^{131}I TREATMENT: HOSPITAL DISCHARGE CRITERIA

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Introduction

In differentiated papillary and follicular thyroid cancers, surgery followed by radioactive iodine (^{131}I) and suppressive therapy of thyroid hormones has been accepted as the ideal mode of treatment. At the National Cancer Institute (NCI) Maharagama thyroid cancers are treated with ^{131}I activities ranging from 3.7 GBq (100 mCi) to 7.4 GBq (200 mCi). Some important factors that need to be considered during discharge of patients administrated with a radionuclide are the residual activity in the patient, home circumstances, method of transport and nursing requirement of the patient. Therefore these patients have traditionally been hospitalized for five nights at the NCI to minimize the external radiation dose to family members and the general public. Dose limits are recommended by calculations that only consider the physical decay which is 8.04 d for ^{131}I. However as the thyroid tissues of these patients have been previously removed by total or near total surgical excision or ablated by prior doses of ^{131}I the body compartments that would retain iodine are relatively small and the effective half life (T_{eff}) of ^{131}I which combines physical decay and biological elimination could be short. The Atomic Energy Authority (AEA) Regulations (1999) allow a licensee to release a patient with a burden of radiopharmaceutical as long as the total effective dose equivalent to another individual is not likely to exceed 5 mSv. The present practice at the NCI is to discharge patients after 5 d when the dose rate would be less than 30 $\mu Sv\ h^{-1}$ at 1 m distance. This paper presents results of a series of external exposure rate measurements of in-house patients who lack normal thyroid glands treated with ^{131}I to estimate T_{eff} and the total effective dose equivalent which could be used to determine discharge criteria of patients for radiation safety purposes.

Materials and Methods

This study was carried out on 60 in-house patients at the NCI who received oral doses of ^{131}I in capsule form. All had undergone total or near total thyroidectomies and were given initial ablative doses or subsequent doses for the treatment of both local tumors and distant metastases. Thyroid hormone replacement therapy had been discontinued for 3 to 4 weeks before to assure adequate hypothyroidism when ^{131}I is administrated. Activities administrated ranged from 100-200 mCi. External exposure rates were measured immediately and thereafter 1, 24, 48, 72 and 120 h following each administration from anterior, posterior, left and right aspects of each patient while standing at 1 m distance with a Mini Rad Series 1000 survey meter and the average value was considered.

T_{eff} is related to the physical half-life and the biological half-life of iodine as follows.

$$\frac{1}{T_{eff}} = \frac{1}{T_{bio}} + \frac{1}{T_{phy}} \qquad (1)$$

Initially the source activity (Thyroid considered as a point source at 1 m) was calculated using dose rate measurements using Equation 2.

$$D = \Gamma(A/d^2) \qquad (2)$$

where D -Dose rate (μSv/h), Γ - Specific Gamma Constant (μGy/h at 1 m from 1 MBq), A -Activity (MBq) and d -Distance from the source in m . Thereafter T_{eff} was calculated from the gradient λ_{eff} of the graph drawn using exponential relationship of activity with time as follows:

$$T_{eff} = \ln 2 / \lambda_{eff} \qquad (3)$$

The dose to an individual exposed to a patient was calculated thereafter using the following equation.

$$D(t) = \frac{34.6\Gamma Q_0 T(1-e^{-0.693/T})}{r^2} \qquad (4)$$

where D(t) is accumulated dose in time t in rems (100 rems = 1 Sv), Qo initial activity at the start of time interval, T= T_{eff}, r is distance in cm, 34.6 is the conversion factor of 24 h/d times total integration of decay.

Results and Discussion

T_{eff} values obtained from Equations 2 and 3 ranged from 17.4-53.3 h with a mean value of 24.6 h. Figure 1 gives the frequency distribution of patients in relation to the T_{eff} indicating that 50 % showed a value ranging from 21–25 h.

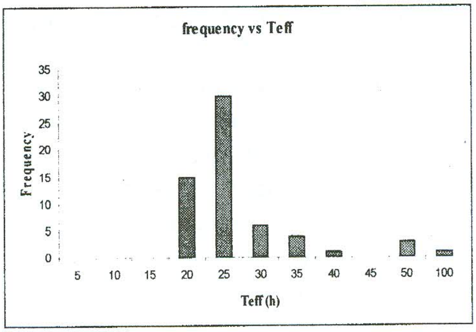

Figure 1. Frequency of T_{eff} values

T_{eff} ranged between 15-20 h in another 25 %. North *et al.*, (2001) reported values ranging from 7.3-106 h from a similar database of 250 administrations. Using Equation 4 total effective dose equivalent was calculated for the study group. Except 4 patients (6.7 %) the rest gave a dose equivalent of less than 5 mSv and a dose rate of less than 20 μSv h^{-1} at 1 m by the end of the third day after administration of the ^{131}I. The 4 patients who did not fall in this category had T_{eff} values at the higher end of the range (48-53.3 h). Such higher values could be due to varying reasons such as residual thyroid remnants, metastatic disease, cell type, age and gender of patient, intake of water, elimination of urine content and stage of disease. However by the end of the 5th day 2 of these patients had a dose rate of 30 μSv h^{-1} and the other 2 patients 20 μSv h^{-1} indicating that they could be released without any undue risk to the public.

Conclusion

This study shows that the biological elimination of ^{131}I is highly variable among patients. There is a protective rule in releasing such a patient with a burden of ^{131}I under the present regulation. According to this study majority of the patients need not be kept in hospital for 5 d but can be discharged after 3 d without any undue risk to the public. The ideal situation would be that discharge criteria for radiation safety purpose should be calculated on the basis of individual measurements.

References

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