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Radiation Dose Rate Levels of Nuclear Medicine Generated Radioactive Wastes in the Nuclear Medicine Unit of Mulago Natural Referral and Teaching Hospital

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Abstract: **Radiation dose rate levels of nuclear medicine generated radioactive wastes within the Nuclear Medicine Unit of Mulago National Referral and Teaching Hospital has been assessed. The wastes considered in this study were used syringes, used cotton, used gloves and empty vials. Dose rate levels of these wastes were monitored using a Red eye PM1703M-01 electronic dosimeter of serial number 286775, which uses a cesium iodide scintillator and a Geiger Mueller tube. The radiation dose rate levels recorded were compared with the International Atomic Energy Agency (IAEA), World Health Organization (WHO), International Commission on Radiological Protection (ICRP) and Atomic Energy Council of Uganda (AECU) guidelines and they were found to be low relative to the set guidelines for the shortest distance from any individual bag containing the wastes to be disposed.**

Keywords: **Radiation Dose rates, Generated Radioactive wastes, Working day, Red eye dosimeter.**

1. INTRODUCTION

Many Diagnostic and therapeutic Nuclear Medicine facilities use technetium-99m and iodine-131 radionuclide's (Mas 2008, Mark *et al*.2007). For their efficiency, they are tagged to pharmaceuticals to form radiopharmaceuticals which convey the radionuclide's to specific organs, tissues or cells for diagnostic or therapeutic purposes (Brix, et al. 2005).

In Nuclear Medicine, the use of unsealed sources generates radioactive wastes of different kinds during radiopharmaceutical preparation, patient's examination and care (Smart R .2004). The wastes have to be safely managed because they are potentially hazardous to people and the environment. Their inadequate management especially the sealed sources results in radiation exposure of the public or contamination of equipments, buildings or land.

Hospital radioactive wastes are of different types. They may be of high activity such as technetium generator and sources used in radionuclide therapy, or low activity wastes from biomedical procedures or research. These wastes may be in solid, liquid or gaseous form.

The solid wastes include, cover papers, used gloves, empty vials and used syringes, radionuclide generators, items used by hospitalized patients after radionuclide therapy, sealed sources used for calibration of instruments and other biological wastes (patients stool).

Liquid wastes include; radionuclide residues, patient excreta, liquid scintillation solutions and the gaseous wastes include; ventilation exhausts from facilities handling radioactive materials such as fume box and exhausted gas from patients.

For any Nuclear medicine setting, radioactive wastes from nuclear medicine procedures can be dealt with either by simply storing the waste safely until radioactive decay has reduced the activity to a safe level or possibly by disposal of low activity waste into the sewage system. Long half-life or high activity waste may need long term storage in a suitable storage area, basically, the hot laboratory. Technetium-99m waste normally requires storage for only 48 hours, in a plastic bag inside a shielded container. The container should be labelled with the radionuclide and date. Gallium-67, Iodine -131 and other longer half-life materials should be placed in a separate labelled and dated plastic bag and stored safely.

Several studies have been conducted to find the radiation dose rate levels of nuclear medicine generated radioactive wastes and according to the International Atomic Energy Agency Basic Safety Standards (IAEA General Safety Requirements Part 3 2012, IAEABSS 1996) and the International Commission on Radiological Protection (ICRP, 2012), any individual bag containing nuclear medicine radioactive wastes for disposal should have a dose rate level of 5µSv/h.

In Uganda, in the nuclear medicine unit of Mulago national referral and teaching hospital, there has been an increase in the applications of nuclear medicine procedures mainly using technetium-99m and iodine-131radiopharmaceuticals. This has resulted into increased generation of nuclear medicine radioactive wastes leading to many questions concerning their storage and disposal.

In this paper, we present the radiation dose rate levels of nuclear medicine generated radioactive wastes on the day of their collection and on the day of their disposal at the different distances from the storage container during the different working days of the week.

2. MATERIALS AND METHODS

2.1 COLLECTION AND PREPARATION OF RADIOACTIVE WASTE MATERIALS

During the period of this study, between February and July 2019, six hundred thirty patients were administered with technetium-99 for different diagnostic procedures. The total activity of technetium-99m used during this period was 21328 ± 15 mCi. The Unit works five days a week (Monday to Friday) and during these days, the wastes are collected and put in the collection container. The wastes collected on the current working day were always put together with the wastes collected on the previous working day. The wastes collected in the unit were put in a polythene bag, placed in a plastic container and kept in the hot laboratory.

2.2 METHODS

Radiation dose rate levels of the generated radioactive wastes were measured using the Red eye survey meter. The meter was set in the dose rate range and the average back ground readings were determined when no waste was in the hot laboratory. Measurements of radiation dose rate levels at 0.05 m, 0.50 m, 1.00 m and 1.50 m from the plastic container containing the wastes on the day of storage (Monday to Friday) and 0.05 m, 0.50 m and 1.00 m from the plastic container containing the wastes on the day of disposal (Monday of every new working week) were taken. At every distance from the container containing the wastes, the dose rate measurement was done three times and an average dose rate was calculated and thereafter, the average measured values of radiation dose rate levels at each distance from the container for each day of collection (Monday as the 1st day, Tuesday as the 2nd day, Wednesday as the 3rd day, Thursday as the 4th day and Friday as the 5th day) and day of disposal (Monday) were then got.

3. RESULTS AND DISCUSSION

3.1 RADIATION DOSE RATE LEVELS OF RADIOACTIVE WASTES ON DAY OF COLLECTION

Results of mean daily effective radiation dose rate levels of radioactive wastes on the different days of their collection during the whole period of study in the Nuclear Medicine Unit are given in Table 1

Table 1: Mean daily radiation dose rate levels of collected radioactive wastes

	Mean radiation dose rate level (µSv/h)				
Distance (± 0.01m)	1st	2nd	3rd	4th	5th
0.05	66.11	48.40	30.82	19.89	15.83
0.50	43.00	22.75	18.44	10.27	8.73
1.00	21.00	16.94	11.76	8.85	6.76
1.50	6.65	3.44	1.93	0.72	0.56

As seen in table 1, the radiation dose rate level was highest at the least distance from the container and this decreased as the distance from the container increased. According to Amer. B (2001), this same trend was observed. This is because as distance increases, there is reduction in the radiating intensity (power) of the stored radioactive wastes leading to low radiation dose rate levels. The reduction in the radiating intensity is due to the fact that as distance increases, the area within which the radiation is provided increases making the radiation has more space in which it escapes to and at the same time, radiation spreads in all directions about the source when the distance is increased.

3.2 RADIATION DOSE RATE LEVELS OF RADIOACTIVE WASTES ON THE DAY OF DISPOSAL

Results of mean daily effective radiation dose rate levels of radioactive wastes on the day of their disposal (every Monday of the new working week) during the whole period of study in the Nuclear Medicine Unit at different distances from the disposal container are given in Table 2.

Table 2: Mean daily radiation dose rate levels of disposed radioactive wastes

Distance (±0.01m)	0.05	0.50	1.00	1.50
Mean radiation dose rate level (µSv/h)	15.83	7.60	4.87	0.19

Results indicate that on the day of the disposal of the wastes, the radiation dose rate levels decrease as distance from the container increases, as distance goes to 1.50 m, the dose rate is almost equal to the radiation dose rate level in the Unit which is 0.16 **µ**Sv/h.

4. CONCLUSION

Radiation dose rate levels of Nuclear medicine generated radioactive wastes in the Nuclear medicine unit of Mulago Natural Referral and Teaching Hospital should not be alarming. The results from the study indicate that the dose rate is really low in case the distance is increased from the container having the wastes on the day of disposal as compared to IAEA, WHO, ICRP and AECU safety guidelines. The study has come at the rightful time when there is an increase in the use of Nuclear Medicine procedures in Uganda.

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