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THE SPECIFIC ACTIVITY OF TRITIUM IN THE ORGANIC
COMPONENTS OF THE SKIN AND FAT OF MAN FOLLOWING
EIGHT MONTHS' CHRONIC EXPOSURE TO HTO IN BODY FLUIDS

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ABSTRACT

A healthy 39-year-old male weighing 65 kg was exposed for a period of 8 months to varying levels of HTO. The average tritium activity in body fluids over the entire period was 23 $\mu\text{c}/\text{liter}$. A few weeks after exposure, when the HTO activity in body fluids had declined to about 0.2 $\mu\text{c}/\text{liter}$, a biopsy was performed on skin and fat taken from the region of the lower abdomen and the material was analyzed for tritium activity. The skin showed an average activity equivalent to 0.4 $\mu\text{c}/\text{kg}$ of dry tissue and the fat about 0.3 $\mu\text{c}/\text{kg}$ of dry tissue. The radiation dose per unit time from these activities was only 1 to 2 per cent of the radiation dose per unit time during the 8-month exposure period. It was concluded that the radiation hazard due to retention of tritium in the organic components of these tissues of man after chronic exposure was negligible compared to the radiation hazard from HTO activity in the body fluids which was necessary to induce the activity into the organic components. Comparable experiments on mice previously reported indicate that this conclusion may hold for all tissues in the body.

The water content of the skin and fat of man was found to be 71 per cent and 20 per cent, respectively, on the basis of the wet weight. The hydrogen content of skin was 7.6 per cent, and of fat 11.4 per cent, of the dry weight of the tissue.

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TABLE

Table I. Tritium Activity in the Dried Organic Components of the Skin and Fat of Man after Eight Months of Chronic Exposure to HTO

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1. INTRODUCTION

Earlier experiments showed that when mice were exposed either acutely or chronically to HTO in body fluids, some tritium activity appeared in the organic components of their various tissues.^{1,2} Several weeks after exposure the specific activity of tritium in the organic components of the mouse tissues was considerably higher than that in body fluids at the same time, being highest in the organic components of brain, skin, and muscle, and lowest in the organic components of liver and fat. Although the radiation dose delivered to the mouse by the tritium activity in the organic components of the tissues was small compared to the radiation dose delivered by the HTO activity in body fluids necessary to introduce the tritium, the activity introduced into the organic components was of some significance because of the longer biological half-time in the body.

The data in this report were obtained to determine the specific activity of tritium remaining in the organic components of the skin and fat of man after chronic exposure in order to make a comparison with the studies using mice. It was thought that such information might be of use in evaluating the radiation hazard associated with large-scale processing of tritium. These data might also help in evaluation of tritium incorporation in organic components of the body when one is calculating tolerance exposures. Previous experiments³ indicated that the rate of incorporation of tritium into normally nonlabile positions in the organic constituents of tissues was not large enough to constitute an important radiation hazard in comparison with the hazard from the HTO in body fluids necessary to induce significant incorporation.

2. METHODS

The chronic exposure in this experiment was incidental to and resulted from repeated exposures of the subject to HTO over a period of 7-1/2 months during studies of the rates of HTO uptake through the skin, lungs, and gastrointestinal tract. The varying levels of HTO prevailing in the body fluids during the exposure period are shown graphically in Fig. 1. The rapid increases in activity seen in this figure resulted from short exposures to HTO made during studies of HTO absorption rates. The slow decay between experiments resulted from the elimination of HTO from body fluids. It was observed that the half-time for elimination ranged from 8 to 12 days for this subject. The activity in body fluids from October 11, 1951, to May 14, 1952, ranged from 70 to 6 $\mu\text{c}/\text{liter}$. The integrated average activity maintained in body fluids over this period was 23 $\mu\text{c}/\text{liter}$, which is equivalent to 0.05 rep/week total body radiation. After an exposure made on April 29, 1952, the HTO activity in body fluids declined exponentially with time until by June 20 it had reached a level of about 0.2 $\mu\text{c}/\text{liter}$.

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On June 20, 1952, a biopsy of skin about 25 cm² in area with about 6 g of underlying fat was obtained from the lower abdomen. Samples of the skin and fat were dried to constant weight in vacuo at 60°C, and the dry samples were burned in a stream of oxygen over cupric oxide at 850°C. The water of combustion was condensed in a dry ice trap and analyzed for HTO activity by methods previously described.³

3. RESULTS

Table I shows the results obtained on the skin and fat biopsy material collected from man as described above. These results indicated a water content for the skin of man of 71 per cent and a water content for the fat of man of about 20 per cent. The hydrogen content of the dried organic components of these tissues was 7.6 per cent for skin and 11.4 per cent for fat. The specific activity of tritium in the hydrogen of the organic constituents of these tissues was somewhat higher than in body water at the time of biopsy (Fig. 1), but the activity of skin was a factor of 40, and of fat a factor of 80, lower than the average activity maintained in body fluids over the several months of exposure. It was concluded from these results that the radiation hazard resulting from incorporation of tritium in the organic components of these tissues after chronic exposure to HTO was small compared to the hazard due to HTO in body fluids necessary to induce the activity into the organic constituents. Chronic exposures of mice² showed specific activities for tritium in the organic constituents of skin and fat 4 weeks post-exposure which were comparable to the results for man. In mice, the brain showed the highest tritium activity after the exposure, with skin only slightly less and other tissues lower. Assuming similar relations for the various tissues of man, the tritium activity found for the organic components of skin in these experiments would be higher than that in other tissues, with the exception of the brain.

4. SUMMARY

A healthy 39-year-old man weighing 65 kg was exposed for a period of 8 months to varying levels of HTO in body fluids. The tritium activity averaged 23 µc/liter over this period. A few weeks after exposure, when the HTO activity in body fluids had declined to about 0.2 µc/liter, a biopsy of skin and fat tissue was performed, and the material analyzed for tritium activity. The skin showed an average activity equivalent to 0.4 µc/kg of dry tissue and the fat about 0.3 µc/kg of dry tissue. The radiation dose per unit time from these activities was only 1 to 2 per cent of the radiation dose from the tritium in body water during the 8 month exposure period. It was concluded that the radiation hazard due to retention of tritium in the

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organic components of these tissues of man after chronic exposure was negligible compared to the radiation hazard from HTO activity in the body fluids which was necessary to induce the activity into the organic components. Comparable experiments on animals indicated that this conclusion may hold for all tissues in the body.

The water content of the skin of man was found to be 71 per cent of the wet weight, and of fat, 20 per cent of the wet weight. The hydrogen content of the dried skin of man was 7.6 per cent of the dry weight, and of dried fat, 11.4 per cent.

5. REFERENCES

1. R. C. Thompson, HW-20092 (1951).
2. E. A. Pinson, LA-1467 (1952) (in press).
3. E. A. Pinson, LA-1218 (1951).

6. ACKNOWLEDGMENTS

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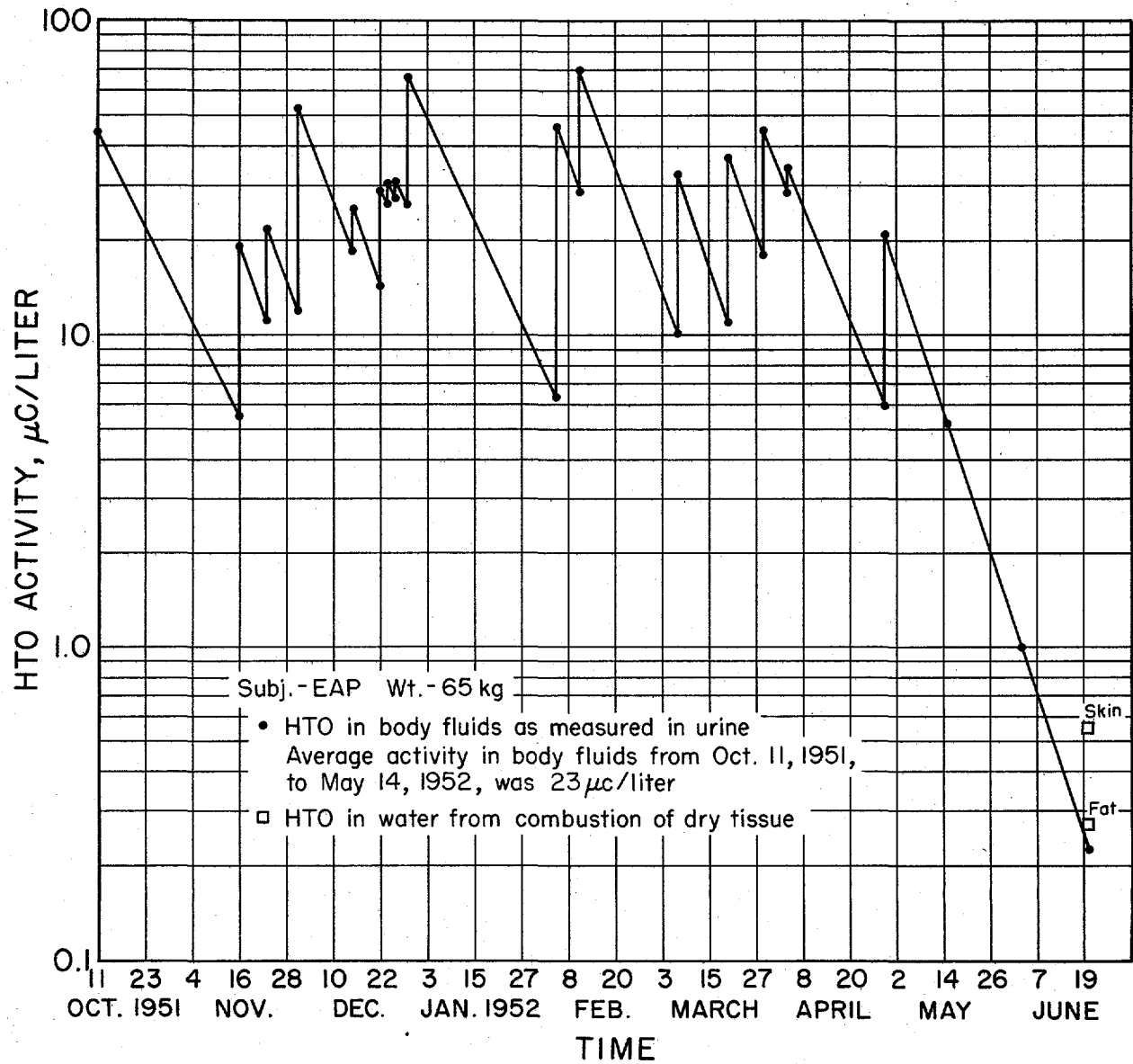


Fig. 1. HTO activity in the urine of man during several months of chronic exposure compared to the activity in the water of combustion of dried skin and fat at the end of the exposure period.

Table I.
 TRITIUM ACTIVITY IN THE DRIED ORGANIC COMPONENTS OF THE SKIN AND FAT OF MAN
 AFTER EIGHT MONTHS' CHRONIC EXPOSURE TO HTO^(a)

Tissue Sample	Wet Weight, mg	Dry Weight, mg	Dry Weight, per cent	Dry Tissue, mg	Water Obtained, mg	H ₂ in Dry Tissue, per cent	HTO in Water of Combustion, $\mu\text{c/liter}$	HTO in Dry Tissue, $\mu\text{c/kg}$
Skin	849.9	240.0	28.3	238.8	155.8	7.26	0.4	0.3
Skin	893.6	263.7	29.5	261.6	188.2	7.98	0.7	0.5
Fat	1024.6	823.2	80.2	435.8	449.2	11.45	0.3	0.3
Fat	466.2	378.1	81.2	332.7	337.0	11.23	0.2	0.2
Fat	1502.7	1192.3	79.4	1087.3	1125.4	11.50	0.3	0.3

(a) Integrated average activity maintained in body fluids during the exposure period was 23 $\mu\text{c/liter}$. Tissue samples were taken a few weeks after exposure.