

Late Results of I¹³¹ Treatment of Hyperthyroidism in Seventy-three Children and Adolescents^{1,2,3}

Paul Starr, M.D., Henry L. Jaffe, M.D., and Leon Oettinger, Jr., M.D.

Los Angeles

This study of seventy-three children and adolescents treated in three Los Angeles hospitals between 1949 and 1961, was undertaken to determine whether radioactive iodine administered for the treatment of hyperthyroidism was subsequently carcinogenic or dysmutagenic in these patients who were 18 years of age or younger at the time of the isotope treatment.

CLINICAL MATERIAL

The ages and sex of these children are shown in Table I.

In most cases the diagnosis was established on clinical findings and elevated serum PBI. In 60 children whose PBI determinations pre-therapy were made, the values were as follows: 12 were less than 10 mcg per cent; 25 were from 10 to 15 mcg per cent; 11 were from 16 to 19 mcg per cent, and 12 were over 20 mcg per cent. In 13 cases, the diagnosis was based on clinical findings and I¹³¹ uptake studies. In this group of children the uptake values ranged from 41.5 to 99 per cent in 24 hours. Of the 69 children, including these 13 who had 24 hour uptakes of I¹³¹ tracer doses pre-therapy, 4 had uptakes below 40 per cent; 39 were between 40 and 75 per cent; and 26 were above 75 per cent. In 21 children BMR's were run; of these, 15 were well above normal, but in three patients the metabolic rates were only +2, +8, and +8 per cent. In these three, the serum PBI measurements were 9.4, 13.3 and 12.4 mcg per cent respectively.

Table II indicates the gland size, when recorded, presence of nodularity if noted, and the dates and amounts of I¹³¹ given. The glands of 5 children (#9, 56, 57, 61 and 65) were listed as being nodular; in #10 and #70 nodularity was questionable at the time of diagnosis. No further mention is made of a nodule on subsequent examinations in most of these cases. There was one substernal goiter (#15) and in two instances (#31 and #32), the isthmus was described as enlarged. The child with the substernal extension had had surgery on two occasions, with recurrent thyrotoxicosis; subsequent administration of I¹³¹ was successful.

¹From the Los Angeles County Hospital; Department of Medicine, University of Southern California; The Children's Hospital, and Division of Radiation Therapy, Cedars of Lebanon Hospital. With the cooperation of Robert Freeman, M.D.; and Norman Specht, M.D., White Memorial Hospital, Los Angeles. With the assistance of Mrs. Ruth M. Bourke.

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The first dose of I^{131} was less than 1 Mc in 8 patients; from 1.0 to 3.0 inclusive in 25 patients; more than 3.0, but less than 7.2 Mc in 25 cases; 4 received between 8 and 15 Mc, and one girl was given a total of 29.2 Mc. Forty-two children had only one treatment of radioiodine; 20 had 2 drinks of the isotope; 3 treatments were administered to 9 children; one had 5 doses in 7 months, and one girl received 6 doses totalling 29.2 Mc over a period of 16 months.

Two children were given their first dose 14 years ago; 7 received their first treatment 13 years ago; 16 were treated 11 or 12 years ago; 18, 8 or 9 years ago; 15 received I^{131} 6 or 7 years ago; 14 were treated 3 to 6 years ago, and one was treated during the past 2 years.

Table III shows the age and year of I^{131} therapy that each child received and the date of the last examination by the administering hospital or physician. Two of the 73 children died less than 1 year after therapy, of causes unrelated to their I^{131} treatment. Follow-up has been complete except for 3 cases, *i.e.* 95.8 per cent. The three missing cases are as follows: #21 has married and moved out of the continental USA; to date we have not been able to locate her. Numbers 41 and 46, whose parents had been most uncooperative in the past, have moved out of California; we have just received addresses in the Eastern States, and requests for examinations have been forwarded to their parents.

RESULTS

Hyperthyroidism was controlled in all of the cases adequately treated, even though repeated administration was required in some patients. For example, in the one patient requiring 6 doses, the serum PBI was still 8.8 mcg per cent and the 24 hour uptake 69 per cent after the fifth dose. Finally, after an additional drink of 10 Mc, the PBI dropped to 4.1 mcg per cent and the uptake to 35.

In two cases, subtotal thyroidectomies were done before the isotope treatment was completed. On one of these cases (#16) a recurrence of hyperthyroidism, 6 years after this surgery, was accompanied by the development of a nodule which on scintigram was "hot." Another dose of 10 Mc I^{131} was given, with regression of the nodule and the thyrotoxicosis. This patient has just been seen in June 1963; she is euthyroid with the recurrent nodule still present, 1 cm in diameter. She is taking desiccated thyroid, gr. i, with a serum PBI of 7.4 mcg per cent. In the other patient (#66) hyperthyroidism persisted after one inadequate dose of

TABLE I
SEX AND AGE OF CHILDREN AND ADOLESCENTS TREATED
WITH I-131 FOR HYPERTHYROIDISM

<i>Male</i>		<i>Female</i>	
1- 5 years	2	1- 5 years	2
6-10 years	1	6-10 years	12
11-15 years	8	11-15 years	32
16-18 years	6	16-18 years	10
	—		—
Total	17	Total	56

TABLE II
CONDITION OF THYROID GLAND—DATES AND DOSES OF ¹³¹I GIVEN FOR HYPERTHYROIDISM

Pt. #	Estimated Gland Size	Date Rx	# ¹³¹ I	Total Dose	Pt. #	Estimated Gland Size	Date Rx	# ¹³¹ I	Total Dose	Pt. #	Estimated Gland Size	Date Rx	# ¹³¹ I	Total Dose
1	50-60 gms.	5-1949	0.63		27	diff. enlarged	1-1953	3.0		52	diff. enlarged	9-1956	2.1	6.3
2	diff. enlarged	6-1949	0.83		28	diff. enlarged	4-1953	1.0	4.0			9-1956	2.1	
3	50 gms.	2-1950	5.0		29	.....	4-1953	3.9		53	.....	10-1956	2.1	
4	diff. enlarged	4-1950	0.7	2.2	30	40 gms.	8-1954	3.0	6.9	54	diff. enlarged	1-1957	7.0	
5	.....	2-1954	1.5		31	Lt. lobe larg. rt. isthmus enlarged	10-1953	7.17		55	40-50 gms.	3-1956	2.1	
		5-1950	6.0		32	Rt. lobe & isthmus enlarged	8-1953	7.0		56	enlarged*	4-1956	0.4	
		7-1950	4.0	12.25	33	mus enlarged	6-1954	1.5		57	40 gms.*	5-1956	1.7	4.2
6	diff. enlarged	11-1950	2.25		34	30 gms.				58	diff. enlarged	3-1957	1.5	
		8-1950	1.8		35	4 x 4 cm.	4-1954	2.0				1-1957	7.0	
		9-1950	4.0	8.8	36	45-50 gms.	3-1954	1.5				4-1957	3.0	
7	30 gms.	10-1952	3.0		37	diff. enlarged	7-1954	3.0				6-1957	1.0	
8	diff. enlarged	10-1950	0.92		38	75-80 gms.	8-1954	1.9	4.9			6-1957	3.0	
9	40 gms.*	5-1950	3.1	7.0	39	40-50 gms.	10-1954	7.0	14.0			9-1957	2.1	14.6
10	enlarged rt. lobe larger lt.	2-1951	2.0	6.9	40	30-40 gms.	7-1955	1.25				12-1957	2.1	
11	diff. enlarged	4-1951	2.0		41	4 x 7 cm.	2-1956	2.0	3.25			1-1957	3.2	5.9
		7-1951	3.8		42	diff. enlarged	7-1955	5.0				1-1957	1.6	
12	diff. enlarged	6-1953	3.2		43	30-32 gms.	10-1954	7.0				1-1957	2.7	
		8-1951	5.3	7.0	44	diff. enlarged	2-1956	2.0				1-1957	1.5	
13	75 gms.	6-1952	7.0	6.9	45	bilat. enlarged and firm	5-1955	5.0				1-1957	1.5	
14	50-60 gms. substernal ext.	1-1953	5.0	12.0	46	35-50 gms.	8-1956	1.6	5.6			3-1957	1.3	5.9
15	left**	4-1952	7.0		47	60 gms.	1-1955	2.3				3-1956	1.5	
		12-1952	2.1		48	enlarged	1-1955	1.5				2-1957	1.5	4.5
			1.9		49	40-50 gms.	2-1955	1.0	6.4			7-1957	1.5	
16	diff. enlarged	1-1953	4.6	8.6	50	40-50 gms.	10-1955	1.6				2-1957	1.5	
		1-1952	2.21		51	diff. enlarged	8-1954	1.25	2.25			2-1957	0.5	
17	.....	1-1962	10.0	12.21	52	diff. enlarged	8-1955	1.0				2-1957	0.9	
		4-1952	7.0		53	bilat. enlarged	1-1955	1.5				2-1957	0.7	
18	diffuse	8-1952	7.0	14.0	54	bilat. enlarged and firm	11-1955	1.5				2-1957	0.5	
19	enlarged	4-1952	3.9		55	35-50 gms.	11-1955	1.0	5.6			3-1957	1.5	5.6
20	Mod. large	12-1952	7.0		56	60 gms.	8-1956	1.6				9-1957	5.0	
		10-1952	7.0		57	60 gms.	5-1955	1.7				7-1958	1.5	
		12-1952	7.0	23.0	58	30-32 gms.	6-1955	1.6	6.5			7-1958	0.9	
21	30 gms.	12-1953	9.0		59	50-60 gms.	6-1955	3.2				7-1958	2.8	
		6x from 12-1952	29.2		60	40-50 gms.	4-1955	1.5				7-1958	0.3	
		12-1952	total		61	diff. enlarged	12-1955	2.77				7-1958	1.9	7.3
22	50-60 gms.	8-1952	0.7		62	.....	8-1955	4.0	1.5			5-1951	3.0	
23	.....	4-1953	1.0		63	100 gms.	6-1955	0.5				4-1953	0.75	
24	50 gms.	3-1953	4.0		64	diff. enlarged	11-1955	1.0	1.5			1-1957	3.5	
25	40-60 gms.	1-1953	0.31		65	enlarged***	2-1956	2.0				2-1957	2.5	
26	diff. enlarged	9-1952	8.8	21.0	66	3 x 3 cm.****	4-1956	1.1				3-1957	1.6	7.6
		11-1952	5.0		67	.....	4-1956	0.9	5.89			1-1958	9.5	
		11-1952	4.2		68	75-80 gms.	4-1956	1.1				2-1960	15.0	
		12-1952	3.0		69	100 gms.	4-1956	0.9				3-1961	1.5	
					70	50 gms.	5-1956	1.0				8-1958	5.0	
					71	100 gms.	5-1956	1.6				2-1954	6.0	
					72	30 gms.						7-1950	8.0	
					73	.....							

*Nodules reported on the physical examination before ¹³¹I Rx
 **Surgery two times pre ¹³¹I
 ***Died 11 months post Rx., not related to ¹³¹I
 ****Died 4½ months post ¹³¹I Rx., of thyroidectomy surgical shock

TABLE III
AGE AND YEAR OF I¹³¹ RX WITH DATE OF LAST EXAMINATION AND PBI VALUE

<i>Pt. #</i>	<i>Sex</i>	<i>Age When Rx</i>	<i>Year Rx</i>	<i>Date Last Examined</i>	<i>Last PBI</i>	<i>Last Uptake</i>
1	M	4	1949	12-1961	4.1	
2	F	13	1949	7-1960	7.0	
3	F	15	1950	8-1963	in lab.	
4	F	8	1950			
			1954	12-1961	5.0	
5	F	15	1950	6-1962	1.9	2%
6	F	14	1950			
			1952	5-1961	—	3%
7	F	7	1950	11-1961	6.5	
8	F	10	1950	7-1963	3.0	
9	F	8	1951	2-1961	4.3	
10	F	9	1951	7-1963	3.6	
11	F	14	1951	6-1962	4.2	20%
			1953			
12	F	14	1951	4-1961	—	—
13	M	15	1952	7-1963	3.6	
			1953			
14	F	14	1952	7-1963	3.0	
15	F	15	1952	*	—	—
			1953			
16	F	12	1952	6-1963	7.4	
			1962			
17	F	18	1952	1-1963	4.6	
18	F	7	1952	3-1961	3.5	
19	F	15	1952	7-1963	in lab.	
20	M	18	1952	6-1961	6.4	
			1953			
21	F	15	1952	1-1959**	6.5	
			1954			
22	F	5	1952	6-1963	3.2	
23	F	13	1953	6-1962	6.2	
24	F	18	1953	11-1961	8.6	
25	F	12	1953	1-1962	4.7	
26	M	12	1952	4-1963	3.7	1%
27	F	28 mos.	1953	4-1961	3.0	
28	F	15	1953	1-1961	3.3	
			1954			
29	F	16	1953	7-1963	in lab.	
30	F	17	1953	6-1962	5.2	
31	F	11	1954	6-1963	7.6	
32	M	5	1954	1962	"euthy."	
33	F	11	1954	12-1961	7.2	
34	F	12	1954	11-1961	7.7	
35	M	14	1954	8-1963		
36	F	13	1954	7-1963	2.8	
37	F	14	1954	2-1962	—	7%
38	M	16	1954	9-1962	4.0	
39	F	12	1955	1-1963	6.5	
			1956			
40	M	16	1955	2-1963	5.8	
41	F	9	1955	9-1958	BEI 5.8	
42	F	11	1955	*	—	11.6%
43	F	10	1954	2-1961	"Normal"	
			1955			
44	F	12	1955	4-1963	3.7	6%
			1956			
45	F	12	1955	3-1962	—	10%
46	F	15	1955	7-1958	euthryoid	
47	M	6	1955	8-1962	5.9	2%
48	M	16	1955	11-1962	2.8	
49	F	6	1955	7-1962	6.9	
50	M	14	1956	7-1963	3.7	
51	M	13	1956	10-1962	—	20%

TABLE III—Continued

Pt. #	Sex	Age When Rx	Year Rx	Date Last Examined	Last PBI	Last Uptake
52	M	15	1956	5-1961	5.2	20%
53	F	12	1956	7-1960	5.4	29%
54	F	8	1956	12-1962	2.8	
55	M	13	1957	8-1960	6.1	
56	F	17	1957	2-1962	8.9	
57	F	16	1957	7-1963	6.4	
58	F	14	1957	7-1962	6.4	30%
59	F	14	1957	3-1962	"normal"	26%
60	F	12	1957	7-1962	5.9	7%
61	M	12	1956	3-1961	—	
			1957			
62	F	10	1957	6-1952	—	34%
63	F	14	1957	5-1963	6.2	
64	F	13	1958	7-1960	—	8%
65	F	17	1951	deceased	—	
66	F	8	1953	deceased	—	
67	F	16	1957	5-1962	6.5	5%
68	F	17	1958	3-1963	6.3	
69	M	18	1960	3-1960	8.2	
70	F	8	1961	10-1962	10.4	
71	F	16	1958	6-1963	7.4	
72	F	11	1954	1-1962	4.8	
73	F	18	1950	6-1963	1.0	

*Last examination in 1959—direct correspondence with patient (now out of California) indicates she is in good health. Reports have been requested from their physicians.

**Moved out of continental USA.

radioiodine. The patient moved to a small city in another state, where unfortunately, thyroidectomy was attempted. The operation was followed by shock and death. With the exception of #16, #66, #39, #3 and #29 there was no mention of the development of nodules after I¹³¹ therapy.

In one patient (#39), 12 years old at the time of treatment, and now 20 years of age, who had had a goiter three times normal size before the I¹³¹ therapy, a nodule appeared in the shrunken gland 2 years and 3 months after the first of two I¹³¹ treatments. This was removed, and surgical pathology reported this to be a papillary adenocarcinoma of the thyroid with an encapsulated nodule with invasion of the surrounding panenchyma. A single lymph gland was negative. No recurrence has been recognized in the 5½ years which have elapsed since this surgery. She is taking desiccated thyroid gr. 3. It is believed that the interval between the I¹³¹ therapy, and the discovery of the cancer is so short, that I¹³¹ is not likely to have been causative. This girl had had chronic hyperthyroidism for 3 years before the radioiodine therapy. During the two years before final surgery she had received repeated periods of treatment with Propylthiouracil or Lugol's solution. In addition, this child was recognized to have congenital heart disease at 2 years of age. For diagnosis of this condition, she received repeated x-ray examination during the 10 years preceding the administration of radioiodine for hyperthyroidism. As far as can be determined, she did not have x-ray treatment to the head and neck at any time.

Hypothyroidism, as indicated by a subnormal PBI, occurred sometime after therapy in 43 of the children, although many of these were brought to a euthyroid state with medication. At the time of their last examinations, the serum PBI de-

terminations of 16 of these 43 were still below the normal value: #13 and #14 had not been found to be hypothyroid; #36 who had never been below normal developed hypothyroidism in 1962—*i.e.* seven years after the I^{131} treatment in 1954. We have proof of normal thyroid capacity, however, in only 12 other patients—*i.e.* normal serum PBI values without thyroid medication.

Forty-eight of the 71 living patients are on some form of thyroid medication. It is our practice to give our patients thyroid hormone substitution medication shortly after the administration of therapeutic doses of I^{131} , while they are still thyrotoxic, rather than wait for the development of hypothyroidism which may aggravate the orbital pathology. Ultimate dosage is decided by clinical findings and the serum PBI. This practice, common in our series, but still only observed in half of the cases, may well be of value in the prevention of chronic TSH hypersecretion, which has been shown to be carcinogenic in laboratory animals. Sufficient daily thyroid hormone medication to produce normal metabolism, continued for life in such patients, is indicated.

TABLE IV
CHILDREN AND ADOLESCENTS WHO HAVE HAD CHILDREN AFTER I^{131} RX FOR
HYPERTHYROIDISM AS OF 1963

<i>Patient #</i>	<i>Sex</i>	<i>Age When Rx</i>	<i>Year Rx</i>	<i>Children born post Rx</i>	<i>Remarks</i>
2	F	13	1949	1	
3	F	15	1950	2	
6	F	14	1950 1952	3	
8	F	10	1950	3	
9	F	7	1951	1	
11	F	14	1951 1953	1	
12	F	14	1951	1	Again pregnant when last seen
13	M	15	1952 1953	1	Wife again pregnant in 1963
14	F	14	1952	2	
16	F	12	1952 1962	1	
19	F	15	1952	2	
24	F	18	1953	1	
25	F	12	1953	1	
29	F	16	1954	2	
34	F	12	1954	2	
38	M	16	1954	2	
56	F	17	1957	1	
57	F	16	1957	2	
72	F	11	1954	1	
73	F	18	1950	2	

Table IV lists the 20 patients who have married and had children after therapy. Included are 2 males (#13 and #38). In the case of #13, his wife who was also reported as being hyperthyroid, but who did not receive any radioiodine, had several miscarriages after her husband's treatment; one of these, had the pregnancy been completed, would have resulted in Siamese twins; there is one normal healthy child born since her husband received I¹³¹, and at present she is in the first trimester of another pregnancy. After therapy #3 delivered 2 normal healthy children, preceded by 2 premature births—one lived for 17 hours, and the other for one month. A total of 31 normal children are known to have been born to these 20 adolescents included in this study. With the exception of the Siamese twins, mentioned above, there have been no abnormalities. Fertility seems to be unimpaired!

TABLE V
GROWTH OF CHILDREN AND ADOLESCENTS SINCE I¹³¹ TREATMENTS

Patient #	Year 1st Rx	Age at Rx	Ht. Pre-treatment	Wt. Pre-treatment	Post Rx Exam.	Age	Ht.	Wt.
1	1949	4	3'8"	40 lbs.	1960	15	5'1½"	115½ lbs.
22	1952	5	3'7"	38	1963	16	4'11"	103
32	1954	5	3'11"	44¼	1963	14	5'3"	95
49	1955	6	4'¾"	58	1962	13	5'4½"	140¼
7	1950	7	3'9"	37	1960	17	4'8"	81
70	1961	8	4'5"	63¼	1963	10	5'½"	89
10	1951	9	4'6"	64	1963	23	5'6¼"	135
41	1955	9	4'5"	54	1958*	12	4'11¼"	95
8	1950	10	4'11"	72	1963	23	5'5"	224
43	1954	10	4'9"	75¼	1960	16	5'1¾"	147¼
31	1954	11	4'11"	66	1963	20	5'4"	139
16	1952	12	4'9"	82	1963	23	5'4"	105
33	1954	12	5'2¼"	96	1963	21	5'6¾"	119
36	1953	12	5'3"	99	1963	22	5'4½"	123
34	1954	12	4'5"	60	1960	18	5'4¼"	121
39	1955	12	5'½"	103	1962	19	5'1½"	117
2	1949	13	5'0"	88	1960	24	5'2½"	124
14	1952	14	5'5"	117	1963	25	5'7"	138½
35	1954	14	5'7"	115	1963	23	6'2½"	205
50	1956	14	5'3"	128	1963	21	5'3"	225
63	1957	14	5'3"	98	1963	20	5'4½"	110½
3	1950	15	5'8"	122	1963	28	5'10"	142
13	1952	15	no rec.	137	1963	26	5'11"	160
57	1952	16	5'3"	116	1963	27	5'5"	149
48	1955	16	5'5¾"	119	1962	23	5'6"	133
38	1954	16	6'0"	160	1963	25	6'0"	199
40	1955	16	5'9"	139	1963	24	5'9"	185
42	1955	16	4'2"	51½	1962	23	6'3¾"	127

*No recent contact.

The condition of the thyroid glands on physical examination in the years following the isotope treatment is reported as "normal," "not remarkable," "impalpable" or "results good." No compensatory hypertrophy developed in spite of the high incidence of hypothyroidism reported above.

In two-thirds of this series (51 patients), slight to moderate exophthalmos was present before the administration of the isotope. After therapy, 28 of these showed improvement; in no case has progressive proptosis or malignant exophthalmos developed.

Growth and development of the children has been remarkably good in view of the uncertain maintenance of adequate thyroxine administration in some patients. As shown in Table V, for example 27 children treated with I^{131} and thyroid hormone medication have grown to normal height, and reached normal body weight.

There were no deaths attributable to the I^{131} treatment of hyperthyroidism; nor is there any evidence of parathyroid deficiency, laryngeal cord paralysis or blood dyscrasia; and there is no case of thyroid cancer attributable to this internal radiation therapy.

DISCUSSION

Winship and Rosvoll (1) collected 562 cases of childhood cancer from all parts of the world. They found that approximately 80 per cent of the patients questioned received external x-ray irradiation during infancy or childhood for an enlarged thymus, hypertrophied tonsils or adenoids. Since the histology and growth rate of the thyroid gland tissue and the distribution and physical form of the radiation, and the associated lymphoid disease are so different from the conditions of therapy in the I^{131} treatment of hyperthyroidism, it is our opinion that this experience is not applicable.

Sheline, Lindsay, McCormack and Galante (2) reported a study of 256 patients treated with radioiodine between 1946 and 1953, who were reexamined between January 1959 and April 1961. In this group, were 18 patients who were 20 years or younger. In 8 of these, on physical examination 5 to 14 years after therapy, one or more nodules were found. Total or subtotal thyroidectomies were performed; the histopathology of 1 case is thought to represent early carcinoma. In none of the above 8 persons had hypothyroidism been recognized, and none had received exogenous thyroid hormone prior to the discovery of the nodules. Sheline's data also suggest that thyroid nodules are more apt to develop in the younger patient. Perhaps the low incidence of post-therapy nodules in our series is due to our more frequent use of thyroid medication to maintain euthyroidism.

The effects of surgical subtotal thyroidectomy are well known, and have been presented in many reports. A typical conclusion is that of the late Dwight Clark (3) a most experienced and successful surgeon and student of thyroidology: "The mortality should be less than 0.5 of 1 per cent, and complications less than 1 per cent." An excellent review by Kurt Iverson of Copenhagen (4) however, including statistics of Cattell of Boston, tabulates 4 surgical cases covering 1580 thyroidectomized patients (of all ages) as follows: mortality 2.2 per cent; parathyroid tetany 1.8 per cent; laryngeal paralysis 3.9 per cent.

It is our feeling that the simplicity and success to date of I¹³¹ therapy, the absence of mortality and/or morbidity, would seem to make this the treatment of choice, particularly for the younger patients.

This is a preliminary report. It is conceivable that malignant changes in the thyroids of these young people may appear in the next decade. The present condition of all such groups of patients should be published now, with follow-up records to be presented in the future.

SUMMARY

Seventy-three children and adolescents ranging in age from 28 months to 18 years were treated with radioiodine for hyperthyroidism.

Hypothyroidism is known to have developed some time after therapy in 43 of the 71 living cases, and only 12 others maintained normal thyroid capacity without exogenous thyroid hormone.

A nodule was found after therapy in five cases; one girl, on whom a subtotal thyroidectomy was performed before the first isotope therapy was completed, was found to have a "hot" nodule seven and one half years post-surgery; a second dose of 10 McI¹³¹ was given, with regression of the nodule and thyrotoxicosis. A nodule, in case #39, remaining after shrinkage of a large gland by I¹³¹ treatment was diagnosed at the time of surgery 2 years and 3 months after isotope administration as papillary adenocarcinoma. It has not recurred in the 5½ years since this surgery.

Neither of the two deaths which occurred in less than one year after treatment is attributable to the I¹³¹ therapy. Three children were subjected to subtotal thyroidectomy after incomplete I¹³¹ treatment; one of these died of surgical shock.

Hyperthyroidism was controlled in all the cases adequately treated, even though repeated administration was required in some cases.

The growth and development of these patients, particularly those less than 11 years of age, has been normal.

A total of 31 healthy normal children have been born to 20 of the adolescents reported in this series. No abnormal children have been produced, although one pregnancy (of the wife of one of our patients) if completed, would have resulted in Siamese twins.

There were no deaths attributable to the I¹³¹ treatment of hyperthyroidism; nor is there any evidence of parathyroid gland deficiency, laryngeal cord paralysis, or blood dyscrasia, and there is no case, including the malignant nodule found in case #39, of thyroid cancer that is attributable to this internal radiation therapy.

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