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Original Article

Radioactive iodine (I-131) therapy isolation rooms: Introduction of lead glass window on the wall for patient comfort and better ambience

ABSTRACT

For administration of radioactive iodine for the treatment of differentiated cancer thyroid patients, activities ranging between 1.85GBq and 7.0GBq are used. The construction of concrete rooms cleared by national regulatory authorities do not recommend the presence of windows on the walls or advise same lead equivalence of wall for the lead glass if they are put on the walls. To avoid phobia of patients to give consent for I-131 treatment and to stay in isolation rooms, a necessity was felt to introduce glass window on the opposite side wall of *entrance door*, which had a service corridor with restricted entry, opening toward garden area. Commercially available lead glass used for X-ray computed tomography scanner was fixed on the 0.35 m thick concrete wall in two rooms. The adequacy of protection offered by the lead glass was determined. A I-131 capsule 600 MBq was moved at a distance 50 cm away from the wall inside the room, and transmitted radiation was measured outside the room. An end window pancake type, beta-gamma survey meter was used. The measured values were normalized for 3.7 GBq at 2 m bed position in µSv/h. The obtained maximum exposure rate was 1.48 µSv/h transmitted from the glass window, against 0.44 µSv/h transmitted at full concrete wall level. As the patients provide shielding to the administrated activity, also the activity is progressively decreasing fast with an effective half-life, the stray radiation levels will be decreasing outside, reducing the mean radiation level to 0.74 µSv/h, and increasing the efficacy of protection. The patient's bed position is at lower level by 0.5 m from the lower edge of the lead glass, so that during patient is in bed the stray radiation levels reduce further. As there are no reports about such facility for isolation rooms, this report may be of value in health physics literature.

Keywords: Carcinoma thyroid, I-131 isolation rooms, lead glass window, stray radiations

INTRODUCTION

For administration of radioactive iodine for the treatment of differentiated cancer thyroid patients, activities ranging between 1.85 GBq and 7.0 GBq are used. Hospital local safety guidelines stipulate isolation of patients till their radioactive burden reduces to a level <10 µSv/h at 1 m. The construction of concrete rooms gets clearance by national regulatory authorities. The regulatory bodies normally do not recommend the presence of windows on the barrier walls.[1,2] If any windows are provided, it shall have lead equivalence equal to that of the barrier concrete wall, and the side fittings shall have radiation leak proof collars. Centralized air conditioning with filters is incorporated in the design.

Two isolation rooms, originally designed for manual brachytherapy with Cs-137 and Ir-192, were being used as isolation rooms, from 2005, for I-131 therapy patients. We started therapy administrations of iodine-131 during

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February 2006. On an average, 50–60 patients receive I-131 treatments. The I-131 activity in the form of capsules is imported from GE Health Care, Amersham, UK. Details about the method of calibration of capsules, the design of the isolation wards and waste management, clinical data were brought out in our earlier publications.[3-9]

Our experience over a decade showed that many patients have phobia to stay in isolation rooms for >3 days; and hence, many did not take the treatments. A necessity was felt to introduce glass window on the opposite, back side wall of entrance door, which had a service corridor with restricted entry, opening toward the garden area. We outline the measurements undertaken to document the adequacy of radiation protection offered by the lead glass window.

MATERIALS AND METHODS

Commercially available lead glass used for X-ray computed tomography (CT) scanner of size 1380 mm × 620 mm, of physical thickness 8.5 mm (2 mm Pb Equivalent) was fixed on the 0.35 m thick concrete wall in both the rooms as viewing window (VW) [Figure 1]. The adequacy of protection offered by the lead glass was determined using a 600 MBq I-131 capsule moved at a distance 50 cm away parallel from the wall inside the room and measuring transmission outside the room. "An end window beta-gamma (Inovision, Model 190) handheld autoranging wide range survey meter with 'pancake end window GeigerMűller (GM) detector' having μR/h and counts per min" sensitive mode was used. The readings were converted to SI units later (in μSv/h). The uncertainty of measurements with this survey instrument was within ± 15%. Measurements were performed at the middle-level height of the lead glass (on the outer side of the glass), on the edge of the wall. Measurements were carried as a profile at 15 cm intervals up to 90 cm either sides of the midpoint, so as to go beyond both sides of 138 cm lead glass (glass part 69 cm either side). Figure 2 shows the geometry of the measurements carried out. One set of measurements along the edge of the wall below the glass window, along the concrete wall. Another set of measurements along the midline of the VW outside. Background reading of survey meter without radioactive source 10.5 μR/h. The measured values were normalized for 3.7 GBq at 2 m bed position in μSv/h.

RESULTS

The survey meter measured transmission with 600 MBq activity for the two rooms across the middle level of lead glass is shown in Table 1. From Table 1, the maximum exposure rate recorded for Room 1 and Room 2 was 0.58 mR/h and 0.87 mR/h, respectively. As shown in Table 2, the estimated exposure rate for 3.7 GBq of administered activity in the outer corridor in the middle VW level (by calculation) was 1.48 μSv/h. Below the window level, the estimated exposure rate was 0.44 μSv/h.

As the estimates of exposure rates assumed that full activity of 3.7 GBq is all the times present, correction for effective halftime of clearance and also patients' self-shielding to the administrated activity needs to be accounted. Table 3 summarizes the true estimates for one patient for a stay of 3 days with progressively decreasing activity. Therefore, the realistic exposure rate derived in this study is 0.74 μSv/h after fixing of VW.

DISCUSSION

This work has brought out our experience in installing a VW which is commercially available for CT scanner room

Figure 1: Lead glass window on the concrete wall same size in each of the two rooms

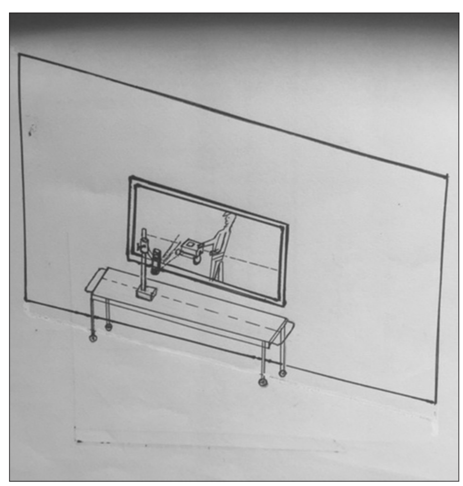

Figure 2: Measurement geometry for gamma beam transmission from I-131 capsule

Table 1: Measured radiation levels (in μR/h) in the outer corridor with 600 MBq

Room	Level	−90	−75	−60	−45	−30	−15	0	+15	+30	+45	+60	+75	+90
1	Mid-VW	5.63	20.2	476	531	446	577*	434	452	497	450	473	113	16.7
	Below VW (wall)	5.10	12.6	78.0	97.0	87.0	60.0	63.0	68.0	83.0	45.6	60.3	70.0	6.8
2	Mid-VW	16.3	43.7	720	870*	761	617	674	522	551	715	627	347	12.7
	Below VW (wall)	6.90	35.3	262	431	395	260	258	279	307	334	172	21.2	11.7

*Indicating maximum radiation level, used for calculations in Table-2, VW: Viewing window

Table 2: The simulated exposure rate at outside corridor during occupancy of a patient

Calculations and corrections
Activity taken for measurement=600 MBq
Assumed activity in isolated patient=3700 MBq (by a factor 6.15)
50 cm is measured activity plane. 2 m distance is patient occupied distance
Therefore, correction for inverse square on these readings $(0.5/2)^2=1/16.0$
Outer corridor readings correspond to edge of the wall
To get exposure rates corrected to "middle of the corridor"
There is a correction with inverse square law, namely, $(2/3)^2=4/9.0$
Viewing window level
Room 1 maximum reading=0.58 mR/h
Room 2 maximum reading=0.87 mR/h
0.87 mR/h as highest of the two sets are taken. The simulated exposure rate to correct for patient's bed position and for 3700 MBq activity=0.87 mR/h × (6.15) × (1/16) × (4/9)=0.148 mR/h
Estimated value for center of the outside corridor, at mid-VW level=1.48 μSv/h
Below viewing window level
Mean maximum recorded exposure rate [Table 1]=0.26 mR/h
Corrected for patient's bed position and for 3700 MBq activity=0.26 mR/h × (6.15) × (1/16) × (4/9)=0.044 mR/h (0.44 μSv/h)

Table 3: Corrected exposure rate estimates at the outer corridor

Parameters used for estimate of radiation level
Effective half life of clearance for cancer thyroid (stop thyroxin patients) $T_{½eff}$=16.5 h (Ravichandran *et al.*[7])
Patient's occupancy in the isolation room=3 days=72 h
Activity at the time of release as per effective decay = A × exp (−0.693×72/16.5)=0.0486.A
=5% of initial activity A
Therefore, the effective activity for exposure rate=(53%) × 1.48 μSv/h=0.74 μSv/h

installation. Separate lead equivalence at 364 KeV photons is not specified in literature, as at this energy there is less of photoelectric effect. As there are no reports about such facility for isolation rooms, this report may be of value in health physics literature. The patients' acceptance for I-131 administration was better after they visit and see the presence of window in these isolation rooms. The isolation rooms were handed over back after the present modification, with recommendations (a) to have a cloth screen on the window inside the room for patient's privacy and (b) to have a caution radioactive sign abstaining use of the service corridor by patients and relatives unless there is an emergency. A report was submitted to the Radiation Safety Expert of the Ministry of Health, Sultanate of Oman, regarding the efficacy of radiation protection offered by this VW.

CONCLUSIONS

The provision of viewing window in two isolation rooms has helped in improving the ambience for patients under treatment. This precedence will help architects to plan lead glass window in I-131 isolation rooms.

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Conflicts of interest

There are no conflicts of interest.

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