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L. VAN MIDDLESWORTH, Ph.D., M.D.
MEMPHIS

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RADIOACTIVE IODIDE UPTAKE OF NORMAL NEWBORN INFANTS

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THYROID function of the newborn was studied by Danowski and co-workers [1] and by Man and co-workers,[2] who determined the plasma level of the thyroxine-like protein-bound iodine and butanol-extractable iodide. In infants 1 to 3 days old protein-bound iodine averaged 12.0 γ per 100 cc., and butanol-extractable iodine in infants of 2 to 6 days was 7.0 to 11.7 γ per 100 cc. These results are compatible with hyperthyroidism in adults or older children.[2] Several reports * indicated that I^{131} uptakes by the thyroids of normal children "less than 1 year" to 14 years of age were well within the broad range of normal adults, i. e., less than 50% of the injected dose of I^{131} accumulated in the thyroid area after 24 or 48 hours.

Apparently, no I^{131} studies have been reported on newborn infants. The absence of such studies results partly from the previous lack of satisfactory instruments for accurate detection of safe doses, such as 1.0 μc,† of I^{131} in the thyroid.

METHODS

Seven normal newborn boys, 2 and 3 days old and weighing 7 to 9 lb. (3,175 to 4,080 gm.), were studied. Six of the subjects were Negroes, and one, no. 2, was Caucasian. Five of the infants were fed at breast every four hours, and the remaining two were bottle-fed every four hours.

A scintillation counter ‡ was constructed for this investigation. The lead shield around the scintillation crystal extended as a lead tube 5 in. (12.7 cm.) beyond the crystal. The open end of this tube was placed snugly against the objects counted (thyroid area, thigh, injection site, or syringe containing the I^{131} dosage). The background was 110 to 118 counts per minute, and all thyroid counts were 14 to 25 times this background.

The test dose of I^{131} § was drawn into a 0.25-cc. syringe by means of a 27-gauge needle. The syringe needle and solution were then held across the end of the lead tube, and a count of the gamma radiation was recorded. The test dose was injected deeply into the gluteus maximus muscle of the infant, and subsequently the syringe and needle were again counted. The difference

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From the Department of Physiology, University of Tennessee College of Medicine and the John Gaston Hospital.

* References 3-6.

† One microcurie of I^{131} in a thyroid weighing 2.4 gm. will produce a maximum total radiation of 60 r (rep), or 144 gm.-r (grams × roentgen equivalents physical). A gastrointestinal x-ray series with fluoroscopy in an infant results in exposure to at least 20 r, or 3,600 gm.-r. The treatment of thyrotoxicosis in an adult with a 30-gm. thyroid will usually require 5,000 r (rep), or 150,000 gm.-r, from I^{131} given as a single dose.

‡ The scintillation tube was obtained from Nuclear Research Corp., Grays Ferry Ave., Philadelphia. A discriminator and preamplifier was built by B. P. McKay, Research Associate, University of Tennessee.

§ Sterile tracer solution (obtained from Abbott Laboratories, North Chicago), 250 μc of I^{131} per cubic centimeter.

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between these two counts was taken as the injected dose,‖ and this was between 1 and 1.5 μc. Twenty-four hours later, the thyroid area of the infant was held against the end of the lead tube, and three counts of one minute each were recorded. The nonthyroidal tissue background was obtained by counting over the thigh. This tissue background was subtracted from the counts per minute of the thyroid area to obtain the I^{131} content of the thyroid gland.¶ Correction was made for 24-hour radioactive decay by dividing the thyroid content by 0.917, and the result was divided by the injected dose in counts per minute, to compute the thyroid uptake as percentage of injected dose.

RESULTS

The results of this study are summarized in the Table. It was evident that in six of the seven infants 60% or more of the I^{131} dosage was taken up and retained in the thyroid area. Two of the subjects, No. 6 and No. 7, accumulated in the thyroid over 90% of the I^{131} test dose. The lowest uptake, in No. 3, was 45.5%, which would be borderline high for an adult.

The Table shows the actual dosage of I^{131} given to each infant and the final counts per minute for the injection site and for the thyroid. The radioactivity of the injec-

Results of Study

Patient No.	Age, Days	Inj. Dose, Counts/ Minute	24 Hr. After Injection: Inj. Site, Counts/ Minute †	24 Hr. After Injection: Thyroid *: Counts/ Minute	24 Hr. After Injection: Thyroid *: % of Inj. Dose
1	3	3,700	118	2,240	61
2	3	3,680	238	2,300	62
3	3	3,340	78	1,520	46
4	2	2,910	81	1,760	61
5	2	2,840	66	1,920	67
6	2	2,700	67	2,640	97
7	3	2,440	71	2,300	94

* Counts per minute over neck minus counts per minute of tissue background and corrected for 24 hr. decay.
† Corrected for background.

tion site was found to be the same as the tissue background. This indicated complete absorption of the injected I^{131}.

COMMENT

These studies show that the thyroid uptake of iodide is stimulated in the newborn infant. Such data, together with the reports of high protein-bound-iodine levels # in infants of the same age, suggest that the newborn infant may experience a period of physiological hyperthyroidism. This could result from several possible mechanisms, i. e., (*a*) increased sensitivity of the thyroid to thyrotropic hormone, (*b*) increased production of thyrotropic hormone, or (*c*) complex alterations of endocrine balance.

‖ The accuracy of this method for estimating the dose was tested by injecting the solution into a ball of cotton 1 cm. in diameter. The cotton was placed at the end of the lead tube and the I^{131} counted. The actual radioactivity in the cotton was 4% greater than the calculated amount.

¶ The error due to secondary radiation was tested by a water phantom [7] and found to be 11%. This was shown to be counteracted, since the thyroid gland was counted at a greater distance (by 4 to 8 mm.) than the injection dose.

References 1 and 2.

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Because several explanations are possible, no therapeutic implications should be drawn from these data until specific experiments have demonstrated the usefulness of possible therapy.

It was necessary to use parenteral injection of the I^{131} tracer dose because valid determinations of the percentage uptake require complete retention of the administered dose. The error which would result from possible regurgitation of gastric contents, common among infants, was thereby eliminated.

The use of radiation in the very young organism is open to some question (Footnote †, p. 439). Therefore, great care and minimal dosage were necessary. The fact that I^{131} has a physical half-life of only eight days means that if there were no metabolic loss of I^{131} the total body radiation would be reduced by 94% in one month by physical decay; after two months a maximum of 0.3% of the original dose could remain in the body. Actually, the metabolic turnover of iodine within the body results in a biological half-life of less than eight days, that is, the effective decay is accelerated by excretion.

The body is always exposed to a certain amount of radiation from atmospheric background and natural-occurring radioactive isotopes. The common form of potassium is radioactive and present in all the body cells. These facts alone may give a false sense of security, because the possible danger of I^{131} results from its great concentration in the cells of the relatively small thyroid gland and from its ionizing beta radiation (in addition to its gamma radiation). No objective biological effect has been reported from a single dose of 100 μc of I^{131} administered to adult human beings.

The dosage used here was calculated on the same weight basis as the 100 μc tracer dose commonly used in adults. The result was divided by four to be well below the per pound adult dose. The infant and adult are not strictly comparable because the rapidly growing infant may be more susceptible to radiation than the mature adult. The dosage was considered by a local group consisting of a radiologist, a radiation physicist, two internists, two pediatricians, a physiologist, and a pathologist. The group considered that according to our best information the dosage of 1 to 2 μc of I^{131} in a 7- to 9-lb. newborn infant was not expected to be harmful. The procedure was described to the mothers of the infants studied, and the mothers gave consent for the study before the tests were made. Only boys were studied because of the low incidence of spontaneous thyroid dysfunction in males. The infants were thoroughly examined and found to be normal before they were studied. The I^{131} was administered by a physician, a film badge was kept within the basinette to obtain a record of the radiation exposure, and disposable diapers were employed during the hospitalization. The children will continue to be evaluated periodically by our outpatient pediatric clinic.

SUMMARY

The I^{131} uptake by the thyroid of seven normal newborn infants has been demonstrated to lie within the range of values which would be found in hyperthyroid adults. The method employed is simple, requires only 1 μc of I^{131}, and it may prove useful in the diagnosis of thyroid abnormalities in infants. A discussion is presented regarding the implications and precautions of the procedure.

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