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Study of Radiation Dose Rate around Patients in Positron Emission Tomography/Computed Tomography (PET/CT) Units

Research Article

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Abstract : The present study has measured the dose rate from the radioactive patients injected with different activities of ^{18}F-FDG in PET/CT units. Data were taken in INMAS (Institute of Nuclear Medicine and Allied Sciences), Bangladesh Atomic Energy Commission, Dhaka Medical College and Hospital campus, Dhaka-1000.The dose rates were measured pragmatically by using a calibrated survey meter around radioactive patients in different locations in PET/CT units. It has been observed from the results that the dose rate decreases greatly with increasing distance. The occupational exposure increases during contact with radioactive patient but significantly decreases by increasing distance. The dose rate reduces greatly with respect to time. The present results show that dose rate in the hot corridor was less than that in the scanning room and injection room. The dose rate was high at the injection room due to the direct handling of radio tracer without proper personal protection. From this study, it can be concluded that the radiation dose was significantly lower after 1.5 m distance from the radioactive patient. The PET/CT occupational workers are recommended to remain at a distance more than 1.5 m from the radioactive patients.

Keywords: *Nuclear Medicine ● Radiopharmaceutical ● Fluoro-Deoxy-Glucose (^{18}F-FDG) ● Positron Emission Tomography (PET) ● Computed Tomography (CT) ● Dose rate*

1. Introduction

Nuclear medicine is an imaging technique in which radioactive materials are used for the treatment and diagnosis of various abnormalities. Occupational exposure in nuclear medicine is a matter of health concern. Handling of radioactive materials can give rise to external and internal exposure of involved staffs. The public can be exposed to radiation from a patient through multiple path ways. Radiation protection in nuclear medicine is an important issue for controlling radiation exposure of workers.

Positron emission tomography/computed tomography (PET/ CT) has been widely used in nuclear medicine. A little amount of radioactive material is used in nuclear medicine to diagnose or treat various diseases, such as cancers, heart disease, endocrine or neurological disorders, gastrointestinal etc.

The (PET/CT) can lead to increase the exposure of staff. ^{18}F-FDG is a positron emitter radiopharmaceutical is being widely used (Donmoon *et al*. 2016). The radioactive decay of ^{18}F-FDG produces high energy gamma photons (511kev). During the radiation exposure assessment the activity of the radioactive material is taken into consideration (El-din *et al*. 2018). Increasing number of uses of ^{18}F-FDG PET/CT rises the issue of harmful doses of radiation to medical staffs those are involved in relevant jobs (Chiesa *et al*. 1997, Guillet

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et al., 2005, Fiona *et al*. 2005). Computed Tomography gives information about the anatomy. The functional changes of tissues as well as metabolic activity of tumor can be visualized by PET/CT scan. The whole body information can be known by a scan.^{18}F-FDG (fluoro-deoxy- glucose) is a glucose analogue (Evelina *et al*. 2008).The radioactive^{18}F-FDG, when injected, travels to the cells of the whole body within very short time. The body cells get energy from glucose. If the group of cells needs more energy, the more radiotracer will be built up in that region. Glucose is exerted in the urine. The images are taken 45-60 min after injection considering the physical half-life of the FDG (110 min). The staffs and the technologists must be protected from the radiation exposure of the patient during uptake period and the scan. The radiations from ^{18}F-FDG are potentially hazardous to the attendants, doctors, nurse and technologists.

The calibrated survey meter was used for measuring the dose rate around the radioactive patients. The instantaneous dose rates in different locations of PET/CT units were recorded. This study can give an assessment of dose rates in different locations inside the ET/CT units and predict the occupational exposure to the technologists and other staffs.

2. Material and Methods

A number of patients have been selected which are injected with 18-FDGin PET/CT units. The sample patients include different tribes, age and gender referred to the Institute of Nuclear Medicine and Allied Sciences (INMAS), Dhaka Medical College Hospital Campus, Dhaka-1000.

The dose rates were recorded using a calibrated survey meter in different locations of PET/CT units during imaging procedures of ^{18}F injection as well in scanning processes. The procedure is similar with Peet *et al*. (2014).The instantaneous dose rates were measured during imaging procedures with FDG activities through hot corridor, injection room and scanning room. At first selected dose was picked up by the calibrated calibrator. The dose was varied due to the weight and height of the patient. Then the selected patient was injected at the injection room. The dose rate was measured by the survey meter at different locations such as, at the contact of the patient, at 0.5m, 1m, 1.5m, 2m and 2.25m distances from the patient body at time of injection, 15 min and 30 min post injection time respectively. Dose rate was also measured at entrance, middle and end of the hot corridor. After the 45 min post from the time of injection, the patient was placed on the scanner bench of the scanning room. The dose rate was measured at the distances stated above again for different specific activities.

Data were taken in different locations around the patient for different activities. Radiation dose rates were measured in PET/CT specific locations during the imaging processes for respective activities of 18F-FDG.The average dose rates are shown in Fig. 1 below.

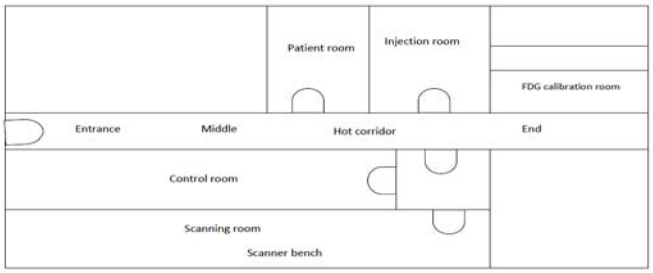

Figure 1: Different measurement points in PET/CT units

3. Results and Discussion

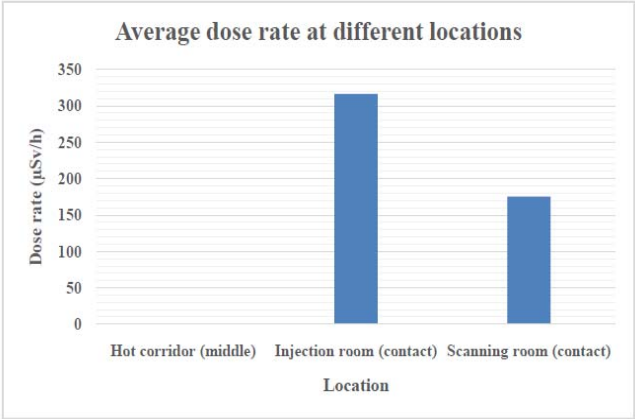

Figure 2: Average dose rate at different locations

Results from the above Fig. 2 indicate that the found dose rate in the hot lab is smaller than that of the injection and scanning rooms. The dose rate was high at the injection room due to the direct handling of radio tracer without proper personal protection.

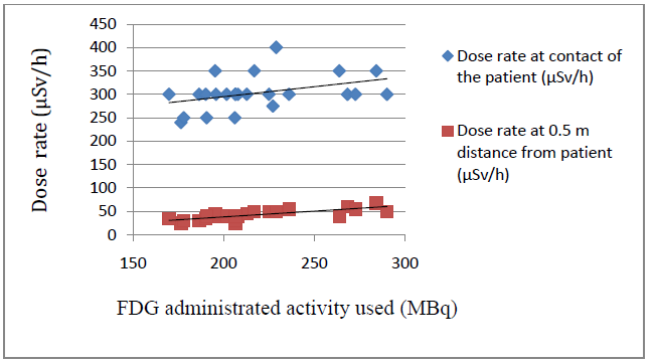

Figure 3: Dose rate for 15 minute post injection at radioactive patient contact and 0.5 m distance from the patient

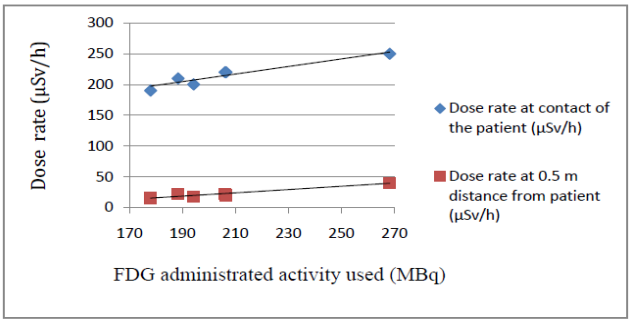

Figure 4: Dose rate 30 minute post injection at radioactive patient contact and 0.5 m distance from the patient

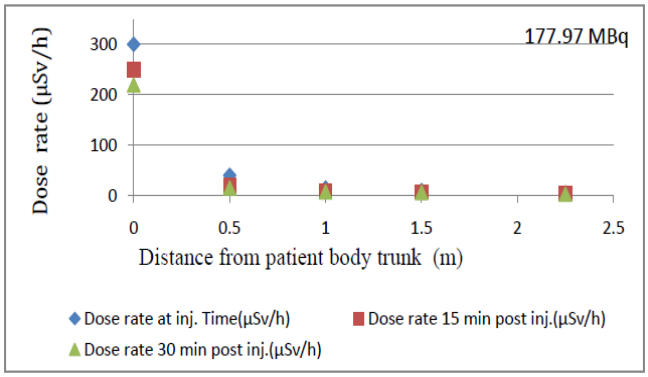

Figure 5: Relationship between measured dose rate and distance from the patient body

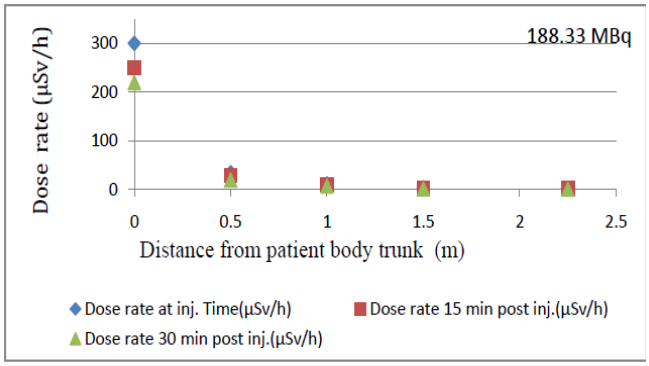

Figure 6: Relationship between measured dose rate and distance from patient body

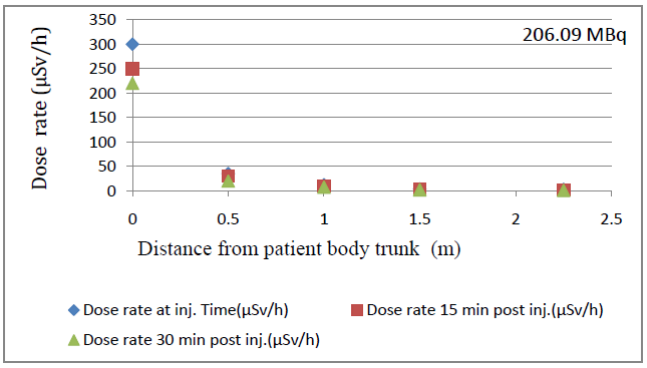

Figure 7: Relationship between measured dose rate and distance from patient body

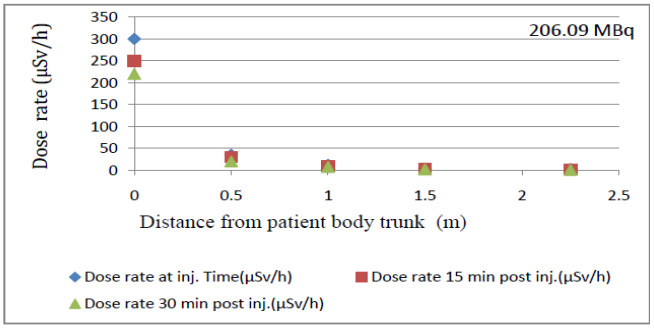

Figure 8: Relationship between measured dose rate and distance from patient body

Figures 3, 4 show that the radiation exposure from the patient decreases with time.

From the above figures (Figure 5, 6, 7, 8) show that the calculated dose rate decreases greatly with distance from the patient. Thus, it is clear that occupational exposure is decreasing with increasing the distance from the patient. According to ICRP the occupational dose limit is 20 mSv per year for whole-body (ICRP, 2007).This study shows that the radiation exposure reaches safe levels (< 20 mSv per year) at distance more than 1.5 m which is similar with El-din *et al.*

4. Conclusion

The dose rate was measured by using a calibrated survey meter around radioactive patients in different locations in PET/CT units. The obtained results show that dose rate which was measured in the hot corridor was less than that in the scanning and injection rooms. At the contact of radioactive patient the occupational exposure increases but significantly decreases with increasing distance from the patients. The present result shows that the radiation exposure can reach a safe level at a distance more than 1.5 m. Thus, this study recommends for Positron Emission Tomography/Computed Tomography (PET/CT) occupational worker like medical technologist, physicist and doctor to maintain the distances more than 1.5 m from radioactive patients. They should wear leaded apron for their protection while working in the vicinity of the patient.

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