Overall External Surface Dose Rate Measurement of ^{131}I Package and ^{99m}Tc Generator at the National Institute of Nuclear Medicine and Allied Sciences

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ABSTRACT

Measuring the external surface dose rate of the radioisotope I-131in order to reduce the radiation hazard during the transportation of this is to perform at National Institute of Nuclear Medicine and Allied Sciences (NINMAS) to the hospitals and clinics is a very basic but important requirement. Measured the external surface dose rate of I-131 after receiving the isotope send to NINMAS in shielded packages by Monrol N.P. Company, Turkey and Radioisotope Production Division (RIPD). The authors also measured the external surface dose rate of Tc-99m generator supplied by RIPD, AERE, Saver, Dhaka, Bangladesh, to check whether the radioisotopes package shielding are within the dose rate limit. From this study, the dose rate was found relatively higher for I-131 transportation by the smaller vehicle than large vehicle, although dose rate in both categories of vehicles are within the permissible limit. The external surface dose rates for Tc-99m generator were also found to be within the permissible limit.

Keywords: external surface dose rate, radiation hazard

INTRODUCTION

People are exposed to radiation from birth, from cosmic rays, from our surroundings and from food and drink that sometimes contain traces of radioactivity. Even the human body contains small amounts of radioactivity (in the form of radioisotopes of potassium, cesium and radium). Radiation is called ‘Ionizing radiation’ when it is powerful enough to break molecular bonds. Ionizing radiation can cause changes in the human body and therefore it is important to understand that the unwanted exposure to radiation which may cause harm will vary depending upon its dose. Tc-99m is used for diagnostic purposes and is administered in the patient’s body in small amount usually from 1 to 20 mCi (37 to740 MBq) of activity. Some radioisotopes are also used for therapy purposes. Radioactive Iodine therapy (I-131) is an integral part of functional thyroid carcinoma therapy in adults. For most thyroid cancer treatments (1), large dose of I-131 are administered to ablate residual thyroid tissue and functional metastasis from thyroid cancer. At NINMAS, all therapeutic patients are admitted into single isolated cabins with attached toilet and bath reserved in a hospital and clinic and is situated at a reasonable distance from the Institute. Therefore, I-131 shielded package has to be transferred to these hospitals and clinics. External surface measurement of I-131(capsule and liquid form) package is very important to reduce the radiation hazard during the transportation of I-131 from NINMAS to hospitals or clinics.

MATERIALS AND METHODS

A survey meter (Model Austral Rad Mini 8-in-1# 1091 Australia) is used to measure the radiation at the external surface of all radioisotope packages. At first the investigators measure external Surface dose rate of all radioisotope after receiving the I-131 package and Tc-99m generator from Monrol N.P Company, Turkey and RIPD, AERE Saver, Dhaka, Bangladesh. The data obtained are presented in table 1 and 2 respectively.Tc-99m used for diagnostic purposes and are administered in the patient’s body in small amounts that vary from 1 to 20 mCi (37 to740 MBq).

All therapeutic patients are admitted into a clinic or hospital's separate room with attached toilet. The external surface dose rate measured during transportation of I-131 from NINMAS to clinics or hospitals are shown in Tables 3-9. During transportation we deploy taxicab, clinic ambulance or institute's transport. Investigators use radiation symbol at the front side of the vehicle. Investigators follow the rules, during the transportation of radioisotope I-131 for reduction of radiation hazard, developed by the Institute approved by the RCO of the institute.

According to Basic Safety Standard (BSS) the conditions are to be followed while transporting packages of I-131 capsule and I-131solutions to clinics or hospitals. The rules are mentioned as follows:

1. Gate pass must be obtained to take I-131 out of the Institute. Correct account of lead shield to be maintained.
2. Carrier must possess authorization letter issued by the respected person of the Institute.
3. Ambulance of the clinic/Institute vehicle should have a radiation symbol visible from outside.
4. Trolley fitted with handle should be used to transport I-131 packages.
5. Common people should not be in the lift while it is used to transport packages.
6. Technologist must wear Lead-Apron.
7. Technologists must wear Double Hand Gloves.
8. TLD-Badge and Ring-Dosimeter to be worn.
9. Survey meter must be carried for area monitoring.
10. Lead goggles must be worn.

RESULTS

From Table 1 and 2 it can be seen that external surface dose rate of I-131 package and Tc-99m generator is within a permissible limit. From tables 3-9 it can be seen that there is a variation of absorbed dose rate for different types of transportation and sitting arrangements. On the first day, a taxi cab was used for transportation and technologists received dose rates were high, but within the permissible limit (2), than other days when the vehicle was an ambulance /microbus. On the first day, the vehicle was a taxi cab. The back-sit position and technologist sitting position on that vehicle was very near to I-131 package and therefore the dose rates were relatively high.

Table 1: Gamma dose level from the external surface of radioisotope I-131

Days	Batch No	Activity	External surface Dose rate of I-131 Radioisotope package Permissible limit at any point(µSv/h): 2000		Dose rate at 1m distance from the external surface of I-131 Radioisotope package Permissible limit at two meter (2m) distance from the external surface (µSv/h):100	
			Measured dose rate on external surface (µSv/h)		Measured Dose rate at one meter (1m) distance from the external surface (µSv/h)	
			Top of the box	Other four sides of the package	Top of the box	Other four sides of the package
Day 1	327 RIPD,AERE, Saver, Dhaka Bangladesh	100 mCi Liquid	200	217 225 220 206	3.2	3.3 3.4 3.2 3.2
Day2	328 RIPD, AERE, Saver, Dhaka, Bangladesh	100 mCi Liquid	190	215 225 220 206	5.2	5.1 4.9 5.1 4.9
	416478 Monrol N.P Company, Turkey	100mCi Capsule	296	245 275 245 260	3.2	3.1 3.1 3.1 3.3
Day3	328 RIPD,AERE, Saver, Dhaka, Bangladesh	100mCi Liquid.	200	215 228 223 206	6.2	6.0 6.1 6.1 6.0

Day4	416530 Monrol N.P. Company Turkey	75mCi	500	560 600 570 540	5.3	5.0 5.1 5.1 4.9
		100mCi	187	274 263 260 271	3.2	3.0 3.0 3.1 3.0
Day5	416741 Monrol N.P. Company Turkey	75mCi	500	580 600 579 585	8.3	8.0 9.4 7.4 10
	,,	100mCi	187	275 265 260 232	4.2	3.8 4.0 4.1 4.2
	332 RIPD,AERE, Saver, Dhaka, Bangladesh	100mCi Liquid	190	217 220 206 212	7.5	8.4 8.2 8.0 8.3

Table 2: Gamma dose level from the external surface of radioisotope Tc-99m Generator

Days	**Batch No**	**Activity**	**External surface Dose rate of TC-99m Radioisotope drum** **Permissible limit at any point(µSv/h): 2000**		**Dose rate at 1m distance from the external surface of TC-99m Radioisotope drum.** **Permissible limit at two meter (2m) distance from the external surface (µSv/h):100**	
			Measured dose rate on external surface (µSv/h)		**Measured Dose rate at one meter (1m) distance from the external surface (µSv/h)**	
			Top of the box	Other four sides of the package	Top of the box	Other four sides of the package
Day 1	B525 G21	834mCi	350	300 290 290 289	16	15 13 14 12
Day2	B525 G19	575mCi	287	270 275 270 250	13	14 12 10 11
Day3	B526 G20	578mCi	290	267 258 260 200	12	11 13 10 14
Day4	B527 G17	486mCi	280	260 245 237 238	11	12 10 10 11
Day5	B528 G21	717mCi	340	285 280 300 110	14	12 11 13 14

Table3: Dose rate at front side of the vehicle during transportation of I-131

Days	Activity (mCi)		At the front side external surface of the vehicle (µSv)/h	At the 1m dis. front side of the vehicle (µSv)/h
	Capsule	Solution		
Day 1	1700	75	2.5 (Taxi cab)	1.5
Day 2	2150	30	4.1 (Ambulance)	2.7
Day 3	2000	30	1.5 (Large Ambulance)	0.7
Day 4	2100	0	4 (Institute Microbus)	2.9
Day 5	1850	0	1.3(Institute Microbus	0.9

Table 4: Dose rate at left sideof the vehicle during transportation of I-131

Days	Activity (mCi)		At the left side external surface of the vehicle (µSv)	At 1m distance from left side of the vehicle (µSv)
	Capsule	Solution		
Day 1	1700	75	6.7(Taxi cab)	4.5
Day 2	2150	30	6.7(Ambulance)	5.5
Day 3	2000	30	16(large Ambulance)	7
Day 4	2100	0	11(Institute Microbus)	10
Day 5	1850	0	7.6(Institute Microbus)	6.1

Table 5: Dose rate at right side of the vehicle during transportation of I-131

Days	Activity (mCi)		At the right side external surface of the vehicle (µSv)	At 1m dis. from right side of the vehicle (µSv)
	Capsule	Solution		
Day 1	1700	75	6.5 (Taxi cab)	5.8
Day 2	2150	30	8.2 (Ambulance)	5.8
Day 3	2000	30	27 (large Ambulance)	14
Day 4	2100	0	15.1(Institute Microbus)	9.8
Day 5	1850	0	8.5(Institute Microbus)	7

Table 6: Dose rate at back side of the vehicle during transportation of I-131

Days	Activity (mCi)		On the back side external surface of the vehicle (µSv)	At 1m dis. from back side of the vehicle (µSv)
	Capsule	Solution		
Day 1	1700	75	137 (Taxi cab)	24
Day 2	2150	30	75 (Ambulance)	10
Day 3	2000	30	90(Large Ambulance	16
Day 4	2100	0	100(Institute Microbus)	18
Day 5	1850	0	94 (Institute Microbus)	20

Table 7: Dose rate at technologist (1) seat of the vehicle during transportation of I-131

Days	Activity (mCi)		Technologists' seat position (μSv)/h)			At 1m distance from Technologists' seat position (μSv)		
	Capsule	Solution	Head	Chest	Gonad	Head	Chest	Gonad
Day2	1700	75	31	26	14	2.5	2.0	2.7
Day2	2150	30	5.5	5	3	0.06	0.07	0.05
Day 3	2000	30	15	10.7	7.1	1.0	0.08	0.05
Day 4	2100	0	5.6	5.5	4.4	0.05	0.05	0.05
Day5	1850	0	5.6	4.8	4.4	0.07	0.05	0.04

Table 8: Dose rate at technologist (2)of the vehicle during transportation of I-131

Days	Activity (mCi)		Technologists' seat position (μSv)/h)			At 1m distance from Technologists' seat position (μSv)		
	Capsule	Solution	Head	Chest	Gonad	Head	Chest	Gonad
Day2	1700	75	26	16	10	2.6	1.9	1.01
Day2	2150	30	6	5	3	0.07	0.05	0.02
Day 3	2000	30	13	13.8	11.5	1.0	0.09	0.04
Day 4	2100	0	12	11	10	0.09	0.05	0.03
Day5	1850	0	2.4	2.8	2.2	0.03	0.02	0.02

Table 9: Dose rate at driver seat of the vehicle during transportation of I-131

Days	Activity (mCi)		Drivers'seat position (μSv)/h)			At 1m distance from Drivers' seat position (μSv)		
	Capsule	Solution	Head	Chest	Gonad	Head	Chest	Gonad
Day2	1700	75	14.0	9.0	43.0	0.08	0.05	0.04
Day2	2150	30	4.0	2.0	1.0	0.04	0.02	0.02
Day 3	2000	30	5.2	5.7	4.5	0.05	0.02	0.02
Day 4	2100	0	10.0	7.0	4.0	0.07	0.03	0.03
Day5	1850	0	5.2	5.4	2.8	0.03	0.02	0.02

DISCUSSION

From above result, it must be taken into account that vehicle and sitting arrangement is very important to reduce radiation hazards. Although the results show that the observed gamma dose rate was below the permissible limit of 2mSv/h at any point on the external surface dose of the conveyance as per (2). In addition, the measured dose rate at 1m distance from the vehicle was below 0.1 mSv/h, so it is obviously below the permissible limit of 0.1mSv/h at 2m distance from the external surface of the vehicle (2). In NINMAS, once in a week the I-131 package is shifted to the hospitals or clinics .Technologists perform their duties by rotation. From analysis of dose level obtained by technologist, the calculated dose may exceed the dose limit for working in regularly occupied working areas (3) if the vehicle is small and the gap between the radioisotope packages and technologist is smaller. To reduce the received dose, the vehicle should be large and technologist must wear a lead apron. They should follow the Institute's rules, as discussed above.

CONCLUSION

Gamma dose rate was found relatively higher in smaller vehicles than large vehicles which are used in NINMAS, although dose rate in both categories of vehicles were within permissible limit. Surveys are only a supplementary form of radiation control in nuclear medicine because without survey it is impossible to know that small vehicle has large risk in transporting radioisotope. The basic methods of control are to follow the code of practice and involve others to comply with the rules and standards. As dose is not seen, one tends to be ignorant about it. Radiation protection standards attempt to minimize exposure to radioactive materials. Use of Radiation has proven to be safe and beneficial when radiation protection is practiced.

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