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see p 1264 for isolated case.

# RADIOIODINE CONCENTRATION IN FETAL HUMAN THYROID FROM FALLOUT

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**Abstract**—From July, 1959 to January, 1963, 139 human fetal, 87 adult, 12 child and 154 hog thyroid glands were counted in a spectrometer well-counter system capable of detecting 1.5 pc $I^{131}$/g of tissue. Neck muscle counts served as background. Using published MPD values of 0.5 rems (population) and 1.5 rems (individual), hog thyroid radioactivity exceeded individual MPD once in September, 1959, and once in September, 1962; exceeded population MPD three times in November, 1961, and three times in August–September, 1962. Human fetal counts never reached the MPD and only once rose to more than half adult thyroid radioactivity. Fetal: maternal thyroid radioactivity in a pregnant woman dying suddenly was 1.08 pc/g:0.82 pc/g. High radioactivity concentration in hog thyroid always preceded high radioactivity in human adult and fetal thyroids. It is concluded that hog thyroid gland monitoring can be used in lieu of human adult and fetal thyroid gland monitoring until very high concentrations of $I^{131}$ are found in hog thyroid.

## INTRODUCTION AND METHODS

VAN MIDDLESWORTH[1] and COMAR[2] first reported radioactive concentrations of $I^{131}$ in adult human thyroid glands as a result of nuclear weapons testing. LEWIS[3] continued these studies and calculated the radiation dose to the thyroid of infants and young children due to the fallout $I^{131}$ in milk. BEIERWALTES *et al.*[4] first reported $I^{131}$ concentration in the human fetal thyroid glands from fallout and compared it with concentrations observed in adult human thyroids and hog thyroids.

In this study,[4] conducted during the period of November, 1958–July, 1959, it was found that the $I^{131}$ concentration was highest in human fetal thyroids, next in human adult thyroids and lowest in hog thyroid glands.

Since this earlier publication, the analytical procedure employed was changed to the scintillation well-counting technique after it was found that the extraction procedure for iodine was recovering only 26 per cent in hog thyroids, and 80 per cent in human adult thyroids.

Since July, 1959, an additional 139 fetal, 12 child, 87 adult and 154 hog thyroid tissues have been counted using a transistorized scaler-spectrometer with a well-type scintillation counter having a 3 × 3 in. crystal enclosed in a lead cave. With this apparatus it is possible to detect concentration of $I^{131}$ in tissue as low as 1.5 pc/g.

Human thyroid gland and neck muscle samples were obtained from hospitals in and near Ann Arbor. Hog thyroid gland and neck muscle tissue were supplied by a local abattoir. Muscle and thyroid tissue samples nearly equal in weight were counted, with the muscle tissue count taken to represent the background. Empty sample tubes were also counted to check for possible contamination of muscle tissue.

Table 1 presents the formulae used in calculating the Maximum Permissible Dose (MPD). Here rems are expressed in cpm/g by assuming that 1 rem is = to 1 rad for X-, $\gamma$- and $\beta$-radiation. With this assumption applied to the

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*Table* 1. *Calculation of* MPD *in units of* pc/g/day

I. MPD: General population = 0.5 rems/year
Individual = 1.5 rems/year

II. Assumptions: rem = rad × RBE
RBE = 1
rem = rad

III. By Quimby Formula for persons in Ann Arbor area:

$$\text{rad} = \frac{(90)(\times \mu c)(\%\ \text{uptake})}{\text{wt. of gland}}$$

average % uptake = 25%
average gland weight = 20 g

$$\text{for MPD (population)} = \frac{0.5}{(90)(.25)}$$

= 60 pc/g/day
for MPD (individual) = 182 pc/g/day

Quimby Formula and using an average thyroid gland weight of 20 g, 0.5 rems is equal to about 60 pc/g and 1.5 rems are equal to about 182 pc/g.

## RESULTS

Figure 1 presents all of our data from July, 1959, to January, 1963, with time in years and months on the abscissa and net cpm/g at time of death on the ordinate. Also on the graph are lines representing the MPD for the human adult population, 0.5 rems and individual, 1.5 rems.[5] The human values used, together with the rise in hog $I^{131}$ thyroidal concentration, permit adequate warning of possible increase in $I^{131}$ concentration in human thyroid tissue. The periods of nuclear testing are depicted on the upper abscissa of the graph. It can be seen that high $I^{131}$ concentration in hog thyroid usually coincides with high radioactivity in both human adult and fetal thyroids. Hog thyroid radioactivity exceeded the individual MPD in September, 1959 and September, 1962, and exceeded the population MPD three times in November, 1961 and three times in August–September, 1962. Adult human thyroid $I^{131}$ concentration never exceeded the population MPD.

The concentration of $I^{131}$ in human fetal tissue remains fairly constant at background, having never reached the MPD. Human fetal thyroid concentrations above background occurred in May, 1960; October and November, 1961; April, 1962; and from July to December, 1962.

Maximum concentration of $I^{131}$ in the thyroid glands occurred approximately 1 month after a series of nuclear explosions and then dropped to background again in about 4 months, after having reached the maximum.

Within the adult and fetal curves are samples which represent the thyroidal radioactivity of a woman and her 5-month-old fetus, both of whom died of air embolism before admission to the hospital. The counting results of the radioiodine content in the fetal thyroid gland was 1.08 pc/g and 0.82 pc/g in the mother's gland (maternal: fetal ratio 1:1.3). This high concentration in the fetal gland was also found by Eisenbud[6] in one case where both mother and full-term male infant died during delivery. This data is important because it is direct information on the $I^{131}$ concentration in the mother's thyroid as compared to the concentration in the thyroid gland of the human non-pregnant adult. It also makes it possible to judge the concentration of $I^{131}$ in the human fetal thyroid gland when the maternal thyroid $I^{131}$ content is known.

It is apparent from our curves that fallout $I^{131}$ concentration in human fetal, human adult and hog thyroid tissue in the 50-mile vicinity of Ann Arbor can be detected approximately 1 month after a nuclear detonation of proper magnitude and location. Our data suggest that

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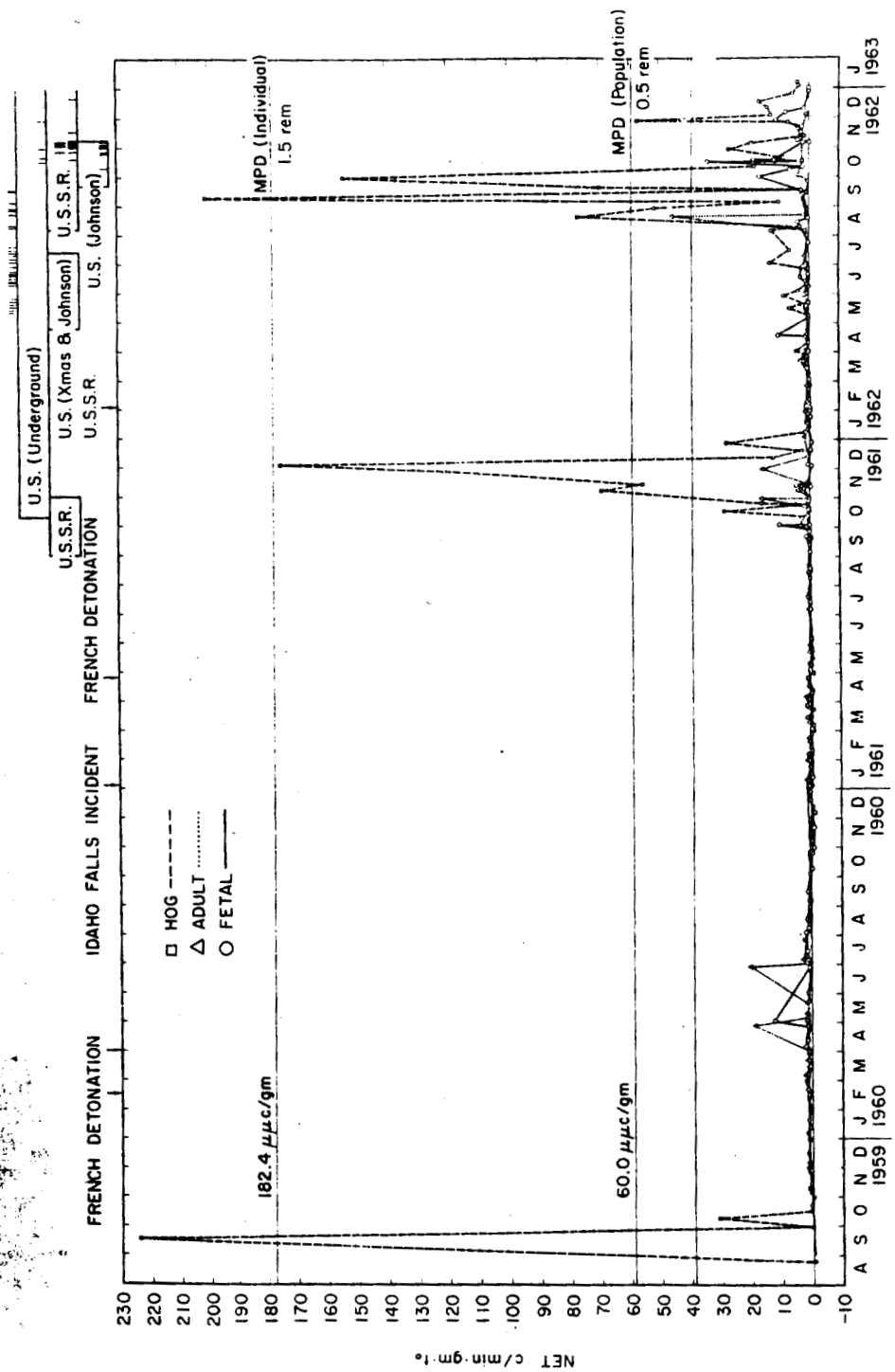


FIG. 1. $I^{131}$ levels in human fetal, adult and hog hyroids related to nuclear detonations.

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hog thyroid gland monitoring can be used in lieu of human adult and fetal thyroid gland monitoring until high concentrations of $I^{131}$ are found in the hog thyroid. This should reduce considerably the amount of work required for human fetal thyroid gland monitoring.

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