

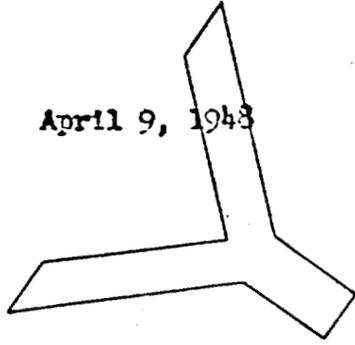
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April 9, 1948



Dr. Shields Warren, Director
Division of Biology and Medicine
U. S. Atomic Energy Commission
Washington 25, D. C.

Dear Shields:

I am enclosing for your own interest a fairly recent reprint of some of our work with fission products and heavy elements which survey the essential points of our tracer projects in this field up to about August 1, 1947. You will note the behavior of thorium, once it has been absorbed following parenteral administration, is very much like that of plutonium, and the distribution in the skeleton, as demonstrated by the radioautographic technique, again indicates the close metabolic similarity of this element to plutonium. In addition, like plutonium and a number of the other heavy elements and fission products, thorium is not absorbed to an appreciable degree from the digestive tract. These studies were, of course, done with carrier-free radioactive thorium in the form of Ux_2 (Th^{234}). The metabolism of thorium on the milligram level, following parenteral administration in the form of soluble compounds of this element, could conceivably be different but I rather imagine that this would not be the case for this particular substance. The inhalation of soluble compounds of thorium, such as the nitrate, chloride, etc., would, in my prediction, result in the absorption of roughly 10% of that inhaled and that this absorption would be followed by the deposition of a little over half of that absorbed by the skeleton, where it would remain for a long period of time. While we have no direct experimental evidence on the behavior of thorium compounds following inhalation, we do know enough about other radio-elements on the carrier-free scale whose chemical properties are similar to thorium, to make this prediction of reasonable accuracy. The situation that might take place following the inhalation of thorium in the milligram range would be expected to reduce the amount of absorption from the lungs, but as to the chemical irritation involved, I am not in position to make any very sensible guesses. It is extremely unlikely that thorium compounds on the milligram level would be absorbed from the digestive tract in view of the fact that absorption is negligible with a carrier-free material. At the present time, some work is going on at Rochester with thorium using Ux_2 as the tracer. In their studies they introduced the carrier-free solutions of radioactive thorium (Th^{234}) by vein and found a very large uptake in the liver. This, I believe, is due to the fact

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PROVENANCE

REPOSITORY: OFFICE OF HUMAN RADIATION
EXPERIMENTS (OHRE)

COLLECTION: PLUTONIUM INJECTION INVESTIGATION
FILES (OHRE 1)

BOX: 3

FOLDER: IRRELEVANT MATERIAL

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Dr. Shields Warren

April 9, 1948

that the majority of thorium compounds are insoluble at the pH of body fluids with the result that a colloid was formed, which in turn was entrapped by the reticulo endothelial system. This, of course, does not represent a true metabolic picture of thorium but simply the behavior of a radioactive colloid. In the main this dilemma may be avoided either by administering material by intramuscular subcutaneous injection or by complexing the radioelement with some organic acid that is readily metabolized, such as citric or lactic acids. I think these points are of no small concern and we have had to face them for over five years with the result that a lot of information has been accumulated to justify this opinion. From the health hazard point of view, insofar as radiation is concerned, there are a number of thorium isotopes which bear watching. The one most likely to cause trouble is probably ionium (Th^{230}) for this has a half-life of 83,000 years and emits alpha particles decaying to form radium. The next most ominous member of the thorium group is radio-thorium (Th^{228}) with a half-life of 1.9 years which has a large number of short-lived descendants, the majority of which emit alpha particles. To the best of my knowledge there is only available in America something in the order of a curie of this isotope of thorium. A year or so ago, I was informed by Mr. Prager of the Canadian Radium and Uranium Corporation that he had available one curie of mesothorium from which this isotope of thorium arises. Next in the group is, of course, Ux_1 which is beta active with a half-life of 21.4 days. With respect to the radiation hazards of ordinary thorium (Th^{232}) it is presumed possible that sufficient might be accumulated over a period of years in the skeleton to cause trouble, even though the half-life is tremendously long. Off the record, I would make the guess that the prolonged inhalation of a dose containing soluble compounds of thorium might conceivably be worse than uranium insofar as bone irradiation is concerned at a low level, as the retention of uranium by the skeleton is apparently considerably less than that of thorium although I wouldn't like to go on record for making this statement. One always thinks of the presumed induction of tumors by the use of thorotrast, which is an insoluble hydroxide of thorium which is picked up and retained tenaciously by the reticulo endothelial system, notably the liver and spleen. If you feel that there is concern in this problem, we could very easily set up some long term tracer studies with thorium to extend for a period of a year or more if you feel that the effort is warranted on the basis of possible thorium poisoning in workers exposed to handling this material.

The information on protoactinium is not quite as complete as that of thorium to date and to the best of my knowledge, we are the only people who have done any experiments along this line. Protoactinium is likewise not absorbed from the digestive tract and shows a rather high degree of deposition and retention by the skeleton.

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Dr. Shields Warren

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We are now in the process of obtaining some radioautographic data of the distribution of this radio-element in bone following its administration in the carrier-free state using the 27 day Pa²³³. This half-life will, of course, preclude any long term studies. The only isotope of protoactinium which appear to me to be a serious health problem is the 32,000 year Pa²³¹. This, of course, emits alpha particles to decay to the 13.5 year Ac²³⁷. Again the issue as to whether further studies should be pursued with protoactinium is pretty much contingent upon the amount of Pa²³¹ available to the various installations of the Atomic Energy Commission, or what may be isolated in the feasible future. It is my impression that the amount of pure Pa²³¹ available is in the range of a few hundred milligrams, although I might be quite mistaken on this point.

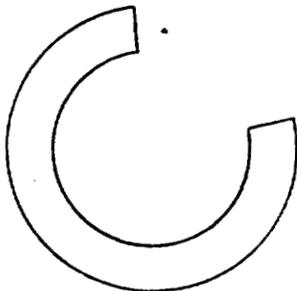
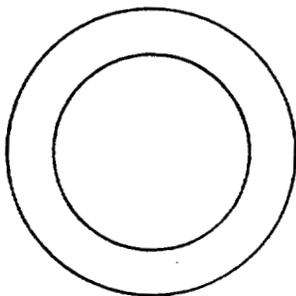
To the best of my knowledge there has been no work done on the radio-toxicity of either of these two elements. The Rochester people have been doing a great deal on the chemical toxicity of thorium, both following parenteral injection and inhalation.

I trust that this rather rambling account may be of some help to you and, needless to say, we will be glad to do anything at this end to elucidate the problem further if you feel such effort is warranted.

Sincerely yours,

Joseph G. Hamilton, M. D.

JGH: jr



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