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May, June, July, 1953

AEROSOL STUDIES

J. G. Hamilton and Patricia Wallace

September 21, 1953

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AEROSOL STUDIES

J. G. Hamilton and Patricia Wallace

Our aerosol program employing monkeys has been initiated. Plutonium oxide was prepared through the courtesy of Professor Seaborg's group. The plutonium oxalate was placed in a small capillary tube, which was sealed off. The capillary tube was heated to a sufficient temperature to convert the oxalate to the oxide. Prior to this a preliminary experiment was performed to determine the feasibility of such a procedure employing 1 milligram of neptunium^{237}. In the neptunium oxide, which was made in a similar manner, the particles were examined under the microscope and were found to be of acceptable size, a large proportion of them being of the order of 5 microns in diameter. In the plutonium oxide the particles from the oxalate tended to be somewhat larger, but in view of the circumstances this was the best material available. One of the monkeys received approximately 1 milligram of plutonium oxide by intratracheal injection. The capillary tube was broken inside a hypodermic syringe containing 10 ml isotonic saline. This solution was introduced into the trachea by direct injection. The use of a fine spray through intratracheal cannulation would have been more desirable, but it was felt that hazards would be too great to render this procedure justifiable.

Preliminary results of the fecal and urinary determinations appear in Table I.

A considerable fraction of the plutonium did not enter the trachea, but the amount excreted appears much smaller than was expected, even so. Many particles had dimensions in the range of 25 microns, and it would be anticipated that most of these would be removed from the linings by ciliary action and excreted in the feces. Analytical difficulties were encountered, inasmuch as the plutonium particles did not readily go into solutions employing 6N nitric acid. Somewhat better results were obtained using 16N sulfuric acid. Unfortunately this procedure produced a rather bulky precipitate, and led to problems in the separation of plutonium by the TTA procedure.

A second monkey is now available for another aerosol experiment, and in this case the possibility of either using a fine spray aerosol through a trachea cannula or introducing the material directly through the trachea without the use of any liquid is under consideration.

These monkeys are to be maintained for observation for an extended period of time to determine the fate of the particles whose size range is from 1 to 5 microns. Of particular interest will be whether there is migration to the hilar lymph nodes and the pleura. Since plutonium oxide in the tetravalent state is highly insoluble, it should be possible not only to localize the particles by radioautographic techniques but also to examine them in the sections with dark-field illumination, which has been done earlier in the rat.

A series of experiments is now being set up employing actinium^{227}. One of the first steps that now appears feasible is to follow the distribution not only of actinium itself but also of its radioactive daughters, namely, thorium^{227} with a half-life of 18.6 days, and radium^{223} with a half-life of 11.2 days. It is

Table I

The Following Figures Give the Values of the Fecal and Urinary Excretion of the Monkey that Received Plutonium Oxide by Intratracheal Injection

Days After Pu Administration	c/s Feces	Days After Pu Administration	c/s Urine
0 - 1	9,650	0 - 1	49.3
1 - 2	16,700	1 - 2	2.2
2 - 3	1,530	2 - 3	4.8
3 - 4	212	3 - 4	6.4
4 - 5	75.9	5 - 5	1.6
5 - 6	134.2	5 - 6	< background
7 - 10	124.0	7 - 10	11.7
11 - 15	127.0		
	Total: 28,253 c/s		Total: 76.0 c/s

entirely possible that translocation exists, since these two daughters of actinium behave somewhat differently metabolically. This is of significance in attempting to evaluate the biological hazards of this highly radiotoxic element. When the experiments are actually started, the material is to be administered by intramuscular injection and complexed with sodium citrate. This point we feel is important, as the intravenous administration of radioelements chemically allied to actinium leads to radiocolloid formations with the tendency of a high proportion to become trapped in the reticulo-epithelial system, and thus does not give as valid a picture of the metabolism of actinium.

The evaluation of radioelements is to be based upon the distribution of actinium and its daughter products, and on changes in weight and growth; in addition, complete blood studies will be made as soon as possible including red- and white-cell counts, differential counts, hemoglobin and hematocrit determinations, and finally a study of the hematopoietic system (which produces erythrocytes) with injections of radioiron at various times after the administration of the actinium. Furthermore, valuable information might be secured by tracer studies of the treated animals, employing other radioelements associated with actinium, namely, radiocobalt, radiocopper and radiozinc.