7/16/97 Event RIDS Dist
SP04

EVENT REPORT COVER PAGE

AGREEMENT STATE

EVENT REPORT NO. SC - 97 - 001
(Followup Report)

DATE: July 15, 1997

TO:
Deputy Director
Office of State Programs

SUBJECT: Followup Report on Medical Misadministration at Tuomey Regional Medical Center, Sumter, SC, on December 11, 1996, Involving I-131

STATE: South Carolina

Signature and Title: Jim Peterson
Dept. Of Health and Environmental Control
Columbia, SC

SP-E-9

Fax Transmission

Bowman Gray School of Medicine
Department of Radiology
Medical Center Boulevard
Winston-Salem, North Carolina 27157
Facsimile (910) 716-2029

DATE: 7/15/97

TO: Melinda Bradshaw
SC DHEC
Nuclear Division

FROM: R. L. Dixon

TELEPHONE:

COMMENTS:

NUMBER OF PAGES INCLUDING THIS COVER SHEET: 4

South Carolina
DHEC
Department of Health and Environmental Control
2600 Bull Street, Columbia, SC 29201

Fax Message

Date: 7/15/97

Number of Pages Including Cover Sheet: 5

Please Deliver This Fax Message

TO: Pat Larkins
Name

US NRC
Organization/Department

(_____) _____
Fax Number

(_____) _____
Office Phone

FROM: Jim Peterson
Name

SC DHEC
Bureau/Division/Section

(803) 737-7412
Fax Number

(803) 737-7407
Office Phone

SUBJECT/COMMENTS: Let us know if you require an AO report for exposure to the thyroid.

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Bowman Gray/Baptist Hospital
The Medical Center

Division of Radiologic Sciences
J. Douglas Maynard, M.D.,
Director

Telephone: (910) 716-7095
Fax: (910) 716-2029

Robert L. Dixon, Ph.D.
Professor - Physics

MEMORANDUM

TO: Susan Starker

FROM: Robert L. Dixon, Ph.D. RLD

DATE: July 15, 1997

RE: Dose calculation for Graves patient, [redacted] who received 10.5 *mCi* of I-131 instead of the prescribed 2.0 *mCi* of I-131 on 12/11/96.

Based on your 63% uptake measurement for this patient, the dose to the thyroid is computed to be 40,400 rad compared to the 7700 rad you would have obtained with 2 *mCi*. The dose to other major organs is estimated to be:

Bladder: 25 rad
Total body: 15 rad
Red marrow: 5.2 rad

I have attached my reference data.

RLD:crc
cc: Melinda Bradshaw, SCDHEC

Radiation Dosimetry for the Adult Female and Fetus from Iodine-131 Administration in Hyperthyroidism

M.G. Stabin, E.E. Watson, C.S. Marcus, and R.D. Salk

Medical Sciences Division, Oak Ridge Associated Universities, Oak Ridge, Tennessee and Nuclear Medicine Outpatient Clinic, Harbor-UCLA Medical Center, Los Angeles, California

Through a study of the iodine kinetics of 127 patients, we have developed radiation dose estimates for major organs and the fetus for patients with varying degrees of hyperthyroidism. We observed a negative correlation between maximum thyroid uptake and biologic half-time of iodine in the thyroid and used this correlation to predict the biologic half-time at fixed values of maximum thyroid uptake. Dose estimates to the bladder, gonads, marrow, thyroid, uterus, and whole body were estimated for maximum thyroid uptakes from 20% to 100%. Bladder dose varied from 0.6 to 1.0 mGy/MBq and dose to the uterus varied from 0.036 to 0.063 mGy/MBq under different model assumptions. Dose estimates to the fetus and fetal thyroid were approximated at all stages of pregnancy. Average fetal dose was a maximum between 0 and 2 mo of pregnancy, with the maximum ranging from 0.048 mGy/MBq to 0.083 mGy/MBq, depending on model assumptions. Some radiation risks for irradiation of the fetus and the fetal thyroid are discussed.

J Nucl Med 1991;32:808–813

Radiation dose estimates have been calculated for euthyroid individuals for several isotopes of iodine by a MIRD Committee Task Group (*1*). This document is very useful for predicting the radiation dose to the thyroid and other major organs from radioiodine administrations. However, the differences in iodine metabolism in patients with Graves' disease are not considered in this model. Although several authors (*2–6*) have estimated doses to the thyroid and some other organs for selected groups of patients with Graves' disease, no comprehensive dosimetry has been done as for the euthyroid case. As radiopharmaceuticals are sometimes accidentally or intentionally administered to pregnant patients, dose estimates for the embryo or fetus may be needed occasionally for the pregnant patient with Graves' disease.

Received Feb. 27, 1989; revision accepted Nov. 6, 1990.
For reprints contact: M.G. Stabin, Medical Sciences Division, Oak Ridge Associated Universities, Oak Ridge, TN 37831-0117.

Using uptake and retention data from patients treated at the Harbor UCLA Medical Center, we have derived a simple model that may be used to estimate the radiation dose to the hyperthyroid patient from administration of iodine-131 (^{131}I). We segregated the patients into groups according to maximum thyroid uptake, which were divided further according to sex and, in the case of females, according to age. Biologic kinetics were studied as a function of maximum thyroid uptake. Radiation dose estimates were derived for the major organs of the body. The radiation dose to the fetus was of special concern, as a majority of hyperthyroid patients are female and may be of childbearing age. In radioiodine therapy studies, the amount of radioiodine administered may be so high that the dose to the fetus from the urinary bladder and other organs may be appreciable. The dose to the fetal thyroid, which may begin to concentrate iodide as early as the tenth week of gestation (*7*), may be extremely high, as this tiny organ concentrates iodide that is available from the mother's bloodstream (*8*).

METHODS

Thyroid uptake and biologic half-time measurements were made on 127 patients treated for hyperthyroidism at the Harbor-UCLA Medical Center. No distinction was made between those with Graves' disease and those with hot nodules, but the majority had Graves' disease. Most uptakes and biologic half-times were measured with ^{123}I, although some measurements were made with ^{131}I. Uptakes were measured at either 2 or 4 hr, and then at 24, 48, and 72 hr. No data on urine clearance or total-body retention were obtained.

The thyroid biologic half-times were determined for all patients through linear regression analysis of the log-transformed data. The biologic half-times were plotted versus maximum percent uptake (rather than 24-hr uptake, as the maximum may occur much earlier than 24 hr in patients who are severely hyperthyroid) to see if the biologic half-time varied with higher maximum percent uptake. The patients were then segregated into groups of maximum thyroid uptake of 20%–30%, >30%–40%, >40%–50%, >50%–60%, >60%–70%, >70%–80%, >80%–90%, and >90%. The patients were further segregated by sex, and then the females were segregated into two groups (those of age less than 45 yr and those aged 45 yr or more) to see whether or not a clear

TABLE 2
Radiation Dose Estimates for ^{131}I in the Hyperthyroid Patient* as a Function of Maximum Thyroid Uptake

Organ		Estimated radiation dose (mGy/MBq) 20'	40'	60'	80'	100'
Bladder	1†	1.0	0.85	0.70	0.60	0.60
	2‡	0.94	0.79	0.66	0.59	0.61
Ovaries	1	0.032	0.030	0.028	0.027	0.026
	2	0.047	0.045	0.044	0.043	0.043
Red marrow	1	0.062	0.10	0.13	0.15	0.14
	2	0.076	0.12	0.15	0.16	0.15
Testes	1	0.026	0.024	0.022	0.021	0.021
	2	0.039	0.037	0.036	0.035	0.035
Thyroid	1	410	780	1070	1240	1150
→	2	400	780	1040	1200	1100
Uterus	1	0.040	0.044	0.040	0.036	0.036
	2	0.063	0.058	0.055	0.052	0.053
Total body	1	0.18	0.29	0.30	0.46	0.42
	2	0.17	0.30	0.39	0.45	0.42

* Adult female (58 kg).
† Maximum thyroid uptake (%).
‡ 1 = thyroid uptake half-time 2.9 hr; and 2 = thyroid uptake half-time 8.1 hr.

total-body biologic half-times were used as input into the dynamic bladder model (*11*).

Table 3 shows the radiation doses to the fetus for maximum thyroid uptakes of 20%, 60%, and 100% and for both thyroid uptake biologic half-times. These values are plotted as a function of stage of gestation in Figures 2 and 3. The figures clearly show the slight increase during the first month, as the growth of the fetus causes a higher fraction of the photon energy emitted from activity in the bladder to be absorbed, and a steady decrease after this, as the increase in fetal mass offsets the increase in absorbed fraction. The figures also show that a higher thyroid uptake

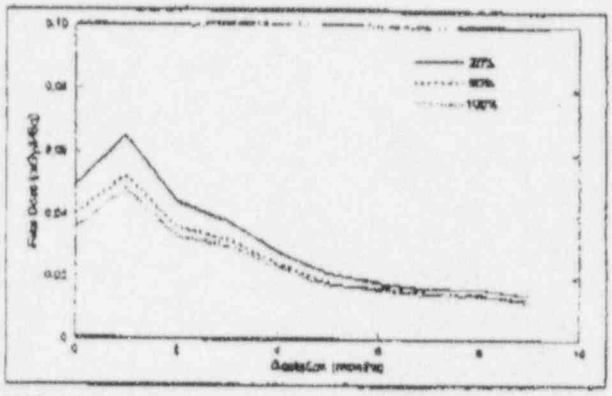

FIGURE 2. Average whole-body dose to the fetus at all stages of pregnancy for patients with maximum thyroid uptakes of 20%, 60%, and 100% and a thyroid uptake half-time of 2.9 hr.

results in a lower radiation dose to the fetus, as more of the iodine is held up in the thyroid and decays before reaching the urinary bladder. Radiation dose estimates for the fetal thyroid have been estimated by Watson (*8*) and Elsasser et al. (*15*). Watson assumed a constant biologic half-time in the infant's thyroid, while Elsasser et al. assumed that the biologic half-time increased with gestational age. Watson's estimates of fetal thyroid dose per unit activity administered to the mother were: month 3, 260 mGy/MBq; month 4, 550 mGy/MBq; month 5, 640 mGy/MBq; month 6, 1200 mGy/MBq; month 7, 810 mGy/MBq; month 8, 620 mGy/MBq; month 9, 490 mGy/MBq. Elsasser et al. estimated the fetal thyroid dose per unit activity administered to the mother to be: month 3, 43 mGy/MBq; month 4, 220 mGy/MBq; month 5, 370 mGy/MBq; month 6, 840 mGy/MBq; month 7, 620 mGy/MBq; month 8, 520 mGy/MBq; month 9, 430 mGy/MBq. In both sets of estimates, the maximum thyroid dose per unit activity given to the mother is seen in month 6. This is the time at which the fetal thyroid

TABLE 3
Radiation Dose Estimates for the Fetus at All Stages of Pregnancy from Administration of ^{131}I to the Mother

Age (mo)	Estimated radiation dose (mGy/MBq)* 20%† T(u) = 2.9 hr	20%† T(u) = 8.1 hr	60%† T(u) = 2.9 hr	60%† T(u) = 8.1 hr	100%† T(u) = 2.9 hr	100%† T(u) = 8.1 hr
1	0.065	0.083	0.052	0.072	0.048	0.071
2	0.044	0.055	0.036	0.043	0.033	0.048
3	0.038	0.065	0.032	0.045	0.030	0.048
4	0.026	0.042	0.024	0.035	0.023	0.037
5	0.021	0.032	0.018	0.028	0.017	0.030
6	0.018	0.029	0.016	0.026	0.016	0.027
7	0.018	0.027	0.015	0.024	0.014	0.025
8	0.016	0.026	0.014	0.024	0.014	0.025
9	0.014	0.024	0.013	0.022	0.012	0.023

* Absorbed dose to the fetus per unit activity administered to the mother.
† Maximum thyroid uptake (%).
T(u) is the assumed thyroid biologic half-time for uptake.