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# THE IODINE BALANCE IN NODULAR GOITER<sup>1, 2</sup>

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Patients with toxic nodular goiter present an increased urinary excretion of iodine. This is greater than that observed in patients with exophthalmic goiter (1). The blood iodine and the basal metabolic rate are also increased, but to a lesser degree than in exophthalmic goiter (1). In non-toxic nodular goiter, however, the urinary excretion of iodine, the blood iodine, and the basal metabolic rate are normal or may be even decreased (3).

More recently we have found that the iodine metabolism of exophthalmic goiter is greatly augmented (2). This is shown in the elevated blood iodine, the increased excretion of iodine through one or all excretory channels, and the increased negative iodine balance on a low iodine intake. It consequently appeared desirable to extend balance studies to patients with nodular goiter, in order better to compare the iodine metabolism in these three thyroid diseases. We have therefore determined the iodine balance of two patients with non-toxic nodular goiter over a total period of 36 days and that of two patients with toxic nodular goiter over a total period of 54 days.

## METHODS

Our experimental and laboratory methods have been given (2, 4, 5). A constant regimen of hospital management was begun five to six days prior to investigation and then maintained throughout the period of study. The daily diets were selected from a limited number of foods. They were low in iodine and calcium content, adequate in other respects, and as attractive as possible. They were constant for each individual during the preoperative period. The iodine content of the food as actually served to each patient was determined (2).

<sup>1</sup> This investigation was aided by a grant from the Committee on Scientific Research of the American Medical Association.

<sup>2</sup> Presented before the American Society for Experimental Pathology, at Baltimore, Maryland, March 31, 1938.

Of necessity, the diets were changed in the immediate postoperative period. The patient was eventually operated on the first day of a period. An aliquot part of the food eaten during the first five postoperative days was analyzed for its iodine content. The total food iodine thus determined was equally divided for the period (three-day) of operation and for the first postoperative (three-day) period. The constant diet used preoperatively was resumed in the later postoperative periods. The water ingested was single distilled and iodine free. The iodine inspired by the average individual in this region has been determined as approximately 1 microgram per day, which is negligible. Methods of preparation of the diet, of collection of the excreta, and of chemical analysis of the specimens have been described elsewhere (2, 4, 5).

## *Non-toxic nodular goiter*

The iodine balance of two women with non-toxic nodular goiter was determined over a total period of 36 days. One showed a physiological iodine balance (Figure 1). The other revealed a tendency toward a greater retention of iodine than normal (Table I).

Protocols may be briefly presented as follows.

### *D. W., Numbers 370617 and 371011*

A white housewife of 23 was readmitted to the Research Surgery Service on February 22, 1937 for the management of non-toxic nodular goiter. She had been aware of goiter for thirteen years. This had grown progressively larger but did not give rise to symptoms until about four years ago. She then noted dysphagia and dyspnea. There were no toxic symptoms. She had received no iodine nor thyroid medication in any form. She had been under hospital observation from February 4 to February 19, but was unable to remain for the completion of our metabolic studies at that time. Physical examination showed a large nodular goiter involving both lobes and the isthmus. Roentgenographic study revealed the trachea deviated to the right and the retrotracheal space widened.

Laboratory examination showed negative Wassermann and Kahn reactions. The blood examination was nega-

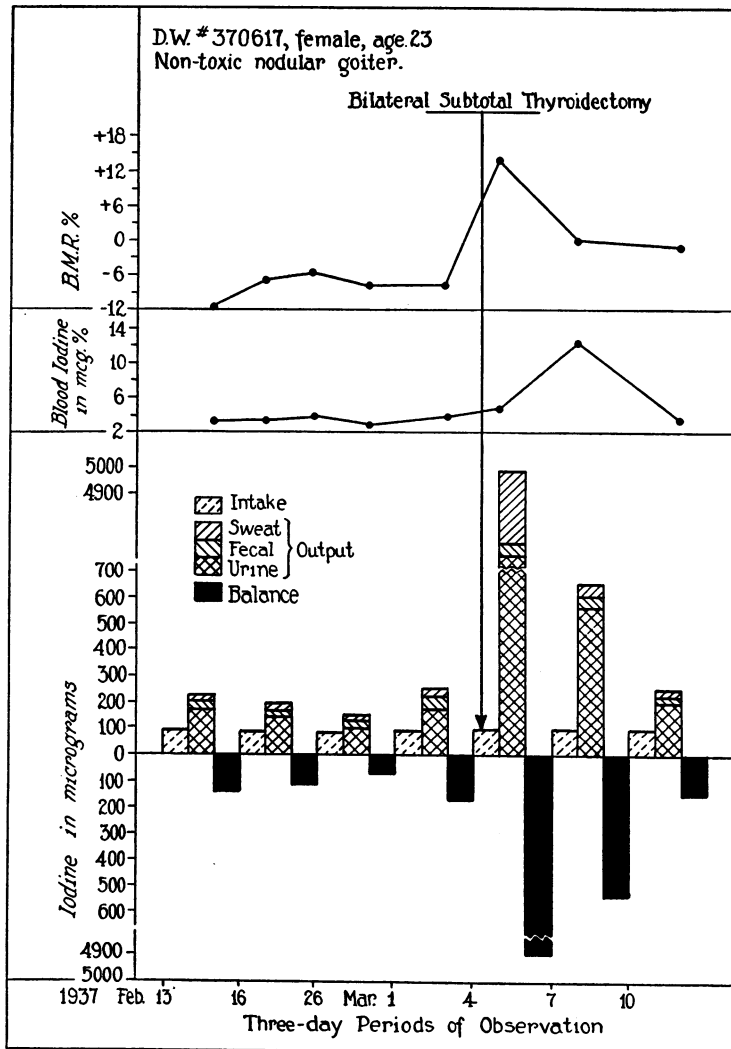


FIG. 1. IODINE BALANCE OF A PATIENT WITH NON-TOXIC NODULAR GOITER

Note the continuous but normal negative iodine balance preoperatively. The iodine excretion and the balance returned to within physiological limits as early as the second postoperative period.

tive save for a moderate hypochromic anemia. The urine was negative. The blood urea nitrogen was 9 mgm. per cent. The phenolsulphonphthalein test for renal function was normal. The basal metabolic rate on February 23 was minus 6 with the basal pulse at 57, respirations 16, temperature 98° F., blood pressure 98/56, and the body weight 115 pounds.

Iodine and calcium balance studies were made from February 13 to February 19 and from February 26 to March 13. Bilateral subtotal thyroidectomy was accomplished on March 4. The postoperative course was uneventful. The patient was discharged on March 13, 1937.

*Comments.* The blood iodine ranged from 2.7 to 3.6

micrograms<sup>3</sup> per cent, which is low normal. On a low iodine intake averaging 74 micrograms per three-day period, the iodine balance remained continuously negative, but normal, and averaged 129 micrograms per three-day period over 12 days. The excretion of iodine was principally through the urine (Figure 1).

Thyroidectomy was accomplished without iodine medication. Immediately postoperatively there ensued a great increase in the excretion of iodine particularly through the urine. This had returned toward normal as early as the sixth day postoperatively (Figure 1).

<sup>3</sup> A microgram equals 0.001 mgm. It is frequently called a gamma.

TABLE I

*B. S., Number 370995, female, age 35; preoperative diet 2250 calories, 52 grams protein; non-toxic nodular goiter*

Period	Date when started	Weight	Iodine						Date	Blood iodine	Basal metabolic rate	Remarks
			Output				In-take	Bal-ance				
			Urine	Feces	Sweat	Total						
	1937	kgm.	micro-grams	micro-grams	micro-grams	micro-grams	micro-grams	micro-grams	1937	micro-grams per cent	per cent	
I	March 1	87	63	29	31	123	92	-31	March 3	2.2	-10	Bilateral subtotal thyroidectomy, March 8, 1937
II	March 4	87	91	27	32	150	57	-93	March 6	2.2	-8	
III	March 7	87	2334	26	161	2521	75	-2446	March 8	2.2	-10	
IV	March 10	87	268	46	30	344	59	-285	March 10	3.1	-5	
V	March 13	87	191	34	30	255	75	-180	March 12	2.2	+12	
									March 15	1.9	+7	

The entire goiter removed weighed 290 grams. It consisted of multiple irregular colloid nodules and revealed the degenerative changes characteristic of nodular goiter. The microscopic examination showed nodular colloid goiter. It contained approximately 48 mgm. of iodine.

*B. S., Number 370995*

A white housewife of 35 was admitted to the Research Surgery Service on February 21, 1937, for surgical treatment of non-toxic nodular goiter. She had been well up to five years ago when she first noted an enlarged neck. This had progressively increased in size. She first noted dyspnea and dysphagia two years ago. A year later she became aware of occasional palpitation and increased nervous instability. She had had no iodine nor thyroid medication in any form. Physical examination showed a bilateral nodular goiter which was partially intrathoracic.

Laboratory examination revealed negative Wassermann and Kahn reactions. The blood was normal save for a moderate hypochromic anemia. The urine was normal. The phenolsulphonphthalein test for renal function was normal. The blood urea nitrogen was 9 mgm. per cent. The basal metabolic rate on February 28 was minus 8 with the basal pulse 68, respiration 16, temperature 97.4° F., blood pressure 132/80, and the body weight 191 pounds.

Iodine and calcium balance studies were made from March 1 to March 16. Thyroidectomy was accomplished on March 8. The postoperative course was uneventful. The basal metabolic rate on March 14 was plus 7 with the basal pulse 69, respirations 18, temperature 97° F., blood pressure 112/78, and the body weight 187 pounds. The patient was discharged on March 16, 1937.

*Comments.* The blood iodine was 2.2 micrograms per cent, which is low normal. On a low iodine intake averaging 75 micrograms per three-day period over 6 days the iodine balance remained continuously negative averaging 62 micrograms per three-day period, which is less than normal (Table I).

Bilateral subtotal thyroidectomy was accomplished without use of iodine. There was, postoperatively, an

immediate rise in the excretion of iodine particularly through the urine and a consequent increased negative iodine balance (Table I). This was still increased when she was dismissed on March 16 (Table I).

Seventy-four grams of goiter was removed. It revealed multiple, irregular colloid nodules. There was evidence of fibrosis, hemorrhage, calcification, and of cystic degeneration. Microscopic examination showed nodular colloid goiter. It contained approximately 19 mgm. of iodine.

*Toxic nodular goiter*

We have determined the iodine balance of two women with toxic nodular goiter (Table II and Figure 2) over a total period of 54 days. On a low iodine intake, averaging 117 micrograms per three-day period over a total period of 15 days, they revealed a profound disturbance of the iodine metabolism and a continuous negative iodine balance which was from three to four times greater than normal (Figure 3).

Protocols may be briefly presented as follows:

*R. J., Number 380303*

A colored woman of 31 was admitted to the Research Surgery Service on January 15, 1938, for the surgical management of hyperthyroidism. She presented the characteristic features of toxic goiter: emotionalism, insomnia, nervousness, tremor, palpitation, moist skin, loss of body weight, and a rise of the basal metabolic rate. She had been well up to 1929 when she first noted a tumor in her neck. This goiter had slowly become larger. However, it remained asymptomatic until about a year ago when she began to note progressive increase in nervous excitability and irritability, dyspnea, palpitation on exertion and excitement, tremor, intolerance to heat, and a loss of approximately 20 pounds of weight. She had had no iodine nor thyroid medication in any form.

TABLE II

*R. J., Number 380303, female, age 31; toxic nodular goiter; diet 2600 calories, 64 grams protein*

Period	Date when started	Weight	Iodine						Date	Blood iodine	Basal metabolic rate	Remarks
			Output				In-take	Balance				
			Urine	Feces	Sweat	Total						
	1938	kgm.	micro-grams	micro-grams	micro-grams	micro-grams	micro-grams	micro-grams	1938	micro-grams per cent	per cent	
I	January 28	49	303	333	30	666	120	-546	January 27	9.5	+27	General Hospital Management
II	January 31	50	298	145	23	466	121	-345	January 30	8.5	+19	
III	February 3	50	293	120	44	457	120	-331	February 2	8.5	+35	
IV	February 6	50	326	101	39	466	122	-344	February 5	9.0	+24	
V	February 9		2793	185	405	3383	120	-3263	February 7	8.1		
VI	February 12		513	138	27	678	120	-558	February 10	8.1		
XI	February 27	48	302	32	16	350	110	-240	March 1	2.0	-10	Bilateral subtotal thyroidectomy—February 9, 1938
XII	March 2	48	231	29	22	282	113	-169	March 4	2.4	-10	

Physical examination showed a well-developed, well-nourished, but unusually apprehensive colored woman. There was a diffuse, symmetrical enlargement of the anterior neck with no palpable nodule formation. The trachea was not palpable. The hands and tongue showed marked tremor. The exophthalmometric readings were O. D. 18 and O. S. 18 mm. There was tachycardia and a soft systolic aortic murmur. Roentgenograms of the neck revealed a large nodule of the left thyroid lobe.

Laboratory examination revealed negative blood Wassermann and Kahn reactions. The blood examination was normal save for a slight hypochromic anemia. The urine was negative. The blood urea nitrogen on January 20 was 15.5 mgm. per cent. The blood cholesterol on January 25 was 155 mgm. per cent. The serum protein on February 7 was 6.4 grams per cent. The glucose tolerance was normal. The bromsulphalein, galactose, and hippuric acid tests for liver function were normal. The phenolsulphonphthalein test for kidney function showed 60 per cent excretion during the first and 15 per cent during the second hour following intravenous administration. The basal metabolic rate on January 18 was plus 35 with the basal pulse 90, respirations 20, temperature 98.0° F., blood pressure 136/76, and the body weight 110 pounds.

Iodine and calcium balance studies were made from January 28 to March 5. She menstruated from February 8 to February 11. Thyroidectomy was accomplished on February 9. Her first four postoperative days were stormy. The temperature, pulse, and respirations were as high as 104° F., 160, and 35 respectively. Ten to fifteen cubic centimeters of a purulent fluid was liberated from the wound on February 13, the fourth postoperative day. Cultures showed a predominance of hemolytic streptococci, with a few nonhemolytic forms. The patient improved almost immediately following drainage. Azochloramide irrigation was instituted. The postoperative course was otherwise uneventful. The basal metabolic rate on March 4 was minus 10 with the

basal pulse 84, respirations 18, temperature 97.8° F., blood pressure 128/88, and the body weight 104 pounds. The patient was discharged on March 5, 1938.

*Comments.* The blood iodine averaged 8.9 micrograms per cent which is elevated above normal. On a low iodine intake averaging 122 micrograms per three-day period, there was a great increase in the excretion of iodine particularly through the urine and feces. This resulted in a greatly increased negative iodine balance which averaged 393 micrograms per three-day period (Table II).

Thyroidectomy was accomplished without iodine medication. There immediately ensued an increased excretion of iodine and an increased negative iodine balance. These returned toward normal as early as the twenty-fourth day postoperatively. The blood iodine and the basal metabolic rate returned to normal (Table II). The clinical status of the patient improved.

A large, irregular nodule of the left lobe of the thyroid was removed. It weighed 175 grams. It was covered by a thin capsule and was composed of a very friable, moist colloid tissue. There was gross evidence of edema, fibrosis, and varying degrees of vascular changes, old hemorrhage, and cholesterol deposits. Microscopic examination showed nodular colloid goiter. It contained approximately 28 mgm. of iodine.

*S. W., Number 370163*

A white housewife of 53 was admitted to the Research Surgery Service for the management of toxic nodular goiter on January 10, 1937. She had been aware of goiter for about 20 years. However, it remained asymptomatic until about two years ago when she noted nervous instability, palpitation, and dyspnea on exertion. These symptoms had become more pronounced during the past four or five months, with an increase in the size of the goiter and an increased appetite accompanied by a weight loss of five pounds. She had had no iodine therapy for three months, since mid-October. Menstru-

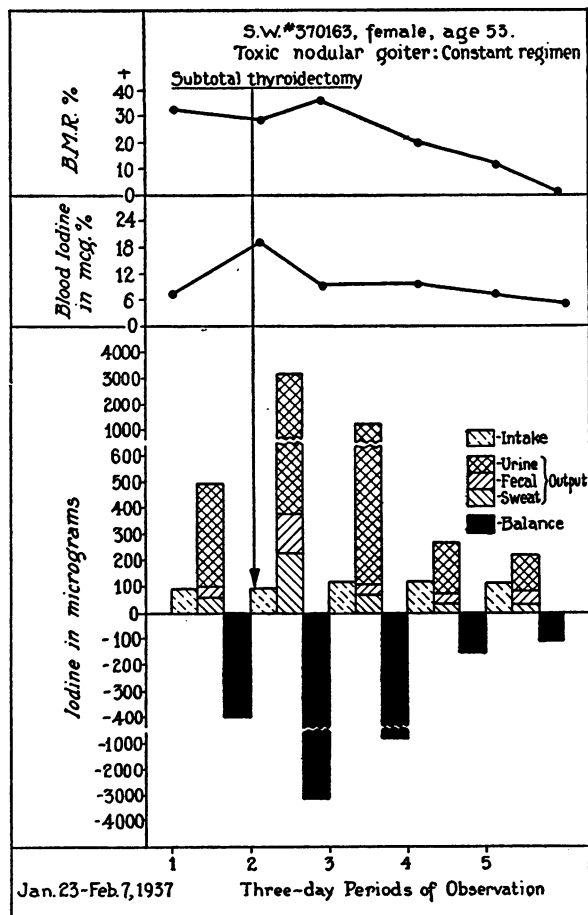


FIG. 2. IODINE BALANCE OF A PATIENT WITH TOXIC NODULAR GOITER

The iodine excretion and the negative iodine balance are typically increased preoperatively. Note that as early as the second period postoperatively the basal metabolic rate and the blood iodine, as well as the excretion of iodine and the iodine balance, had returned to within normal limits.

ation ceased five months ago. Physical examination revealed a bilateral nodular goiter of moderate size. There was slight tremor of the extended hand, tachycardia, and a soft systolic aortic murmur. The exophthalmometric readings were O. D. 16 and O. S. 16 mm.

Laboratory examination showed negative blood Wassermann and Kahn reactions. The blood and urine were normal. The phenolsulphonphthalein test showed 60 per cent excretion of the dye during the first and 5 per cent during the second hour following intravenous administration. The blood urea nitrogen on January 11 was 12 mgm. per cent. The basal metabolic rate on January 22 was plus 25 with the basal pulse 109, temperature 98.4° F., respirations 14, blood pressure 166/94, and the body weight 110 pounds.

Iodine and calcium balance studies were made from January 23 to February 7. Subtotal thyroidectomy was accomplished on January 26. The basal metabolic rate and the clinical status of the patient gradually returned to normal postoperatively. The basal metabolic rate on February 7 was 0 with the basal pulse 81, temperature 98.2° F., respirations 11, blood pressure 142/88, and the body weight 105 pounds. The patient was discharged on February 7, 1937.

*Comments.* This patient with toxic nodular goiter showed an increased negative iodine balance preoperatively (Figure 2). The blood iodine was elevated, averaging 6.9 micrograms per cent. Thyroidectomy was then performed without use of iodine. There was an immediate increased negative iodine balance, principally as a result of an increased urinary excretion of iodine (Figure 2). The basal metabolic rate and the blood iodine were also elevated immediately postoperatively. However, the negative iodine balance returned to within normal limits during the sixth to twelfth day postoperatively. The basal metabolic rate and the blood iodine also returned to within normal range.

The entire goiter removed weighed 80 grams. It was composed throughout of irregular colloid nodules. There was evidence of the characteristic degenerative changes. The microscopic examination showed nodular colloid goiter and a moderate degree of lymphocytic infiltration. It contained approximately 13 mgm. of iodine.

DISCUSSION

Three normal individuals maintained on a low iodine intake, averaging 87 micrograms per three-day period over a total period of 24 days, remained in continuous negative iodine balance which averaged 126 micrograms per three-day period (2) (Figure 3). The total excretion of iodine averaged 213 micrograms per three-day period (Figure 3). The greatest excretion was through the urine, averaging 72 per cent. Fifteen per cent was excreted through the feces and 13 per cent through the sweat (2) (Figure 3). The blood iodine averaged 4.3 micrograms per cent. These data would indicate that in normal individuals a certain amount of iodine is excreted daily over an as yet undetermined length of time. Only when iodine was furnished in excess of this amount was there established a positive iodine balance (2). There are several variants in the iodine metabolism of normal individuals (2, 6).

Two non-toxic nodular goiter patients maintained on a low iodine intake, averaging 74 micrograms per three-day period over a total period of 18 days, showed an average negative iodine balance which was within physiological limits (Fig-

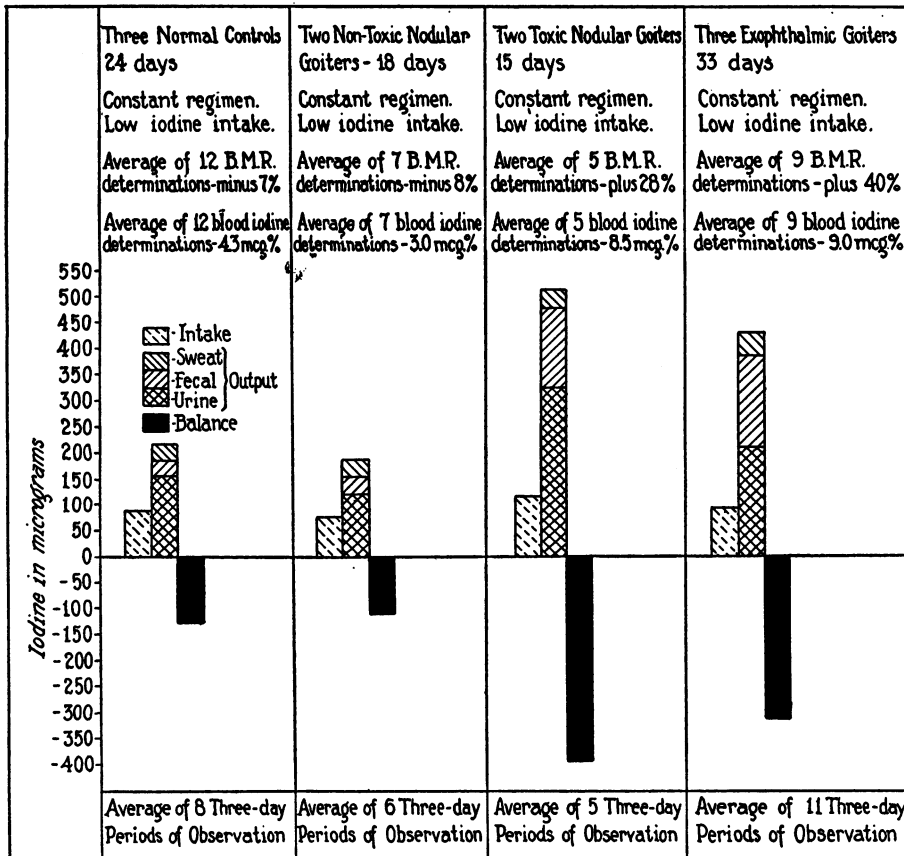


FIG. 3. A GRAPHIC REPRESENTATION OF THE IODINE BALANCE OF THREE NORMAL CONTROLS COMPARED WITH THAT OF TWO PATIENTS WITH NON-TOXIC NODULAR GOITER, TWO PATIENTS WITH TOXIC NODULAR GOITER, AND THREE PATIENTS WITH EXOPHTHALMIC GOITER AS SHOWN IN TABLE IV

ure 3). The total excretion of iodine averaged 180 micrograms per three-day period. The greatest excretion was through the urine averaging 67 per cent. Seventeen per cent was excreted through the feces and 16 per cent was excreted through the sweat. However, one patient even showed a tendency for retention of iodine greater than normal (Table I). This latter confirms the findings of Scheffer and v. Megay (7). The decreased total excretion resulted principally from a decreased urinary excretion of iodine (Table I). The blood iodine was low normal, averaging 3.0 micrograms per cent.

Three patients with exophthalmic goiter, maintained on a low iodine intake averaging 86 micrograms per three-day period over a total period of 33 days, showed a great increase in the excretion of iodine particularly through the feces

(2) (Figure 3). This resulted in an increased negative iodine balance of from two to three times the normal (Figure 3). The total excretion of iodine was 414 micrograms per three-day period. The greatest excretion occurred through the urine, averaging 49 per cent. Forty per cent was excreted through the feces and 11 per cent through the sweat (Figure 3). The blood iodine was increased, averaging 9.0 micrograms per cent. Two other patients with exophthalmic goiter were maintained on an iodine intake sufficient to keep a normal individual in positive iodine balance. These two patients also showed a negative iodine balance. There are several factors which may influence the increased negative iodine balance of exophthalmic goiter. The increased iodine balance returned to within normal limits subsequent to adequate thyroidectomy. Increased iodine

feeding to an exophthalmic goiter patient resulted in an immediate tremendous retention of iodine and a consequent positive iodine balance which was twice that of the normal control. A negative iodine balance is not necessarily characteristic of exophthalmic goiter. Even a positive iodine balance can be readily maintained if the intake of iodine is sufficiently large or in excess of the increased requirements of the hyperthyroid organism (2).

Two patients with toxic nodular goiter investigated on a low iodine intake averaging 117 micrograms per three-day period over a total period of 15 days showed a great increase in the excretion of iodine particularly through the urine (Figure 3). This resulted in an increased negative iodine balance of from three to four times the normal (Figure 3). The total excretion of iodine was 510 micrograms per three-day period. The greatest excretion occurred through the urine, averaging 63 per cent. Twenty-nine per cent was excreted through the feces and 8 per cent through the sweat (Figure 3).

Our data would indicate, therefore, that there may be a fundamental difference in the excretion of iodine in toxic nodular and exophthalmic goiter. We have recently demonstrated that in 9 patients with toxic nodular goiter there is an increased daily excretion of iodine in the urine over that of 40 patients with exophthalmic goiter who showed a much higher basal metabolic rate (3). Furthermore, our present data (Figure 3) reveal that in two patients with toxic nodular goiter and a basal metabolic rate of plus 28 there

is a greater total excretion of iodine than that in three exophthalmic goiter patients with a basal metabolic rate averaging plus 40 (Figure 3). This resulted in a greater negative iodine balance than in exophthalmic goiter (Figure 3). In addition, in exophthalmic goiter the greatest increase in excretion was through the feces; in toxic nodular goiter the greatest increase was through the urine (Figure 3).

The true significance of these differences in the iodine excretion in toxic nodular and exophthalmic goiter is obscure. In an attempt to determine the nature of these differences we investigated the excretion of iodine through the various channels during and immediately following desiccated thyroid therapy to a patient with hypothyroidism (Table III). This patient showed a basal metabolic rate of approximately minus 20 immediately before administration of desiccated thyroid, four grains daily, and about five months prior to our iodine balance studies. Desiccated thyroid therapy in similar dosage was continued during the first six days of investigation. The basal metabolic rate was established at minus 4. There was an increased excretion of iodine through all channels but particularly through the urine. However, the iodine intake was also increased by desiccated thyroid ingestion so that the iodine balance remained physiologic (Table III). The total iodine excreted averaged 1250 micrograms per three-day period. The greatest excretion occurred through the urine, averaging 80 per cent. Sixteen per cent was excreted through the feces and 4 per cent through the sweat (Table

TABLE III  
I. M., Number 366101, hypothyroid male, age 34; diet 2890 calories, 64 grams protein

Period	Date when started	Weight	Iodine						Date	Blood iodine	Basal metabolic rate	Remarks
			Output				In-take	Balance				
			Urine	Feces	Sweat	Total						
	1936	kgm.	micrograms	micrograms	micrograms	micrograms	micrograms	micrograms	1936	micrograms per cent	per cent	
I	November 17	91	910	240	52	1202	1220	+18	November 17	6.1	-4	Desiccated thyroid grains 4 daily from Nov. 18 to Nov. 23
II	November 20	93	1110	160	37	1307	1220	-87	November 20	5.4	-11	
III	November 23	91	413	122	36	571	68	-503	November 23	5.1	-5	
IV	November 26	91	311	68	36	415	68	-347	November 26	3.7	-7	
									November 27		-15	
V	November 29	92	142	33	25	200	68	-132	November 29	4.3	-11	
									December 1		-21	
									December 2	3.4	-19	



III). This simulated the percentage excretion of iodine through the various channels of normal individuals (2) and of patients with toxic nodular goiter rather than that of patients with exophthalmic goiter (2). Thyroid therapy was then discontinued. Immediately there ensued an increased negative iodine balance which simulated that of hyperthyroidism. This presumably resulted from the continued consumption of stored thyroid hormone and a consequent continued mobilization and excretion of iodine in the presence of a lessened iodine intake. As the stored thyroid hormone of this hypothyroid patient was depleted, the excretion of iodine slowly decreased from 1250 to 200 micrograms per three-day period over 9 days following cessation of ingestion of desiccated thyroid (Table III). The iodine balance again returned to within physiological limits. This was accompanied by a decrease in the basal metabolic rate of from minus 4 to minus 20 (Table III). The percentage excretion of iodine through the various channels did not appreciably change. Seventy-three per cent was excreted through the urine, 18 per cent through the feces and 9 per cent through the sweat. This again simulated that of normal individuals and that of toxic nodular goiter rather than that of exophthalmic goiter. Further investigation of the nature of these differences in the excretion of iodine in these diseases of the thyroid should prove valuable.

The increased negative iodine balance of hyperthyroidism may result from previous iodine feeding and the subsequent high storage of easily mobilizable iodine within the body as discussed earlier (2). However, in each instance an average of approximately 90 per cent of the goitrous tissue was removed. The total iodine content of

each gland removed in non-toxic nodular goiter averaged 34 mgm. which is greater than that of toxic nodular goiter which averaged 20 mgm. Therefore, the primary mechanism for this increased excretion of iodine in toxic nodular goiter was not caused by a higher storage of total iodine in the thyroid over that of non-toxic nodular goiter.

In all instances (Figures 1 and 2) (Tables I and II) there occurred, postoperatively, a transient increase in the excretion of iodine and particularly through the urine. This resulted, in part, from iodine containing catgut which was used as suture material (8). However, of greater significance is the fact that the excretion of iodine and the iodine balance had returned to normal in subsequent periods (Figures 1 and 2).

In toxic nodular goiter the clinical symptomatology had improved as early as the sixth to the twelfth day postoperatively (Patient S. W.). The basal metabolic rate and the blood iodine had returned to within normal limits (Figure 2). The excretion of iodine and the iodine balance had also returned to within physiologic limits (Figure 2). This would indicate that the increased excretion of iodine in toxic goiter results directly or indirectly from an overfunctioning thyroid gland.

#### SUMMARY

1. Two non-toxic nodular goiter patients maintained on a low iodine intake showed an average negative iodine balance which was within physiological limits. One patient even showed a tendency for retention of iodine over that of the normal controls. The blood iodine was low normal, averaging 3.0 micrograms per cent.

2. Two patients with toxic nodular goiter investigated on a low iodine intake showed a great

TABLE IV

*The iodine balance in diseases of the thyroid gland. A comparison of the iodine balance of normal individuals with that of nodular and exophthalmic goiter patients*

Type of goiter present	Number of patients	Total days of investigation	Average basal metabolic rate	Average blood iodine	Average output per 3-day period				Average intake per 3-day period	Average balance per 3-day period
					Urine	Feces	Sweat	Total		
			<i>per cent</i>	<i>micrograms per cent</i>	<i>micrograms</i>	<i>micrograms</i>	<i>micrograms</i>	<i>micrograms</i>	<i>micrograms</i>	<i>micrograms</i>
1. None: normal controls	3	24	-7	4.3	154	31	28	213	87	-126
2. Non-toxic nodular . . . . .	2	18	-8	3.0	120	31	29	180	74	-106
3. Toxic nodular . . . . .	2	15	+28	8.5	323	149	38	510	117	-393
4. Exophthalmic . . . . .	3	33	+40	9.0	204	164	46	414	86	-328

increase in the excretion of iodine and particularly through the urine. This resulted in an increased negative iodine balance of from three to four times the normal. The blood iodine was increased, averaging 8.5 micrograms per cent.

3. In two toxic nodular goiter patients with a basal metabolic rate of plus 28 there was a greater total excretion of iodine than that of three exophthalmic goiter patients with a basal metabolic rate of plus 40. In exophthalmic goiter the greatest increase in excretion was through the feces; in toxic nodular goiter the greatest increase was through the urine.

4. The percentage excretion of iodine through the various channels during and immediately following desiccated thyroid therapy to a hypothyroid patient simulated that of normal persons and that of patients with toxic nodular goiter rather than that of exophthalmic goiter.

5. This increased mobilization, circulation, and excretion of iodine and the profound disturbance of the iodine balance of toxic nodular goiter returned to within normal limits as early as the sixth to the twelfth day following adequate thyroidectomy.

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