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TO: D. F. Cronin

FROM: Frances L. Sachs

SUBJECT: TOXICOLOGY AND RADIATION HAZARD OF POLONIUM

DATE: August 13, 1951

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SUMMARY OF LITERATURE SEARCH FOR D.F. CRONIN, L.C. EMERSON AND DON ROSS

Subject:

AT1

TOXICOLOGY AND RADION HAZARDS OF POLONIUM

Date:

Report requested May, 1951
Report completed August 6, 1951

Tools Searched:

Chem. Abstracts 1907-1949
Nuclear Science Abstracts 1947 to June 1951
Y-12 Reports Catalog
Y-12 Technical Library Catalog
AEC Catalog
Abstracts of Classified reports 1947 to June 1951
Wilson Cumulative Book Lists 1928 to 1950

Explanation:

1 NSA
4 Y-12 Reports
4 CA
28 AEC
5 ACR
1 Wilson Cum. Bk. Lists

44 titles selected.

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TOXICOLOGY AND RADIATION HAZARD OF POLONIUM

TOXICOLOGY AND METABOLISM

"QUARTERLY REPORT FOR BIOLOGY JANUARY, FEBRUARY, AND MARCH 1950"

Harring, M. M.

MLM-442 Secret

"POLONIUM TOXIC EFFECTS BIBLIOGRAPHY OF REPORTS AND PUBLISHED LITERATURE"

Atomic Energy Research Establishment

AERE - Inf/Bib - 57 January, 1950 Restricted 7 pages

Twenty one items; reports issued up to December, 1949 and papers noted in Chemical Abstracts 1924-1949 and in Index Medicus, 1916-1948.

"BIOLOGICAL STUDIES WITH POLONIUM, RADIUM, AND PLUTONIUM"

Fink, R. M.

McGraw, 1950

"THE THERAPEUTIC USE OF BAL IN POLONIUM TOXICITY"

Hursh, J. B.

UR-83 July 12, 1949 Restricted

Bal, British Anti Lewisite (2,3-dimercaplopropanol) and related dithiol compounds have been tested for their effects on the toxicity of Po in rats. When Po was injected intravenously BAL, the most effective of the dithiols tested approximately doubled the 10 day excretion of Po. In subcutaneous injection BAL was less effective than BAL acid (NDR 317) or the urea derivative of BAL (NDR 399). The tissue distribution results showed that the BAL rats at ten days had consistently higher Po concentration in muscle than did the control rats. When BAL was given as a single

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intramuscular injection 1 hour after intravenous Po administration, the Po concentration in the whole blood was sharply decreased. Tissue distribution of Po 3 hours post administration was given for BAL and control rats. These data showed that BAL mobilized Po from the blood into muscle, intestine, and kidney. Twenty rats were injected with a dose of Po (36 mc/kg) which was known to be associated with a median survival time of about 25 days. Ten rats were treated with intermuscular BAL. Records were kept of survival time, daily wt, and periodic blood sample findings. The treated rats had a median survival time of 82 days as contrasted with 21 days for the untreated rats. The data indicated that the therapeutic effect of BAL was related to both the increased excretion of Po and to the shift of Po to less radio-sensitive tissues.

"A QUANTITATIVE METHOD FOR THE DETERMINATION OF POLONIUM IN ANIMAL TISSUES"

Mulhaney, Thomas J. and William P. Norris, Walter Ekisieleski

ANL-4333 June, July, 1949 Unclassified pp. 103-109

"BIOLOGICAL STUDIES WITH POLONIUM AND RADIUM"

Fink, Robert M.

AECD-2591 May 18, 1949 Declassified 214 p.

Distribution and excretion of Polonium.

"PROGRESS OF THE LONG-TERM POLONIUM-MOUSE EXPERIMENT OF BIOLOGICAL AND MEDICAL DIVISIONS QUARTERLY REPORT NOVEMBER, DECEMBER, AND JANUARY"

Finkel, Miriam, Gertrude Hirsh, Donald Gardener, and Ruth McNanis

ANL-4401 pp. 78-95

An analysis has been made of a portion of the data that are being collected on the long-term toxicity of intravenously administered polonium chloride. The experiment involves 720 CF-1 female mice including controls. At 280 days the unquestionable deleterious effects of 0.027 to 0.008 mc/g and possible adverse effects of 0.004 mc/g on survival, body weight, intestinal infection, spleen weight, and white blood cell count were evident. Changes in the x-ray appearance of the long bones appeared in animals that recieved as little as 0.0009 mc/g and

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osteogenic sarcomas occurred in two animals that were given only 0.00046 mc/g.

"INVESTIGATION OF POLONIUM IN URINE"

Thorburn, R. C.

HW-12217 November 17, 1948 Secret

"A SERIAL STUDY OF PATHOLOGICAL AND HEMATOLOGICAL EFFECTS OF INTRAVENOUSLY INJECTED POLONIUM IN RATS"

Casarett, George W.

UR-42 November 4, 1948 Secret 70 p.

Effects from a single injection of 10 or 20 microcuries per kilogram of body weight; rats sacrificed and autopsied at eleven different periods; effects upon organs; peripheral blood, semen, lymphatic tissues, bone marrow, testes, femur, kidneys, etc.

"STUDIES ON THE METABOLISM OF POLONIUM IN EXPERIMENTAL ANIMALS AND LONG-TERM CHRONIC EXPOSURE OF ANIMALS TO RADIOACTIVE MATERIALS"

Stanndard, J. N. and J. B. Hursh

UR-39 July 28, 1948 Secret

A serial pathology experiment is being undertaken in which rats received 1, 5, and 10 mc/kg of polonium chloride intravenously and sacrificed over a period of 1½ years depending on developments. In addition to the gross and microscopic pathology, hematological changes and the polonium content of tissues at sacrifice are being determined routinely. It is believed that the lowest dosage employed in this series is below the critical level for biological significant effects of Po on the total white cell count. Data extended up to 90 days after injection indicated that, in general, the distribution is comparable percentage-wise to that following administration of higher dosages. One exception appears in the red blood cells which showed some tendency to contain relatively more of this material than in previous studies and possibly also to accumulate it with time.

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"PRELIMINARY REPORT ON THE METABOLISM OF POLONIUM"

University of Rochester

M-1529 Secret

Essentially quantitative methods were developed for isolation and measuring polonium from tissues and excreta. A perchloric and nitric acid digestion was followed by chemical deposition on silver foil. Following a single subcutaneous sublethal dose (22.8 mc/kilo) of Po as the chloride, an adult female rat excreted 0.05% of the dose in the urine in the first 24 hours. Thereafter, the urinary excretion fluctuated about the value of 0.02% of the dose daily for 24 days. The excretion in the feces was in general about 50 times as high as the urine, most of the values fluctuating near 1.0% of the dose per day. In neither case was there any pronounced drop in the rate of excretion to ward the end of the twenty day period. A second adult male rat with approximately the same dose administered intravenously, has shown approximately double the above rate of excretion in urine and feces for the first 9 days. Examination of the tissues of the rat, sacrificed after 20 days, showed the kidney and spleen retaining several times more Po/gram than other tissues. Bone marrow per gram had about 5% of the Po content of kidney. Bone/gram had about 8% of Po content of kidney. From the body of the rat 52% of the injected dose was recovered. In the feces 20.5% and in the urine 6% of the injected dose was found. Total recovery was 73.6% of the injected dose. This suggests that at least in the rat the skin and lungs do not play the predominant role as organs of excretion that have been ascribed to them in the rabbit. The much greater amount of Po found in the kidney, as compared with that found in bone marrow is consistent with previously reported work indicating that kidney damage has an importance comparable with blood changes in producing death from Po injection.

"MONTHLY PROGRESS REPORT"

Hursh, J. P.

M-1985 July 21, 1947 Secret

Excretion of Po.

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"MONTHLY PROGRESS REPORT"

Hursh, J. P.

M-1973 June 19, 1947 Secret

Excretion of Po.

"MONTHLY PROGRESS REPORT FOR MARCH, 1947 PART II"

Hursh, J. P.

M-1960 March, 1947 Secret

Excretion of Po.

"BIOLOGICAL STUDIES WITH POLONIUM, PLUTONIUM AND RADIUM"

Fink, Robert M.

AECD-2593 January 1, 1947 Declassified

Part III. Intravenous lethal dose of polonium, plutonium and radium.

"BIOLOGICAL STUDIES WITH POLONIUM, PLUTONIUM AND RADIUM"

Fink, Robert M.

AECD-2605 January 1, 1947 Declassified May 18, 1947

"PROGRESS REPORT FOR MONTH OF JUNE 1946"

Hamilton, Joseph G. (UCRL)

P-721 June 30, 1946 Secret 9 p.

Metabolic properties of plutonium and allied materials.

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"INHALATION OF VOLATILIZED POLONIUM BY RATS"

Kimball, C. P., and R. M Fink

M-1811 December 20, 1945 Secret

Rats were exposed to air laden with Po (presemably as the oxide) evaporated from electrically heated nickel foils. Two types of experiment were carried out for the purpose of estimating the amt. of Po lodged in lungs and upper respiratory tract after inhalation of air containing a known concentration of volatilized Po, but neither type was wholly satisfactory. The first type, allowing the rat to breathe from an airstream into which Po was getting volatilized, did not permit direct measurement of the amount of air actually inhaled by the rat. This introduced considerable uncertainty as to the actual percentage of the inhaled Po which was deposited in the rat, but did give an approximate value for the percentage. The second type of experiment, making the rat inhale through one nostril and exhale with the other, was theoretically better, but many technical difficulties were encountered which resulted in the complete failure of a high proportion of the experiment. The data outlined indicate that (1) a large proportion (probably over 30% and perhaps in some cases approaching 100%) of the vaporized Po inhaled by a rat is retained in the lungs, (2) most of the Po captured by the lungs is absorbed into the blood stream, giving essentially the effect of an intravenous injection and (3) sufficient Po may be retained in the lungs for a prolonged period to produce direct effects in that organ.

"HEALTH DIVISION AND BIOLOGICAL SECTION OF RESEARCH DIVISION"

Werth, J. E. and K. Z. Morgan, H. J. Curtis

CH-2597 March 15, 1945 Secret

Polonium Problem.

"PROGRESS REPORT ON THE METABOLISM OF POSTUM"

Fink, R. M. (University of Rochester)

M-1551 September 21, 1944 Secret

Polonium.

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"UNEQUAL PERMEABILITY OF DIFFERENT ORGANS OF DIFFUSION FOR POLONIUM"

Cotelle, Sonia and A. Lacassagne

Compt. Rend. Soc. Biol., 129 1938 pp. 248-50

Po compds. are absorbed to only a very slight extent from the digestive tract. When a very small amt. is given parenterally in the mouse it diffuses readily through the kidneys and mammary glands into the urine or milk, but does not through the placenta into the fetus. More is retained in the liver than in the kidneys and spleen.

"BIOLOGICAL STUDIES WITH POLONIUM, RADIUM, AND PLUTONIUM"

Fink, Robert M.

National Nuclear Energy Series VI-3

Including distribution and excretion of polonium, distribution and excretion of radium and toxicity of solonium, plutonium, and radium in rats.

"LOCALIZATION OF POLONIUM IN THE ORGANISM DEPENDENT ON THE NATURE OF THE SOLUTION INJECTED"

Lacassagne, A. and M. Servigne

J. Pharm. Chim. 21 1935 pp. 145-51

Previous results as to the localization of Po in the various organs of the rabbit after injecting aq. solns. of Po are verified. However, when aq. solns. are replaced by oil solns. of an equal no. of units of Po regardless of its chem. linkage, the lungs retain a much larger quantity of Po after injection of an oily than an aq. soln. With aq. injection examn. of the urine shows rapid max. elimination of Po at first; with oil injection elimination is more uniform; toxicity is also diminished when oil solns. are injected.

"BIOLOGICAL EFFECTS OF POLONIUM"

Lacassagne, A. and J. Lattes, J. Lavedam (trans. M. Nickson)

N-1911 (CH) Restricted
J. de Radiologie et d'electrologie, 9 1925 pp. 1-14, 67-82

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"PRELIMINARY REPORT ON THE METABOLISM OF POLONIUM"

University of Rochester

M-1529 Secret

Development of quantitative methods for isolating and measuring polonium from tissues and excreta.

MONITORING, HANDLING, AND DECONTAMINATION

"OPERATIONAL PROBLEMS ASSOCIATED WITH BISMUTH AND LITHIUM AS COOLANTS"

Cornett, Varge

NEPA 1232 December 7, 1949 Secret

Includes stress on hazard from polonium.

"LIQUID METAL-COLLED, BERYLLIUM MODERATED REACTORS FOR NAVAL APPLICATION"

Argonne National Laboratory

ANL-4312 July 1, 1949 Secret

Includes Po hazards and handling.

"RULES AND PROCEDURES FOR RADIOLOGICAL SAFETY; FINAL REPORT"

Naval Radiological Defense Laboratory

AD-136 (H) April, 1949 Unclassified 48 p.

This manual consists of 2 parts: Section I gives general rules and procedures concerning radiological hazards; Section II contains a glossary of terms and specific information on various procedures pertaining to handling radioactive materials.

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"REMOVAL OF ACTIVITY FROM EFFUENT (SOME EXPERIMENTS ON THE USE OF TANNIC ACID AND LIME)"

Smales, A. A. and L. Airey

AEERE-C/R-289 December, 1948 Confidential

Experiments are described which showed that a simple treatment of tap water with tannic acid followed by lime water to ph 7.5 will remove 98-100% of the α activity due to added U, Pu or Po whereas in the absence of tannic acid very little U is removed.

"THE APPLICATION OF TYPE AND FILTER PAPER FOR THE REMOVAL OF AIRBORNE CONTAMINATION RESULTING FROM THE PROCESSING OF PO."

Endebrock, R. (Monsanto)

M-4090 April 18, 1947 Secret

"THE REMOVAL OF POLONIUM FROM SURFACES AT ELEVATED TEMPERATURES"

Nichols, M., J. Payne, E. M. Larren, J. J. Burbage

M-4179 July 31, 1946 Secret

"HEALTH SAFETY REPORT; CHEMICAL AND METALLURGICAL DIVISION"

Popham, R. A. (Los Alamos)

LAMS-108 June, 1944 Secret 5 p.

Work of safety committee relative to radiation monitoring equipment; radiation levels; hand decontamination.

"PROGRESS REPORT, MAY 1-15"

Monsanto Chemical Company - Dayton

M-2817 1944 Secret 39 p.

Po production research; separation of Po from wastes, sample techniques

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for alpha counting; hand decontamination.

"CHEMISTRY DIVISION. SEMI-MONTHLY REPORT FOR PERIOD ENDING FEBRUARY 29, 1944"

Johnson, W. C., and Associates (Clinton Laboratories)

CN-1296 February 29, 1944 Secret (Limited)

Separation studies; oxidizing agents; isolation and purification of Pu; detection of Po; effect of radiation on water; fission product analysis; adsorption; etc.

"HEALTH REPORT"

Hempelmann, Louis (Los Alamos)

LAMS-67 February 25, 1944 Secret 6 p.

Includes safety requirements for handling polonium.

"THE STORAGE OF POLONIUM SOLUTIONS"

Rosenblum, Charles and E. W. Kaiser

J. Phys. Chem, 39 1935 pp. 797-801

The use of glass vessels for the storage of Po solns. is undesirable. A coating of paraffin eliminates the disturbing radiocolloid effect of Po in soln. Po solns. of 0.00059 N concn. in HNO_3 can be used as a radioactive indicator for more than 1 week stored in paraffined vessels. More concd. solns. can be used for a longer time.

"THE PENETRATING RADIATION OF POLONIUM"

Blau, Marietta and Elisabeth Kara Michailova

Sitzber Akad. Wiss. Wien Math-naturw Klasse Abt.II a 140 1931 pp. 615-22

A lead shield 3 cm thick between counter and prepn. gave an intensity decrease of 90.1% radiation.

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"CHEMISTRY AND METALLURGY HEALTH HANDBOOK OF RADIOACTIVE MATERIALS"

Aebersold, P. C., and L. H. Hempelmann, W. H. Hinch, J. C. Hoffman, W. L. Longham, J. F. Tribly

LA-391 (CN-H Limited) Secret

Pu, Po and U toxicology and protection procedure, radiation monitoring instruments, etc.

"INTERNAL RADIATION HAZARD IN INDUSTRY FROM USE OF POLONIUM IN STATIC ELIMINATION DEVICES"

Bryan, Fred A. and Louis B. Silverman

UCLA-18 AECU 343

"PROGRESS REPORT MARCH 1-15"

Monsanto Chemical Company - Dayton

M-2813 1944 Secret 20 p.

Covers Po production research (Keln Process, Bismuth Process); Po plating (thermal deposition, electrolytic); hand decontamination.

TOLERANCE

"PRESENT STATUS OF POLONIUM TOLERANCE ESTIMATES"

Hursh, J. B. and J. N. Stannard

UR-44 October 14, 1948 Secret

This report contains a summary of biological information on distribution, excretion and toxicity of Po; a comparison of results obtained when maximum permissible exposure rates for man are calculated from available data by different methods; and critical evaluation of the present status of Po tolerance estimates. A maximum permissible body content of the order of 0.2 mc/70 kg. man is obtained by 2 methods.

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Applying an urinary excretion rate of 0.1% of body content/days, effective half life of 34 days, and certain corrections for the non-exponential nature of Po excretion, maximum permissible air and water concentrations and urinary excretion rates have been computed. Extrapolation from present data to calculations of tolerance levels in man is still difficult, and there appears to be no substitute for actual long term experiments. On the other hand, permissible exposure levels quoted in the report appear to a large extent, consistent with conservative practice.

"TOLERANCE AND PERMISSIBLE CONCENTRATION OF POLONIUM IN THE WATER AND AIR"

Morgan, K. Z.

M-4207 October 6, 1945 Secret

The formula used in calculation found in CH-2801. It would seem that the tolerance concentration of polonium in water should be 10^{-8} m gm/cc ($= 4.3 \times 10^{-5}$ mc/cc = 100 dis/min/cc water) and the tolerance concentration of polonium in air should be 10^{-13} m gm/cc ($= 4.5 \times 10^{-10}$ mc/cc = 1000 dis/min/cu. meter of air) for continuous consumption.

"SUMMARY OF STUDIES ON THE PHYSIOLOGICAL BEHAVIOR OF POLONIUM"

Silberstein, H.

M-1519 June 1945 Secret

Tolerance data, distribution of injected Po in rabbits, and elimination of injected Po from rabbits are discussed. 6 references.

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