to the radiation therapy should be annually monitored on regular basis in order to be aware from the radiological quality and safety [7]. Such radiation therapies include radiologic procedures that require very long fluoroscopy times, radiolabeled monoclonal antibodies and intravascular brachytherapy [8]. Many studies have demonstrated that the exposure of nuclear medicine technologists arises primarily from radioactive patients rather than from preparation of radiopharmaceuticals [9]. However, in order to devise strategies to reduce exposure to nuclear medicine technologist, it is necessary to identify the specific tasks within each procedure that result in the highest radiation doses [10]. International Commission on Radiological Protection (ICRP) has set the limits on exposures to ionizing radiations which should not be more than 1 and 20mSv per annum for general public and nuclear medicine technologists, respectively.

The Tc-99m is most widely used radioisotope in nuclear medicine diagnostic techniques and is employed in 80% of all nuclear medicine procedures. It is meta-stable radioisotope of artificially-produced element technetium having almost ideal characteristics i.e., gamma energy and half life, for a nuclear medicine scan.

Punjab Institute of Nuclear Medicine (PINUM) is a nuclear medicine center in Faisalabad, providing the facilities of nuclear medicine diagnostic techniques. A number of patients visit this hospital for different scans like liver, heart scan, thyroid, bones, renal and thallium heart etc. therefore, the present research work was planned to evaluate the radiation exposure to nuclear medicine technologists from radioactive patients who have gone through these nuclear medicine diagnostic techniques.

MATERIALS AND METHODS

This study was conducted at Punjab Institute of Nuclear Medicine (PINUM), Faisalabad, Pakistan. The materials used in this study were; pen dosimeter (Arrow-Tech W138) having range 0-200mR, survey meter, e-cam single head gamma camera (Seimens), Mo-99/Tc-99m radionuclide generator and record of registered patients for all scans.

The diagnostic techniques used in this study were; heart scan (Rest and Stress MIBI), bone scan, renal

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Table 1: Maximum Injected Dose and Patient's Rest Time After Dose Administration

Sr. No.	Scan	Injected Dose (mCi)	Rest time (min)
1	Heart (Rest MIBI)	20	45
2	Heart (Stress MIBI)	22	45
3	Thyroid	3	5
4	Bone	20	180
5	Liver	5	No time required
6	Renal	2	No time required
7	Heart (Thallium)	2.4	45

scan, liver scan, thyroid scan and thallium heart scan, moreover, the pharmaceuticals used for these techniques were MIBI (Methoxy-Isobutyl-Isonitrile), MDP (methylene diphosphonate), DTPA (diethylenetriaminepentaacetic acid), Phytate, Plane Tc-99m (technetium 99m) and Thallium-201, respectively.

The maximum injected doses for all scans and the rest time for patients after the dose administration, is presented in Table **1**.

The reading of exposure for each scan was measured in two phases; first, from the time of injecting a patient to his exit from the hot lab. Secondly, the reading was measured in the Gamma camera room during the scan until the exit of patient from the room. The time required for heart scan (Rest and Stress MIBI), bone scan, renal scan, liver scan, thyroid scan and thallium heart scan was 20min, 25 min, 30min, 30min, 5min and 20min, respectively. Total exposure for a complete scan was measured. The proposed procedure was revised for ten patients per scan in order to avoid personal, systematic or random errors.

RESULTS AND DISCUSSION

The measurements of the gamma exposure were made using a calibrated pen dosimeter. The mean exposure and standard deviations of these exposures for each scan are shown in Table **2**. Table **3** shows the equivalent dose received by the nuclear medicine technologists from the selected scans.

CONCLUSION

The nuclear medicine diagnostic techniques used in this study were; heart scan (Rest and Stress MIBI), bone scan, renal scan, liver scan, thyroid scan and thallium heart scan.

Radiation exposure to nuclear medicine technologists from radioactive patients who had gone through these techniques was evaluated. The heart scan (Stress MIBI) was found to give maximum exposure (0.584 mR) amongst all these scans as injected dose was maximum (22mCi) for this scan and during the stress procedure the patient gave more exposure to the nuclear medicine technologist. The equivalent dose corresponding to this exposure was

Table 2: Mean Exposure with Standard Deviation of Selected Nuclear Medicine Diagnostic Techniques

Sr. No.	Scan	Mean Exposure (mR)	Standard Deviation	Mean ±SD
1	Heart (Rest MIBI)	0.486	0.179	0.486±0.179
2	Heart (Stress MIBI)	0.584	0.111	0.584±0.111
3	Thyroid	0.263	0.379	0.263±0.379
4	Bone	0.518	0.353	0.518±0.353
5	Liver	0.390	0.515	0.390±0.515
6	Renal	0.285	0.477	0.285±0.477
7	Heart (Thallium)	0.364	0.175	0.364±0.175

Table 3: Equivalent Doses Received by the Nuclear Medicine Technologist from each Scan

Sr. No.	Scan	Injected Dose (mCi)	Mean Exposure (mR)	Equivalent Dose (μSv)
1	Heart (Rest)	20	0.486	4.86
2	Heart (Stress)	22	0.584	5.85
3	Thyroid	3	0.263	2.63
4	Bone	20	0.518	5.18
5	Liver	5	0.390	3.9
6	Renal	2	0.285	2.85
7	Heart (Thallium)	2.4	0.364	3.64

found to be 5.85μSv. Stress procedure was also performed during Thallium heart scan but in that case the injected dose (2.4mCi) was much lower than that of Stress MIBI (22mCi). Therefore, the mean exposure from Stress MIBI was taken as standard and compared with all other scans.

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