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BROOKHAVEN NATIONAL LABORATORY

The Medical Research Center

MEMORANDUM

Brookhaven National Laboratory

Upton, L. I., New York

DATE: Sept. 16, 1953

TO: BNL Committee on Use of Radioactive Isotopes in Human Subjects

FROM: J. Edward Rall

SUBJECT: Project H-33 - Use of I^{132} as tracer in studies of role of triiodothyronine in body metabolism

REPOSITORY Records Holding Area Bldg 494
COLLECTION Protocols-Clinical
BOX No. 4
FOLDER Human Protocols 1950-1963

Purpose: To investigate the effect of thyroxine and triiodothyronine on the uptake of tracer doses of I^{132} so as to establish exact time relationships.

I^{131} is inadequate because of its longer half-life for frequent uptake determinations.

Patients to be used: Although the radiation delivered by the doses of I^{132} planned are close to "tolerance", it is purposed that patients with limited life expectancy, i.e., breast carcinoma, prostatic carcinoma, etc., be used. No more than 5 doses will be given in any week.

Program: Patients will be given daily doses of 50 μc of I^{132} followed by neck readings for several days to establish a base line of thyroid function.

After this, a known dose of thyroxine will be administered and further daily I^{132} uptake determinations will be done.

Following a period sufficiently long to insure return of thyroid function to normal levels, this will be "corroborated" by another "baseline" period, and the response to an equivalent dose of triiodothyronine will be similarly measured.

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Calculation of maximum radiation to thyroid and to total body by 50 μc tracer doses of I-132:

(Note: In the limited literature available to us on I^{132}, certain data, such as exact decay spectrum, etc., are as yet incomplete. It is, therefore, necessary to make certain assumptions for the sake of calculation of radiation. One is that the mean intensity of the β particles may be taken as roughly 0.3 to 0.4 of the maximum energy levels given*.

It is further assumed that the two γ-rays of intensity 0.6 Mev and 0.85 Mev, respectively, occur in cascade, both occuring in 50% of disintegrations, thus allowing us to assign a value of 0.5 for "P" in the case of all three γ-radiations.)

*The data below are taken from Nuclear Data, National Bureau of Standards Circular 499, with the exception that (1) "Mean Energy in Mev" and "Average of Mean Energies, $\bar{E}_\beta$" and (2) "i_γ" and "μ" are taken from the graphs on pp. 273 and 274 respectively of Dosage Determination with Radioactive Isotopes by Marinelli, Quimby, and Hine. "P" is assigned as previously explained.

I^{132} t 1/2 2.4^h emits	Max. Energy in Mev.	Mean Energy in Mev.			Average of Mean Energies, $\bar{E}_\beta$
β ~ 50%	0.9	~ 0.3			
	~ 1.35	~ 0.44			0.49
~ 50%	2.2	~ 0.73			
		i_γ	μ	P	
γ ~50%	0.6	1.1	0.03	0.5	
	0.85	1.6	0.032	0.5	
~ 50%	1.4	2.8	0.029	0.5	

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Radiation to Thyroid: Assuming gland = 25 gm.
Tracer Dose = 50 µc.
Neck Uptake = 20%

For β-radiation:

(1) $D_\beta = K_\beta C$ e.r.

where

(2) $K_\beta = 88\ \overline{E}_\beta T$ e.r. per µc d / gm tissue

($\overline{E}_\beta = 0.49$

T = half-life in days = 0.1)

Substituting,

$K_\beta = 88 \times 0.49 \times 0.1$ e.r. per µc d / gm tissue
$= 4.32$ e.r.

$C = 50$µc x 20% uptake/ 25 gm gland
$= 0.4$ µc/gm

Thus $D_\beta = 4.32 \times 0.4$ e.r.

$D_\beta = 1.728$ e.r.

For γ-radiation:

(3) $D_\gamma = K_\gamma C_g$ roentgens

(4) $K_\gamma = 1.44\ t\ I_\gamma \times 10^{-3}$

where

t = half-life of isotope in hours = 2.4, and
I_γ = dose rate in roentgens/hr.

(5) $I_\gamma = \Sigma_\gamma (i_\gamma)_\gamma$

$= (0.5 \times 1.1) + (0.5 \times 1.6) + (0.5 \times 2.8)$

$I_\gamma = 2.75$

Then, substituting in (4),

$K_\gamma = 1.44 \times 2.4 \times 2.75 \times 10^{-3}$

$K_\gamma = 9.5 \times 10^{-3}$

$g = 17.6$ = geometrical factor for "normal" thyroid

Substituting in (3),

$D_\gamma = 9.5 \times 10^{-3} \times 17.6 \times 0.4 = 6.696 \times 10^{-2}$ r

Thus $D_{(\beta+\gamma)} = (1.728 + \cancel{0.0696})$ 0.067 e.r.

$= 1.795$ e.r.

1.795

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Radiation to Total Body: Assuming 70kg man

$$C = 50\mu c / 70{,}000 \text{ gm}$$
$$= 7.15 \times 10^{-4}$$

Thus, for β-radiation

$$D_\beta = 4.32 \times 7.15 \times 10^{-4} \text{ e.r.}$$
$$= \underline{3.09 \times 10^{-3} \text{ e.r.}}$$

For γ-radiation:

(Here, $g = 3.4 + 4140\mu$ $\mu = 0.03$
$= 189.8$)

$$D_\gamma = K_\gamma C g \text{ roentgens}$$
$$= 25.8 \times 10^{-3} \times 7.15 \times 10^{-4} \times 1.898 \times 10^{2}$$

$$D_\gamma = 3.53 \times 10^{-3}$$

$$D(\beta + \gamma) = (3.02 + 3.53) \times 10^{-3} \text{ e.r.}$$
$$= \underline{\underline{6.55 \times 10^{-3} \text{ e.r.}}}$$

It is appreciated that a great many assumptions have been made in the course of these calculations. Throughout, however, all the assumptions have been chosen to provide the maximum total radiation possible in order to show that the radiation thus calculated still falls safely below the "tolerance" level.

I^{132}, with its half-life of 2.4 hours, will decay to less than 0.1% of dose over 24 hours (or 10 half-lives), even assuming no excretion. Hence, the problem of cumulative effects from daily doses is obviated.

Approved:

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