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These data further define the complex and interesting adjustments made by the newly born.

Thyroidal Radioiodine Uptake Rate Measurement in Infants

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Introduction

Considerable information has accumulated regarding newborn metabolic functions including data suggesting interesting alterations in several parameters of thyroid function during the neonatal period. During the first several days of life, beginning as early as 12 to 24 hours of age, serum hormonal iodine values reach hyperthyroid levels.[1-3] There is a subsequent fall to normal levels by 2 to 3 weeks. Dowling et al.[4] have shown that thyroxine-binding capacity in the sera of infants, though increased, is less than that of their mothers. Spafford et al.[5] and Marks et al.[6] have demonstrated a relative increase in I^{131}-labeled triiodothyronine red blood cell uptake in infants during the first week indicating that the neonatal elevation of serum hormonal iodine is not due to the increased thyroxine-binding protein. Neither can it be accounted for by dehydration. The extrathyroidal hormonal iodine pool must actually be increased during the first week of life; this excess thyroxine must be derived either from an increased rate of hormone release by the infant's thyroid secondary to an increased thyroid-stimulating hormone (TSH) effect or from a decreased rate of hormone degradation by liver and/or peripheral tissue. The thyroidal I^{131} uptake should be increased in the former and decreased in the latter circumstance.

Several reports of measurements of I^{131} uptake during the neonatal period have appeared. In general these are contradictory. Elevated 24-hour I^{131} uptake measurements have been reported by Van Middlesworth[7]

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(7 infants, 2 to 3 days of age) and by Gomirato-Sandrucci and Nicola[8] (8 infants, 2 to 9 days of age). Martmer et al.[9] (70 infants, 2 to 63 days of age) and Ogborn et al.[10] (26 infants, 3 to 7 days of age) reported normal mean 24-hour I^{131} uptake values of 30.1% and 20.3%, respectively. The present investigation was instituted in a further attempt to clarify neonatal thyroid I^{131} uptake, especially during the first days of life when the elevation of serum hormonal iodine is occurring.

Materials and Methods

Because of the possible influence of renal excretion, it was decided to compare the 24-hour I^{131} uptake with earlier measurement of the thyroidal uptake rate. Application of such early measurements requires assessment of the contribution of nonthyroidal radioiodine in neck tissues, which, during this stage, may contribute as much as half the total neck counts. Knowledge of the relative changes in iodide space with time is also essential to the fractional uptake rate calculations.[11] Thus, investigation of these parameters was also undertaken.

A brief summary of the early metabolism of a tracer dose of radioiodine before a significant amount leaves the thyroid gland in organic form will serve to clarify the observations made. The principles of the uptake measurement are the same for infants as for adults, and detailed mathematical descriptions have been published.[11,12] The following symbols and abbreviations are used in the discussion to follow:

E indicates fraction of the I^{131} dose excreted renally up to time t;

G indicates fraction of the I^{131} dose accumulated in the thyroid up to time t;

k minute^{-1} indicates average fractional rate of removal of radioiodide, by the thyroid gland plus the kidneys, over the period $t=0$ to 30 minutes;

k_1 minute^{-1} indicates corresponding rate of removal of radioiodide by the thyroid gland;

k_2 minute^{-1} indicates corresponding rate of removal of radioiodide by the kidneys;

N indicates fraction of the I^{131} dose measured by counting over the neck at time t;

P indicates fraction of the I^{131} dose remaining in the iodide space at time t;

Q indicates fraction of the iodide space represented by the extrathyroidal neck tissues visible to the counter at time t;

Q_0 indicates value of Q at time $t=0$;

$Q\infty$ indicates value of Q at large values of t;

t minutes indicates time after injection of the I^{131} dose;

U_{24} indicates observed 24-hour uptake as a percentage of the I^{131} dose;

V liter indicates volume of the radioiodide space at time t;

V_{30} liter indicates volume of the radioiodide space at $t=30$ minutes;

W indicates patient's weight in kilograms;

ϕ indicates ratio of the average value of $1/V$ from zero to t minutes to the average $1/V$ from zero to 30 minutes after injection.

A tracer dose of radioiodine, injected intravenously, mixes rapidly with the circulating plasma iodide and subsequently diffuses more slowly into intercellular and intracellular fluids, with probable concentration in saliva, gastric secretions, and liver. Thus, the radioiodine per unit volume of circulating plasma decreases, quite apart from any decrease which results from removal of iodide by the thyroid gland or the kidney. In other words, the apparent volume V of the extrathyroidal "iodide space" increases with time after injection, approaching asymptotically a maximum saturation value as diffusion proceeds.

Concurrently with this diffusion, radioiodide is removed from the plasma by the thyroid gland and the kidneys at rates representing the clearance[13] of iodide from a fixed volume of plasma each minute. If the iodide space had a constant volume V, these combined clearances would result in the removal of a constant percentage of the circulating iodide each minute, the fraction P remaining being given by a simple exponential term of the form e^{-kt}. In practice, however, as diffusion progresses, V increases, the iodide concentration decreases as $1/V$, and there is a decreasing percentage rate of removal by thyroidal and renal clearance. Such a decreasing rate can be allowed for by introducing a factor ϕ so that $P=e^{-k\phi t}$ represents the proportion of the injected dose remaining in the plasma iodide space t minutes after injection. The factor ϕ is proportional to the average value of $1/V$ from zero to t minutes, and it may be "normalized" to choose $\phi=1$ at some arbitrary time after injection; this is customarily taken as 30 minutes.[11,14]

For determination of the uptake rate the basic quantities to be considered are as follows.[11,12]

The fraction G of the dose accumulated in the thyroid gland at time t:

$$G=(1-e^{-k\phi t})\,k_1/k \qquad (1)$$

The fraction E of the dose excreted in the urine up to time t:

$$E=(1-e^{-k\phi t})\,k_2/k \qquad (2)$$

The fraction P of the dose remaining in the plasma iodide space at time t:

$$P=e^{-k\phi t} \qquad (3)$$

The rate factor k_1 represents the average fractional rate of removal (per minute) of radioiodide by the thyroid gland over the period $t=30$ minutes.

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The corresponding rate for the kidneys is k_2 and the total k

$$k=k_1+k_2 \quad (4)$$

In other words, over any given time t the thyroid gland clears an average amount of 100 $k_1\phi$% of the total radioiodide space each minute.

The assessment of thyroid function with radioiodine tests depends primarily on measuring G so that k_1 or some function of k_1 may be calculated. A radiation detector aimed externally at the thyroid gland receives γ-radiation from the thyroid dose fraction G together with some radiation from radioiodine in the neck and adjacent tissues within the field of view of the lead collimator. The additional radiation will represent some portion of the plasma radioiodide fraction P, say QP, so that the total observed neck content, N, expressed as a fraction of the injected dose, will be

$$N=QP+G$$
$$=Qe^{-k\phi t}+(1-e^{-k\phi t})\,k_1/k \quad (5)$$

The size and shape of the lead collimator on the radiation detector determines Q; obviously it is advantageous to keep Q small so that G is more accurately derived from Equation 5. This can be done by keeping the collimator small in relation to the size of the patient, but large enough to make sure that all of the thyroid gland is included in the field of view.

The value of Q varies appreciably with time t after injection, because proportionally more diffusion of iodide occurs outside the field viewed by the detector; Q appears in practice to decrease asymptotically with time to an equilibrium value which can be found experimentally. Finally, for a given collimator Q will be larger for the smaller patients because the detector views a larger fraction of the iodide space in such cases.

Consideration of Equation 5 shows that when t is not great, say up to an hour or two after injection, proper evaluation of QP is necessary so that G and k_1 are calculable. However, in this case only a rough measurement or estimate of the urinary output E is needed because the renal rate k_2 enters into the calculations only as a small correction.

At long times t, such as 24 hours, P is nearly zero, QP is small, and Equation 5 gives the 24-hour per cent uptake as approximately

$$U_{24}=100\,k_1/(k_1+k_2) \quad (6)$$

Equation 6 shows why the 24-hour uptake depends so much on the renal excretion rate k_2 and why it does not distinguish between high and very high values of the thyroidal clearance rate k_1.

The scintillation detector used in the present investigations consisted of a 2 × 2 in. NaI crystal with a conical tapered lead collimator 4 in. long from the crystal face to the open end. The internal diameter was 2 in. at the crystal, widening to 2.5 in. at the open end. With the skin over the thyroid gland 1 in. from the end of the collimator, a circular region 2.6 in. (6.6 cm.) diameter was within the umbral field of view. The detector was operated with a spectrometer scaler with the window set at the 365-kiloelectron volt (kev) I^{131} γ-ray energy; with this arrangement the background was kept low so that doses of 0.25μc. to 0.5μc. of I^{131} could be used in newborn term infants and 0.2μc. to 0.25μc. in premature infants.*

The sterile doses, of carrier-free NaI^{131} in 3 ml. of saline, were injected in term infants through a polyethylene umbilical catheter which also allowed timed blood collections for iodide space determinations. Radioiodine was administered intravenously via scalp vein infusion sets in the premature infants. Thereafter, 10-minute counts were made over the thyroid gland at selected times after injection with the infant held firmly in position by a "Flexicast" pillow. Urine collections were made with polyethylene bags secured around the genitalia with a nonirritating rubber cement.

For measurements of the iodide space, 3 ml. heparinized blood samples were withdrawn at about 8, 27, and 110 minutes after injection.

The neck uptake N was calculated from the ratio of net counts over the patient's neck to the net counts with a reference standard I^{131} source in a wax neck phantom of approximately comparable dimensions. Blood for PBI determinations was obtained before administration of the radioiodine and at other selected times in certain patients. PBI was determined by the method of Barker et al.[16]

Where indicated, thyroid responsiveness was tested by administration of 5 units of TSH, followed by a repeat I^{131} study begun 24 hours later.

Results

Determination of Iodide Space V.—For each newborn term infant the iodide space

* Prolonged thyroid I^{131} decay curves were determined on 9 of the premature infants in the study. The effective half life ($Teff$) was determined from the calculated biological half life (T_{50} *biol*) and the radioisotope decay half life (T_{50} *radio*) as follows:

$$Teff=\frac{T_{50}\ biol \cdot T_{50}\ radio}{T_{50}\ biol+T_{50}\ radio}$$

Values ranged between 2.8 and 6.7 days with a mean of 4.7 days. Quimby et al. have estimated the thyroid radiation dosage per microcurie I^{131} per gram thyroid to be 90 rad.[15] This estimate assumed an effective half life of 6 days and a spherical gland. Modifying this estimate for the 4.7-day half life and using an estimate of thyroid gland weight of 0.5 gm. per kilogram body weight, thyroid radioiodine in the present study ranged from 0.02μc. to 0.35μc. and thyroid radiation dose from 2 to 24 rad. Mean thyroid radiation in the term infants presuming a constant I^{131} dose of 0.5μc. was 14.8 rad.

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TABLE 1.—*Apparent Volume of Iodide Space per Unit Weight in Infants at Different Times After Injection*

Quantity	Mean Time After Injection, Min. 8.3	27.3	115.1
Number of tests	30	31	30
Mean V/W in liter/kg	0.332	0.418	0.479
Standard deviation	0.068	0.073	0.106
Standard error of the mean value	0.012	0.013	0.019

V was calculated from the radioactivity in the plasma. Observed values of N and E were plotted against t so that these quantities could be found for the actual times of collection of the blood specimens.

Extrapolation of the N curve back to zero time gave the initial neck fraction $Q=Q_0$, and Q at later times was taken to be $0.665Q_0$. This approximation was adequate for calculating P, involving errors in P of less than 1%.

When urine collections were reliable P was calculated by combining Equations 2, 3, and 5 to give

$$P=\frac{1-N-E}{1-Q} \qquad (7)$$

Alternatively, where urine collections were not available, k_1/k was taken to be equal to the neck fraction $N_{1,440}$ measured at 24 hours; this gives, with Equations 3 and 5

$$P=\frac{N_{1,440}-N}{N_{1,440}-Q} \qquad (8)$$

Finally the iodide space V was calculated by dividing P by the measured concentration of the plasma

$$V=P\div(P/V)$$

Observed results for V/W, where W is the infant's body weight in kilograms, are summarized in Table 1.

The mean V/W at $t=27$ minutes is significantly different (probability $P<0.001$) from that at $t=8$ minutes, and the change between values at $t=27$ and $t=115$ is also significant (probability $P=0.01$).

Normalizing Factor ϕ.—The normalizing factor ϕ was defined as the average value of $1/V$ up to time t expressed as a ratio to the average up to $t=30$ minutes. For the group of infants studied W/V (from Table 1) was plotted against t, enabling ϕ to be calculated from the cumulative areas under

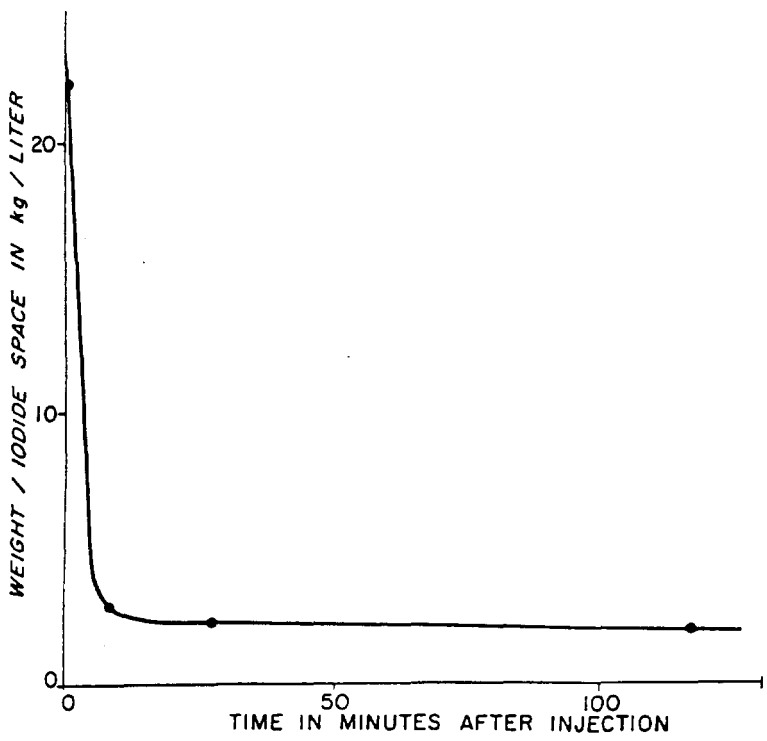

Fig. 1.—Ratio of body weight to iodide space in newborn infants at different times after injection.

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TABLE 4.—*Results of Tests on Premature Infants*

Patient	Age	W, Kg.	Thyroidal Uptake Rate 10^3k_1	24-Hr. Uptake U_{24}, %
27	10 hr.	1.97	2.91	90.9
	12 da.		0.09	7.8
28	30 hr.	1.42	5.90	84.6
	7 da.		2.90	50.1
29	16 hr.	1.56	2.06	69.3
	13 da.		0.44	13.5
	42 da.	2.58	1.12	24.8
30	39 hr.	1.62	4.73	101
	17 da.		0.26	21.0
31	76 hr.	1.42	2.25	46.2
	13 da.	1.40	1.16	20.5
32	35 hr.	1.90	4.67	74.1
	12 da.	1.97	1.35	13.2
33	39 hr.	1.72	3.40	-
	9 da.	1.72	0.54	21.8
34	23 hr.	1.76	3.07	47.9
	14 da.		0.24	16.2
35	5 da.	1.72	0.53	19.0
36	5 da.	1.80	0.73	18.5
37	6 da.	1.74	1.74	24.4
38	6 da.	1.97	0.92	25.0
39	10 da.	2.16	0.81	19.8
40	11 da.	2.21	0.75	11.8
41	11 da.	1.94	0.65	14.5
42	14 da.	2.13	0.69	14.6
43	14 da.	2.21	0.50	11.8
44	19 da.	2.24	0.64	15.9
45	50 da.	1.84	0.00	8.1
46	55 da.	1.76	0.05	14.2

As expected, the actual value of the initial neck fraction Q_o was found to depend on the weight W of the infant, decreasing as W increased. Observations of 32 infants and children up to 12 months old are plotted logarithmically in Figure 3. The straight line shown was found by least squares and represents the relation

$$Q=0.32\,W^{-0.73} \qquad (10)$$

Values of Q_o calculated from the formula agree with the observed values with a standard deviation of ±13.5%.

Clinical Results.—Clinical results on a series of 26 normal newborn term infants are shown in Table 3, those on 21 premature infants in Table 4, and results on 5 term infants, whose diagnoses might be questioned, in Table 5.

The mean iodide space per unit weight, at 30 minutes after injection, for all 30 tabulated values was found to be 0.432± 0.072 (standard deviation) liter per kilogram.

For the euthyroid term group, the average age was 25 hours (12-48 hours), and the mean PBI was 9.1±1.4 (standard deviation) μg/100 ml.

Neither k_1 nor U_{24} values would be expected to have a normal statistical distribution; however log k_1 should do so by analogy with results for adult patients.[18] Statistical limits were calculated for these 2 parameters on that basis, with results for the euthyroid term infants as shown in Table 6.

The results of k_1 and U_{24} studies in 20 premature infants are shown in Table 7.

The U_{24} values are shown graphically in Figure 4 for the 47 term and premature infants.

Comment

The present results confirm an elevated thyroid I^{131} uptake rate very early in the

TABLE 5.—*Results of Tests on Infants with Possibly Doubtful Diagnoses*

Patient	Description	Age, Hr.	W, Kg.	PBI μg/100 Ml	Thyroidal Rate 10^3k_1	Renal Rate 10^3k_2	Iodide Space V_{10}/W Liter/Kg	24-Hr. Uptake U_{24}, %
47	Breast fed by mother given IVP	26	2.86	8.8	0.66	-	0.45	28
	2 months before delivery	144	2.95	6.8	0.16	4.3	-	10
	TSH	192	-	-	1.03	-	-	21
48		16	2.64	6.0	-	-	0.57	14
		312	3.00	5.5	0.34	1.9	-	13
	TSH	336	-	-	2.19	3.2	-	37
49	Mongol	46	2.34	-	1.08	0.8	0.37	20
50	Thyrotoxic mother on 250 mg.	Birth	2.46	4.2	-	-	-	-
	$KClO_4$ every 6 hr., last 5 mo.	12	-	3.6	-	-	-	-
	of pregnancy	48	-	3.6	-	-	-	14
		144	-	5.5	-	-	-	-
		408	2.60	7.1	-	-	-	59
51	Thyrotoxic mother, methimazole	30	3.49	9.9	4.84	1.0	-	80
	10 mg. every 8 hr. last 2 mo.	192	3.70	8.9	4.03	3.1	0.46	46

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TABLE 6.—*Results for Euthyroid Term Infants*

Parameter	Mean Value	5% Limits (±1.65 S.D.)	1% Limits (±2.33 S.D.)
PBI μg. %	9.1	6.8 to 11.3	5.9 to 12.3
Uptake rate 10^3k_1	2.37	1.13 to 4.97	0.83 to 6.75
24-hour uptake %	62	37 to 82	28 to 87

neonatal period. This effect appears by 12 to 24 hours, correlating with Danowski's observation of maximal PBI values between 1 and 3.4 days.[1] Values are similar in term and premature infants. The U_{24} values correlate well with the k_1 values at 30 minutes; thus, impaired excretion of iodide does not account for the increased rate of I^{131} uptake. The initially elevated U_{24} values returned to the generally accepted normal range of roughly 10% to 40% by 5 days of age.

The mothers of the infants in the present investigation were, as far as determinable, on a normal diet without evidence of low iodine intake or excessive ingestion of goitrogenic foods. In most cases little or no analgesia was given during labor. An occasional patient received 50 to 100 mg. of meperidine (Demerol) hydrochloride and/or 25 to 50 mg. promethazine (Phenergan)

TABLE 7.—*Results in Premature Infants*

Age Range	Parameter	Mean Value	5% Limits	1% Limits
0 to 76 hr.	Uptake rate 10^3k_1	3.37 *	1.81 to 6.30	1.40 to 8.13
	24-hour uptake %	72 †	34 to 93	21 to 96
5 to 55 da.	Uptake rate 10^3k_1	0.58 ‡	0.12 to 2.74	0.06 to 5.19
	24-hour uptake %	17 §	8 to 33	6 to 42

* 8 studies.
† 6 studies, omitting Patient 30.
‡ 20 studies, omitting Patient 45.
§ 21 studies.

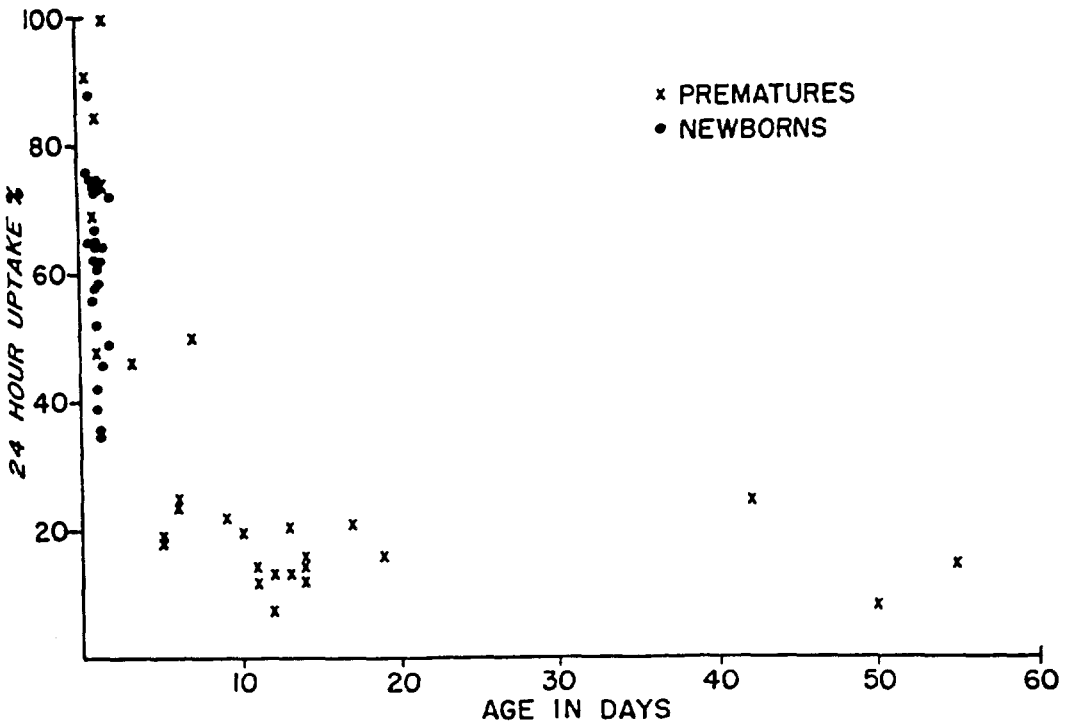

Fig. 4.—Twenty-four-hour I^{131} uptake values during the neonatal period.

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hydrochloride during the course of labor. There was no correlation of this medication with high or low k_1 or U_{24} values.

The several infants listed in Table 5 further substantiate the direct correlation of thyroid activity (TSH effect) with the serum hormonal iodine values. In the first 2 infants (Patients 47 and 48) low thyroidal I^{131} uptake were observed. In Patient 47 the fall in I^{131} uptake rate was associated with a fall in PBI. In Patient 48 the very low initial I^{131} uptake was observed with relatively low PBI which was unchanged at 13 days. Thyroid gland blockage was ruled out by TSH administration. These infants have subsequently developed normally. The only explanation available for their low responses is an absence or a relative unresponsiveness to the factor(s) which usually stimulates thyroid hyperactivity neonatally.

The fourth infant in Table 5 (Patient 50) was born to a thyrotoxic mother who had been on 1 gm. potassium perchlorate daily during the last months of her pregnancy. The infant was born with absent distal femoral and proximal tibial epiphyses and was quite lethargic. Maternal and cord PBI levels were low, and the infant's PBI decreased during the first 48 hours. The U_{24} value at 72 hours was quite low. The infant did well, however, and by 17 days normal gland function had returned.

The fifth infant in Table 5 (Patient 51), also the product of a hyperthyroid mother, had no apparent thyroid effect of the methimazole (Tapazole) dosage employed and had the usual thyroid hyperactivity neonatally.

Thus the usual elevation of serum hormonal iodine values in the neonatal period appears to be associated with an increased TSH effect manifested by an increased rate of I^{131} uptake. Moreover, this effect is associated with increased relative saturation of thyroxine-binding protein indicating an expanded extrathyroidal hormone pool and, presumably, a relative increase in free thyroxine levels. The most likely explanation for the observed thyroid hyperactivity would seem to be a hypothalamic stimulation of TSH release. A recent report of similar TSH values by biologic assay in maternal and cord sera[19] would correlate with the equilibrated PBI and butanol-extractable iodine (BEI) values in maternal and cord sera and suggest that the stimulus for TSH release most likely occurs at the time of birth or postnatally. Since the observed time lag of response of I^{131} uptake to TSH is 8 to 10 hours[20] and the increased uptake is observed by 12 to 24 hours, the TSH stimulus would seem further localized to birth or the early hours thereafter.

Cold exposure has been shown to be a potent stimulus for TSH release, presumably by way of the hypothalamus.[21] Conversely, dinitrophenol and salicylate, by increasing metabolic rate, have been shown to inhibit TSH release in the face of lowered serum hormonal iodine levels.[22,23] Body temperature generally falls shortly after birth with recovery within a few

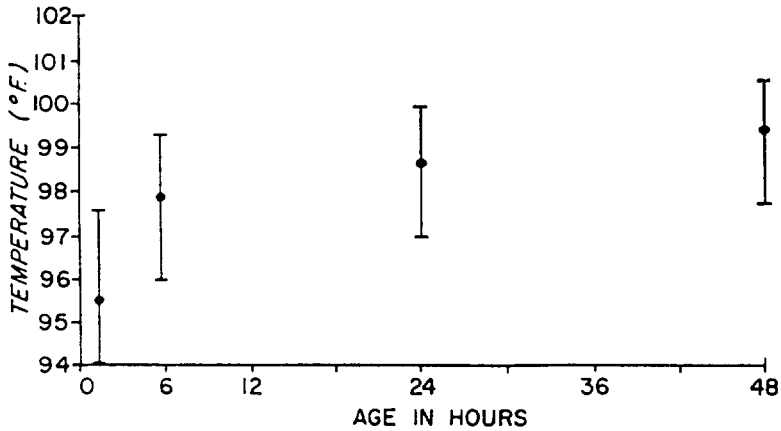

Fig. 5.—Mean and range of rectal temperature in 24 newborn term infants during first 48 hours. Values at 6 hours and beyond were derived from axillary temperature by adding 2 F.

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hours.[24] Such was found to be the case in the present group of infants. Figure 5 shows the mean and range of rectal temperatures in 25 of the infants listed in Table 3 of the present study at various periods after birth. These infants were kept in open plastic cribs in the newborn nursery at a reasonably stable environmental temperature of about 72 F. Of the infants listed in Table 5, Patient 48 did not manifest a temperature above 96 F until 48 hours of age. The other infants listed had temperature responses similar to the infants in Table 3. This neonatal fall in temperature would offer one possible explanation of the thyroid hyperactivity.

A second possibility is a "stress" response to the birth process. Such a response might involve several factors including epinephrine release, corticotropin release, and hydrocortisone (Cortisol) secretion.[25,26] The usual "stress" response includes corticotropin and hydrocortisone secretion with concomitant thyroid inhibition.[25,26] Thyroid hyperactivity is an unusual response to stress and might be conditioned in the newborn by a suggested, although unproven, impairment of hydrocortisone secretion[27-30] which, by virtue of the possible reciprocal relationship of thyroid and adrenal function during stress, might, theoretically at least, enhance TSH secretion. An increased TSH effect with adrenal insufficiency has not, however, been confirmed.[26] Epinephrine secretion in response to stressful stimuli in the newborn is probably normal[31]; epinephrine has been observed to stimulate thyroid activity and has been postulated to act either by stimulating TSH secretion or by enhancing the peripheral utilization of thyroxine.[26]

Estrogen, too, has been shown to stimulate TSH secretion and might offer yet a third explanation of the thyroid hyperactivity. The estrogen stimulation is, however, complicated by an associated elevation of thyroxine-binding protein and a decrease in calculated free thyroxine levels which may stimulate TSH release secondarily rather than directly by way of the hypothalamus.[32-34] Estrogen levels are normally increased in newborn infants,[35] but the possibility of an estrogen release phenomenon from the placenta during delivery further increasing newborn estrogen levels and stimulating TSH release might be considered. The possibility of TSH production by the placenta with release during delivery would seem unlikely; Greer was unable to demonstrate TSH or corticotropin production in hypophysectomized pregnant rats.[36]

Five of the 26 infants in Table 3 were born by elective cesarean section and manifested the usual thyroid hyperactivity neonatally. This would suggest that placental factors play a less likely etiologic role. A postulated placental estrogen effect would be expected relatively to accentuate the thyroid response in infants delivered vaginally. Vaginal delivery produces greater elevations of maternal and cord 17-hydroxycorticosteroid levels than does elective cesarean section.[29] A relative hydrocortisone deficiency neonatally as etiology of the alteration in thyroid function might be expected to produce lesser responses in infants delivered by the vaginal route. The most likely hypotheses, then, to explain the neonatal thyroid hyperactivity would seem to be a TSH stimulation secondary to the neonatal fall in temperature or an epinephrine response with a secondary TSH stimulation.

Summary and Conclusions

Thyroid activity during the neonatal period was investigated in term and premature infants by measurements of the thyroidal I^{131} clearance rates and 24-hour I^{131} uptakes. Simultaneous PBI measurements were obtained in the term infants. Iodide space and renal iodide excretion were measured to allow calculation of k_1, the fraction of the iodide space cleared per minute by the thyroid. Mean iodide space was 0.432 ± 0.072 liter per kilogram. Mean PBI at a mean age of 25 hours in term infants was $9.1 \pm 1.4 \mu g.$ %. During the first 2 days in term infants the mean k_1 value was 2.37×10^{-3} per minute and mean 24-hour uptake 62%. In premature infants within the first 3 days mean k_1 was 3.37×10^{-3}

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per minute and mean 24-hour uptake 72%. Mean k_1 in 21 premature infants between 5 and 55 days was 0.58×10^{-3} per minute and mean 24-hour uptake was 17%. The elevated I^{131} uptake values neonatally were manifest by 10 hours of age and seemed maximal within the first 48 hours. Values returned to normal by 5 days of age.

Neonatal thyroid function, characterized by an early, marked elevation of serum hormonal iodine with an associated relative saturation of thyroxine-binding protein, appears to be secondary to an increased TSH effect manifest by an early increase in thyroid I^{131} uptake rate. Possible etiology of this neonatal TSH stimulation is discussed. The most likely hypotheses would seem to be a TSH stimulation secondary to the neonatal fall in temperature and/or a stress (epinephrine) response.

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THE COST OF FEEDING BABIES

Most pediatricians are glib in their recommendations to mothers regarding milks, vitamins, and solid foods to feed infants. Some may have been concerned about the cost of such items to their low income families and have made cursory comparisons of different brands and kinds of food. Those among you who really would like to know how best to advise mothers to feed their babies economically should obtain and read a report by the Joint Committee on Economics and Efficiency in the Preparation of Infant Feeding of the Food and Nutrition and Maternal and Child Health Sections of the American Public Health Association.

One can satisfactorily feed a baby for the first 6 months for about $26.00 if one knows how. We'd guess most pediatricians advise a regimen of similar efficiency which costs twice as much. A lot of pediatricians probably never have asked how much it costs to feed a mother enough extra food for her to supply breast milk (about 40¢ a day). Some of the mothers in your practice would probably appreciate your going to the trouble to familiarize yourself with this one.

Food and Nutrition and Maternal and Child Health Sections
SOME PRACTICAL CONSIDERATIONS OF ECONOMY AND EFFICIENCY IN INFANT FEEDING
Amer. J. Public Health 52:125 (Jan.) 1962

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