I-131 Patient release criteria based on dose rate measurements at the Bank of Cyprus Oncology Centre (BOCOC), Cyprus

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Introduction

At the BOCOC patients who have radioiodine (I-131) ablation therapy are released from the hospital when the dose rate at 1m is less than 40μSv/h according to the European Commission's Directive 97 (RP 97). All patients are advised to avoid contact with children for at least two weeks after administration and avoid prolonged and close contact with adults for the same period of time. Following their release, all patients return to the hospital for further measurements and all restrictions are retrieved when dose rate is less than 3μSv/h. This study was set out to investigate the time depended dose rate after I-131 administration and estimate the effective half life (T_{eff}) for each patient. Finally, individual restriction periods were derived to limit contact to a member of the public or household to less than 300μSv (MDGN).

Materials and methods

External whole body dose rates at 1m from 106 patients were measured with a survey meter (Victoreen, 451P) immediately after administration and at intervals for up to 7 days after administration. At discharge dose rate measurements at 0.5, 1, 1.5 and 2m were also taken. 58 patients were prescribed 3700MB and 48 patients were prescribed 5550MBq.

Non linear regression (Microsoft Excel Solver) was used to plot the measured dose rate against time (clearance rate) and the effective half-live (T_{eff}) of the decay was found for each patient. The resulted relationship was used to calculate cumulative exposure doses to persons who may come in contact with the patient.

Assumptions for contact patterns of the patient with different groups of people (Figure 1) were made and restriction periods for each group of people were then obtained so that the dose constrain of 300μSv/year is not exceeded. Restriction periods were calculated using iterative methods as described by Cormack and Shearer.

Figure 1. Assumptions made regarding contact of patient with exposed persons (broadly following Barrington et all)	
A	Travel by private transport (1.0m from driver)
B	Travel by public transport (0.1m from other passengers)
C	Adult contact (9h @ 1m)
D	Spouse contact (6h @1m and 8h @0.1m (asleep))
E	2 to 5year child (8h @1m and 4h @0.1m)
F	5 to 11 year child (8h @1m and2h @0.1m

Results

Excel solver (GRG Non linear) was used to establish the clearance rate (dose rate vs time) for each patient. For 78% of the patients a bi-exponential decay fit the data better than a single exponential with a fast clearance phase to be followed by a slower clearance phase. Therefore, for this study a bi- exponential relationship was used for all patients (Equation 1).

$$D = A_1 e^{-\frac{\ln 2 t}{T_{eff1}}} + A_2 e^{-\frac{\ln 2 t}{T_{eff2}}}$$

Equation 1

Where: D is the dose rate in μSv/h; A_1 and A_2 are constants and T_{eff1} and T_{eff2} are the effective half-lives for phase 1 and phase 2 respectively.

On average T_{eff} values for all patients were 9.7 and 23.8 h for the first and second phase respectively. For the patients that were prescribed 5550MBq, T_{eff} was slightly lower (9.2h phase 1 and 19.9h phase 2) than the patients that were prescribed 3700MBq (10.1h phase 1 and 27.1h phase 2). Figure 2 shows distribution of T_{eff} for the two phases for all patients.

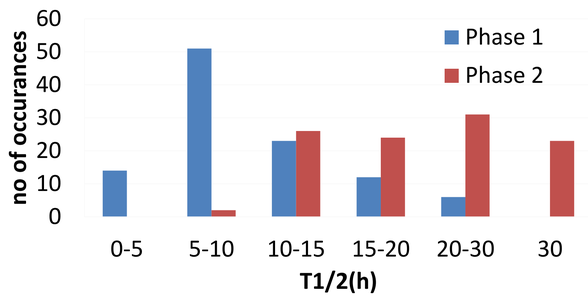

Figure 2: Distribution of T_{eff} for the two phases

Table 1 shows the mean values for activity and dose rate at the time of discharge. There is a large variability in the dose rate at the scheduled time of discharge (Figure 3), nevertheless, only 11.3% of the patients had dose rates higher than 40μSv/h.

	Activity (MBq)	D(uSv/h)	t(h)
mean	421	22.1	50.4
Max	1473	92.2	72.9
Min	30.4	1.6	25.5

Table 1: Mean estimated activities and dose rates at time of discharge for

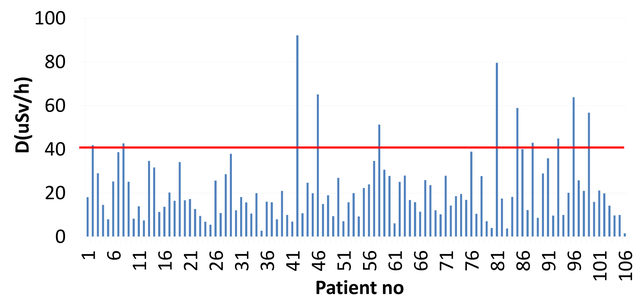

Figure 3: Dose rate at time of discharge for each patient

The relationship between dose rate and distance at the time of discharge was $D = A \times d^{-b}$. Where D is the dose rate in μSv/h and d is the distance in m. A and b are constants. Mean value of b for all patients was 1.5 (max=2.0, min= 1.2). This relationship was used to calculate the exposure at distances other than 1m.

Restriction periods for the 106 patients for the groups described in Figure 1 were then calculated and shown in Tables 2 and 3.

Max time (h)	Group A (N=79*)	Group B (N=106)
mean	21.8	0.7
Max	164.1	4.1
Min	3.4	0.1

* for 27 patients the dose constraint will never be reached

Table 2: Maximum times the patient is allowed to come in contact with members of groups A and B to reach the 300μSv dose constraint

Delay time (h)	Group C	Group D	Group E	Group F
mean	50.5	157.9	142.9	120.5
Max	219.1	501.2	457.1	404.4
Min	19.4	61.4	59.7	51.4

Table 3: Close contact delay times for patients Groups C to F

Discussion

Patients at the BOCOC are kept in the hospital for at least 2 days and until their dose rate measurement at 1 meter is less than 40μSv/h. The doses received by members of the public and family of the patient following the release of the patient from the hospital will depend on the dose rate emitted by the patient and their clearance rate but also will be influenced by the proximity and contact with the patient.

We have shown that the dose rate at the time of release and the clearance rate of each patient vary significantly. In addition, most patients are released from hospital with dose rates much lower than 40μSv/h. For these reasons advise given should not be the same for all patients, but should be tailored to personal circumstances and behavioural patterns of each patient.

We have developed a method that uses Microsoft Excel to estimate the clearance rate from dose rate measurements and calculate the dose received by the members of the public and family members of I-131 patients. Furthermore, the spreadsheet can be used to calculate restriction times for any behavioural pattern and any dose constraint. This last feature was found useful when making calculations for carers of young patients or patients with young children. Finally patients do not need to return to the department to be measured which is inconvenient for the patient and the department.

Literature cited

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