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REPOSITORY DOE-OHRE

COLLECTION PLUTONIUM INJECTION

BOX NO. 1

FOLDER Center for Human Radiobiology (40-005)

ARGONNE NATIONAL LABORATORY
9700 South Cass Avenue, Argonne, Illinois 60439

Telephone: 312-972-7678

February 27, 1986

Dr. Robert G. Thomas
ER-72
GTN
Mail Stop G236
U.S. Department of Energy
Washington, D. C. 20545

Bob

Dear Dr. Thomas:

With respect to your telephone inquiry relating to plutonium studies in the Environmental Health Section (previously Center for Human Radiobiology), I refer you back to the factsheet furnished Dr. Thiessen in 1984 (copy enclosed).

I had follow-up completed on cases Cal-III and HP-6. Case Cal-III died in 1984 of causes not reasonably relatable to plutonium. Case HP-6 is living as of several days ago. Both the interviewer who contacted the household, and a review of the case file, suggest that the functioning of this subject is such that direct contact is contraindicated. I hope this is of some assistance to you.

Best personal wishes.

Sincerely yours,

James H. Stebbings, Sc. D.
Epidemiology Group Leader

JHS:llf

Enclosures

cc w/enc.: H. Drucker, BIM
E. Huberman, BIM
D. T. Goldman, DOE-CH

8000525

YU-005

ARGONNE
NATIONAL
LABORATORY

INTRA-LABORATORY MEMO

November 27, 1985

TO: E. Huberman

FROM: R. A. Schlenker RAS

SUBJECT: Freedom of Information Act Request

We have been unable to locate the memo from Rowland to Schultz dated December 21, 1972 which you requested about 5:15 p.m. yesterday following the receipt of a letter from D. T. Goldman to A. Schriesheim concerning this matter. As today is the last business day before the deadline, December 2, further search is not possible without missing the deadline. Locating this memo is complicated by the fact that Rowland retired about two years ago and Schultz is dead.

Other intra-laboratory memos on the 18 plutonium research subjects referred to in the Goldman letter, mention them by name and give personal information about them. The release of such documents would be a violation of the patients' privacy and the right-to-privacy is protected by law. It would also constitute a violation of normal ethical practice in the handling of patient medical records.

The subjects referred to have been studied by several organizations since the mid 1940s. Non-personal information can be found in the scientific literature. A good review and guide to the literature up to the time of its publication can be found in Patricia W. Durbin, "Plutonium in Man: A New Look at the Old Data," pp.469-530, Radiobiology of Plutonium, Edited by Betsy J. Stover and Webster S.S. Jee, Published by the J. W. Press, Department of Anatomy, University of Utah, Salt Lake City, 1972.

lw

DEC 04 1985

8000526

Chi - II
(WX-300)

PRIVACY ACT MATERIAL REMOVED

MICROFILMED

Name

Hospital No. 377183

Path 6670

Date of birth

Date of injection Dec. 27, 1945

$^{239}Pu(VI.)$ citrate

Age at injection 55

SHOP CODED

1977

Date of death Jan 13, 1946

Age at death

Time after injection - 17 days

Death certificate No

PRIVACY ACT MATERIAL REMOVED

8000527

CENTER FOR HUMAN RADIOBIOLOGY

Please reply to:
Southwest Field Station
M.I.T. Radioactivity Center
5619 E. Monterosa Street
Phoenix, Arizona 85018
Tel. 602-949-5600

September 11, 1973

PRIVACY ACT MATERIAL REMOVED

MEMO TO: Jan Lieben, M.D.

F R O M: Mary Margaret Shanahan

SUBJECT: 40-005

We have checked with the undertaker (and Service, Inc.) re but with little or no success. The same applies to the Cemetery - they had a fire some time in the past and they are not sure whether they still have any record on . They agreed to look and let us know.

Today I called telephone information in Ohio and obtained the following information:

In Dayton, Ohio (was employed by the of):

In Cincinnati, Ohio (she and her father were born there):

This actually lives in Fort Thomas, just across the river from Cincinnati.

We will also check with the Dayton Board of Education and let you know what we learn.

s
xc: M.H.Chalfen
A.F.Stehney

PRIVACY ACT MATERIAL REMOVED

8000528

ARGONNE
NATIONAL
LABORATORY

PRIVACY ACT MATERIAL REMOVED

INTRA-LABORATORY MEMO

Rec'd May 31, 1973

TO: CHR Records Room

FROM: J. Lieben, M.D.

SUBJECT: Sisters

May 28, 1973:

Drove to , Chatham, New Jersey. Met and obtained his and his sister's signature for exhumation of the sisters.

Drove to , Chatham, to obtain signature of . House locked up — left request and forms in mailbox to be mailed to me.

Called and in Orange, New Jersey — nobody home.

Phone calls - May 23, 1973:

Called re exhumation of . "My son wants to talk to you, go and visit him."

Re — called , Cemetery Superintendent (2 calls), Oak Ridge Cemetery, Westchester, 312/ . "On the cremation permit there is a sister listed — , , LaGrange, but we have no ashes. In accordance with instructions, they were scattered in 1945."

JL/jt

cc: A. M. Brues
M. S. Littman
M. M. Shanahan
A. F. Stehney
J. E. Farnham

PRIVACY ACT MATERIAL REMOVED

8000529

ANL-26 (11-68)

ARGONNE NATIONAL LABORATORY

PRIVACY ACT MATERIAL REMOVED

MICROFILMED

INTRA-LABORATORY MEMO

Received - May 23, 1973

SNOP CODED

MAR 4 1977

TO: CHR Records Room

FROM: Jan Lieben, M.D.

SUBJECT: Phone calls and contacts

5-14-73 (1) Re: _____ . Called Chicago information to locate _____ or _____, on _____ Ave., according to my 1971 records, no number listed.

(2) Called _____ in Moberly, Mo., _____ to ask for above number, does not know, will ask my sister, call me back tomorrow.

5-15-73 (3) Called _____ no did not get my sister, you better call her yourself. _____, Moberly _____. Maybe the _____ lived in Blue Island, Illinois.

(4) Called information at Blue Island, no _____ listed.

(5) Made 3 calls to _____ in Loganport, Indiana, nobody home.

(6) Three more calls for _____.

(7) Called _____, see above. She last heard from the _____ four years ago and then their address was _____ Ave., Chicago 60648 (the address we had before) but no phone available.

5-19-73 (1) Drove to _____ to look for _____. A _____ opened the door and informed me that he knew all about Dr. John. _____ is not at home, is only there on Wednesday, stays with her daughter in Mt. _____ phone _____ on Osceola the phone is _____ He did not think she would sign since it would disturb the rest of the family. He said he was a friend of the family.

(2) Re: _____ - Called home of the only _____ Wm. listed in the phone book, wife says she doubts that he is related, is out playing golf.

(3) Went to Oak Ridge Cemetery, spoke to office girl. Superintendent John Westerberg said I have to go through my archives, call me during the week, 312/626-4200.

(4) Went to Hallowell Funeral home 1706 Jackson Blvd., no we don't have records this far back, our place changed hands 10 years ago.

dk

cc: A. M. Brues, M.D.
M. M. Shanahan
M. S. Littman, M.D.
A. F. Stehney

8000530

PRIVACY ACT MATERIAL REMOVED

NL-26 (11-68)

ARGONNE NATIONAL LABORATORY
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PRIVACY ACT MATERIAL REMOVED

CENTER FOR HUMAN RADIOBIOLOGY

Argonne National Laboratory • Massachusetts Institute of Technology • New Jersey Field Station • Southwest Field Station

TO: M. M. Shanahan MIT Radioactivity Center

FROM: A. F. Stehney RER Division

SUBJECT: Exhumation of CHR cases with prefix number 40.

Enclosed are folders containing copies of all CHR information on ten radioactivity patients in the "40" series. These are all the cases in this series for which we now have death certificates.

Please take the necessary steps to locate relatives and obtain permissions to exhume any or all of these ten persons. It should be noted that we want to examine the remains in order to determine the microscopic distribution of residual radioactivity from past medical treatment.

Date

A. F. Stehney, Deputy Director
Center for Human Radiobiology

Today, I received from A. F. Stehney copies of folders for the following ten CHR cases:

40-001	40-005	40-008	40-011	40-015
40-004	40-007	40-010	40-013	40-017

Date

M. M. Shanahan, Deputy Director
MIT Radioactivity Center

dk

cc: R. D. Evans
R. E. Rowland
CHR Records Room

PRIVACY ACT MATERIAL REMOVED

8000531

CENTER FOR HUMAN RADIOBIOLOGY
9700 S[illegible] Avenue, Argonne, Illinois 60439 Tel. 312-739-7[illegible] Ext. 4625

Orig.: Purch. Dept.
cc: R. E. Rowland
A. F. Stehney

PRIVACY ACT MATERIAL REMOVED

CENTER FOR HUMAN RADIOBIOLOGY

January 2, 1973

Mr. Leo A. Ozier
Chief, Office of Vital Records and
Deputy State Registrar
Springfield, Illinois 62706

Dear Mr. Ozier:

We would like very much to have you search the death records of Illinois for the two names below. We do not have the residential addresses, but hope that you can locate the records from the information we do have.

(Female)
Date of Birth: about
Date of Death: 13 January 1965
(Place of Death: Billings Memorial Hospital, Chicago)
(Occupation: High School Teacher)

Date of Birth: about
Date of Death: 3 October 1965
(Place of Death: Billings Memorial Hospital, Chicago)
(Occupation: Machinist)

Again, I am asking that the scientific search fee of $1.00 per name be sent in advance. Please send the results of your search to my personal attention, at the address at the bottom of the page.

Many thanks for your continuing cooperation.

Very truly yours,

PRIVACY ACT MATERIAL REMOVED

Harvey A. Schultz
Curator of Records
Center for Human Radiobiology

dlt

8000532

RADIOLOGICAL AND ENVIRONMENTAL RESEARCH DIVISION, ARGONNE NATIONAL LABORATORY
9700 South Cass Avenue, Argonne, Illinois 60439 Telephone 312-739-7711

AERS-29A (10-72)

CORRESPONDENCE

[redacted]

8000533

40-005

ARGONNE NATIONAL LABORATORY
9700 South Cass Avenue, Argonne, Illinois 60439
Telephone 312/972-4146

July 23, 1984

Dr. Jacob Thiessen
Mailstop E-201, Human Health Studies
Office of Health and Environmental Research
Office of the Environment
U.S. Department of Energy
Washington, D. C. 20545

SUBJECT: Congressional Investigation into Health and Safety Policies of the Department of Energy (DOE)

Dear Dr. Thiessen:

In response to Dr. C. W. Edington's memorandum of June 27, 1984, on the above subject, I have enclosed a factsheet on "Plutonium Studies at the Center for Human Radiobiology (CHR)." The factsheet is in the format requested by Dr. Edington.

Please let me know if you need more information or documentation.

Sincerely yours,

A. F. Stehney
Environmental Research Division

AFS:pat
Enclosures

cc: H. Drucker
H. J. Rauch
P. Failla
P. F. Gustafson
E. Huberman
J. Rundo

Project Name:
Plutonium Studies at the Center for Human Radiobiology (CHR)

Date Started: 2 January 1973
Date Terminated: Ongoing

Principal Investigators: R. E. Rowland, A. F. Stehney

Objectives of Test:

1. To determine the excretion rate of plutonium 27 years after injection.
2. To determine the retention and body distribution of plutonium.

Short Description:

In 1945-1947, 18 hospital patients of limited life expectancy were injected with plutonium in order to obtain information about the retention and organ distribution of plutonium. An important objective was to determine the relationship between the body content and the rate of excretion in order to provide data for estimating the body content of plutonium from measurements of plutonium in excreta (bioassay). The results of this study were described in Report LA-1151 (1950).[1]

The data in LA-1151 were reviewed in a manuscript prepared by P. W. Durbin for publication in the 1972 volume, Radiobiology of Plutonium.[2] Tissue and bone samples had been obtained at autopsy from six of the cases at times ranging from 5 days to 456 days after injection, and the longest collection time for excreta was about 5 years. In addition to preparing the manuscript, Durbin traced the later history of the cases and discovered that four were still living in 1972.

The Center's direct knowledge of the plutonium injection cases dates from December 13, 1972, when Dr. Durbin brought her records to CHR for possible further follow-up. The Center then undertook to determine excretion rates in study subjects who were still alive and to exhume deceased subjects in order to determine the amounts and body distribution of plutonium. During 1973, CHR obtained metabolism samples from three living patients, obtained permission to exhume from next of kin of three deceased patients, and disinterred and transferred to CHR the remains of one of these deceased. The metabolism samples (blood and excreta) were taken at Strong Memorial Hospital (SMH), Rochester, New York.

In 1974, the U.S. Atomic Energy Commission (AEC) reviewed the origins and subsequent follow-up of the plutonium studies. On December 31, 1974, the AEC authorized CHR to proceed with the program of study of the living patients who were injected with plutonium during 1945-1947 and of the bodies of deceased individuals from that group for whom legal consent for examination is obtained.

Follow-up Data:

Table 1 summarizes CHR follow-up activities and last known status (July 5, 1984) for each of the plutonium injection cases.

CHR personnel have published 10 reports on results obtained by study of these cases.[3-12] Copies of these reports are attached.

Table 1. Plutonium injection cases: Summary of CHR activities and last known status (July 5, 1984).

Old Case Number	CHR Case Number	CHR Activities	Status
Cal-I	40-001	10/16/75: Exhumed cremains Aug 78: Returned	Died 1/9/66
Cal-II	40-002	No contacts; said to have died in Australia	Died 1/6/47
Cal-III	40-003	6/11/73: Examined at CHR 6/23-26/77: Metabolism study at SMH	Living 10/19/83
Chi-1	40-004	6/10/75: Exhumed Apr 78: Returned	Died 10/3/45
Chi-2	40-005	No contacts; cremation ashes scattered	Died 1/13/46
Chi-3	40-006	No contacts; case unidentified	Lost to study, 1946
HP-1	40-007	1973: Next of kin refused permission to exhume	Died 1/12/60
HP-2	40-008	1973: Next of kin refused permission to exhume	Died 4/4/48
HP-3	40-009	1/28-2/18/73: Metabolism study and radioactivity measurement at SMH 1/23-24/79: Metabolism study at SMH	Died after 6/5/81
HP-4	40-010	9/24/73: Exhumed Jul 75: Returned	Died 4/29/47
HP-5	40-011	1973: Next of kin refused permission to exhume	Died 4/29/46
HP-6	40-012	2/14/73: Metabolism study at SMH 6/21-7/1/73: Metabolism study at SMH	Living 12/30/74
HP-7	40-013	1973 and 1977: Next of kin refused permission to exhume	Died 10/27/46
HP-8	40-014	No contacts	Died 11/22/75
HP-9	40-015	5/18/78: Exhumed Jul 81: Returned	Died 7/2/47
HP-10	40-016	No contacts	Died 6/2/57
HP-11	40-017	No contacts	Died 2/26/46
HP-12	40-018	No contacts	Died 4/13/53

References:

1. W.H. Langham, S.H. Bassett, P.S. Harris and R.E. Carter. Distribution and excretion of plutonium administered to man. Los Alamos Scientific Laboratory, LA-1151 (September 1950).

2. P.W. Durbin. Plutonium in man: a new look at the old data. In The Radiobiology of Plutonium, B.J. Stover and W.S.S. Jee (eds.), The J.W. Press, Salt Lake city, UT, pp. 469-537 (1972).

3. J. Rundo, P.M. Starzyk, J. Sedlet, R.P. Larsen, R.D. Oldham and J.J. Robinson. The excretion rate and retention of plutonium 10,000 days after acquisition. In Diagnosis and Treatment of Incorporated Radionuclides, Proc. Seminar, Vienna, 8-12 December 1975, IAEA, Vienna, pp. 15-22 (1976).

4. R.E. Rowland and P.W. Durbin. Survival, causes of death, and estimated tissue doses in a group of human beings injected with plutonium. In The Health Effects of Plutonium and Radium, Proc. Symp. Sun Valley, Idaho, 6-9 October 1975, W.S.S. Jee (Ed.), The J.W. Press, Salt Lake City, UT, pp. 329-342 (1976).

5. R.A. Schlenker, B.G. Oltman, and H.T. Cummins. Microscopic distribution of ^{239}Pu deposited in bone from a human injection case. In The Health Effects of Plutonium and Radium, Proc. Symp. Sun Valley, Idaho, 6-9 October 1975, W.S.S. Jee (Ed.), The J.W. Press, Salt Lake City, UT, pp. 437-450 (1976).

6. J. Rundo and F.H. Ilcewicz. Blood content and excretory plasma clearance of plutonium 10^4 days after injection. Abstracts of Papers-22nd Ann. Mtg. Health Phys. Soc., Atlanta, 3-8 July 1977, Pergamon Press, NY, p.26 (1977); Health Phys. 33, 668 (1977).

7. R.E. Rowland. The risk of bone sarcoma from plutonium-239. In Biological Implications of Radionuclides Released from Nuclear Industries, Proc. Symp., Vienna, 26-30 March 1979, Vol. II, IAEA, Vienna, pp. 211-224 (1979).

8. R.P. Larsen, R.D. Oldham, and R.E. Toohey. Macrodistribution of plutonium in the human skeleton. In Actinides in Man and Animals, Proc. Snowbird Actinide Workshop, 15-17 October 1979, M.E. Wrenn (Ed.), RD Press, Salt Lake City, UT, pp. 191-197 (1981).

9. J. Rundo. The late excretion of plutonium following acquisition of known amounts. In Actinides in Man and Animals, Proc. Snowbird Actinide Workshop, 15-17 October 1979, M.E. Wrenn (Ed.), RD Press, Salt Lake City, UT, pp. 253-260 (1981).

10. R.A. Schlenker and B.G. Oltman. Plutonium microdistribution in human bone. In Actinides in Man and Animals, Proc. Snowbird Actinide Workshop, 15-17 October 1979, M.E. Wrenn (Ed.), RD Press, Salt Lake City, UT, pp. 199-206 (1981).

11. R.A. Schlenker and B.G. Oltman. Uranium concentrations in human bone. In Actinides in Man and Animals, Proc. Snowbird Actinide Workshop, 15-17 October 1979, M.E. Wrenn (Ed.), RD Press, Salt Lake City, UT, pp. 473-476 (1981).

12. R.E. Toohey, C.G. Cacic, R.P. Larsen, and R.D. Oldham. The concentration of plutonium in hair following intravenous injection. Health Phys. 40, 881-886 (1981).

Attachments:
Reprints of references 3-12 are attached.

40-005

Department of Energy
Argonne Area Office
9800 South Cass Avenue
Argonne, Illinois 60439

NOV 21 1985

Dr. Alan Schriesheim, Director
Argonne National Laboratory
9700 S. Cass Avenue
Argonne, Illinois 60439

Dear Dr. Schriesheim:

SUBJECT: FREEDOM OF INFORMATION ACT (FOIA) REQUEST DATED OCTOBER 30, 1985, DOCKET NO. 11048504D

The enclosed FOIA request is for a copy of a memo from R. E. Rowland to H. A. Schultz dated December 21, 1972, which discusses records of 18 plutonium research subjects. The requestor is also asking for any supporting documentation and any subsequent memos regarding the subject.

Due to statutory time limitations for responding to FOIA requests, we must have your response no later than December 2, 1985.

Sincerely,

Thomas J. Balcerak

for David T. Goldman
Area Manager

Enclosure:
As Stated

cc: A. Zilberstein, ANL, w/enclosure
R. E. Rowland, Princeton, KY, w/enclosure 502-365-2979
[redacted]

DEC 04 1985

8000539

40-005

THE KNOXVILLE JOURNAL

A GANNETT NEWSPAPER
P.O. BOX 911
KNOXVILLE, TENNESSEE 37901

1985 NOV -4 PM 3:39

Oct. 30, 1985

Mr. Ronald Turner
MA-232.1
U.S. Department of Energy
Freedom of Information and Privacy Act Branch
1000 Independence Ave. S.W.
Washington, D.C. 20585

To the FOI Officer:

This request is made under the federal Freedom of Information Act, 5 U.S.C.'552.

Please send me copies of Memorandum, dated 12-21-72, from Dr. R.E. Rowland to H.A. Schultz, senior staff assistant, Records and Data Processing, Center for Human Radiobiology, Argonne National Lab. Memo discusses instructions from Rowland to Schultz on records of 18 plutonium research subjects. Records were transferred to Schultz for his disposition. Please include any supporting documentation and any subsequent memos regarding this subject.

As you know, the FOI Act provides that if portions of a document are exempt from release, the remainder must be segregated and disclosed. Therefore, I will expect you to send me all nonexempt portions of the records which I have requested, and ask that you justify any deletions by reference to specific exemptions of the FOI Act. I reserve the right to appeal your decision to withhold any materials.

I promise to pay reasonable search and duplication fees in connection with this request. However, if you estimate that the total fees will exeed $50, please notify me so that I may authorize expenditure of a greater amount.

I am prepared to pay reasonable search and duplication fees in connection with this request. However, the FOI Act provides for waiver or reduction of fees if disclosure could be considered as "primarily benefiting the general public." I am a journalist employed by The Knoxville Journal and intend to use the information I am requesting as the basis for a planned article. Therefore, I ask that you waive all search and duplication fees. If you deny this request, however, and the fees will exceed $50, please notify me of the charges before you fill my request so that I may decide whether to pay the fees or appeal your denial of my request for a waiver.

As I am making this request as a journalist and this information is of timely value, I will appreciate your calling me by telephone, rather than by mail, if you have any questions. Thanks and I will look forward to your reply within 10 business days, as required by law.

Sincerely,

Randell L. K, reporter
(615) 522-4141, Ext. 423

DEC 04 1985

0h50008

40-005

DOE F 1325.8
(7-78)

U.S. DEPARTMENT OF ENERGY

memorandum

DATE November 12, 1985

REPLY TO ATTN OF MA-232.1 – Joan Ogbazghi

SUBJECT Freedom of Information Request #1104850

TO Jane Monhart, CH Operations Office

Attn Bernie Russ

The attached Freedom of Information (FOI) request is being sent to you for action as the records requested appear to be principally within the purview of your organization. If our determination is incorrect, please inform me immediately to whom you are forwarding this request.

If other divisions, offices or field organizations also have records relevant to this request, you as the appropriate FOI Office are responsible for requesting their participation and for coordinating the response. It is important that an appropriate response be forwarded to the requester within 10 working days as failure to act can be deemed a denial.

On the reverse side of this memorandum, a "Reminder of Procedures for Handling FOI Requests" should assist your staff. If you have any questions, I can be reached on FTS 252-5955.

John H. Carter
Chief of FOI and Privacy Acts
Activities Branch
Division of Reference and
Information Management

Attachment

DEC 04 1985

8000541

40-005

November 14, 1985

Mr. Randall Beck
The Knoxville Journal
P.O. Box 911
Knoxville, TN 37901

Re: 1104631050
1104685070
1104625080
1104685220

Dear Mr. Beck:

Your October 30, 1985, Freedom of Information requests (copies enclosed) addressed to the U.S. Department of Energy were received on November 4, 1985, and have been sent to our Freedom of Information Officers at our Chicago, Oak Ridge, Richland and San Francisco Operations Offices. They will correspond directly with you about your requests.

In compliance with the Freedom of Information Act, the 10 day response period will begin when the offices designated above have received your requests. If you need further assistance, please contact Jane Monbart, Chicago Operations Office, 9800 South Cass Avenue, Argonne, IL 60439, (312) 972-2076; Wayne Range, Oak Ridge Operations Office, P.O. Box E, Room 1012, Oak Ridge, TN 37831, (615) 576-0885; Gail M. Bobkan, Richland Operations Office, 825 Jadwin Avenue, P.O. Box 550, Richland, WA 99352; (509) 376-8274; Elsie Mutobo, San Francisco Operations Office, 1333 Broadway, Wells Fargo Building, Oakland, CA 94612, (415) 273-4358.

We have assigned the above referenced numbers to your requests and ask that you refer to these in any future correspondence.

Sincerely,

Original signed by John H. Carter

John H. Carter
Chief of FOI and Privacy Acts
Office of Administrative Services

cc: Official File Copy
Action Officer &
Official File (RF)
Reading File
MA-232.1:JBO:sjb:26025:11/13/85

DEC 04 1985

8000542

HISTORICAL

8000543

[illegible]

[illegible] were of necessity exposed to some degree to plutonium and [illegible] known to be very radiotoxic it was [illegible] desirable to [illegible] determining whether or not a given person had any plutonium [illegible] [illegible] desirable to be able to [illegible] as accurately as possible [illegible] deposited in any person. Animal experiments were used to [illegible] [illegible] possible. Some human studies were needed to [illegible] to the human problem. Hence, two people were selected [illegible] [illegible] was such that they could not be endangered by injections of [illegible]

I. CASE HISTORIES

Chicago Case #1
RER 12/19/72

[illegible] year old white male was admitted to the Billings Hospital [illegible] [illegible] treatment of a recurrent [illegible] of the [illegible] [illegible] the Billings Hospital in March, 1945 [illegible] [illegible] were limited to the [illegible] in the face [illegible] [illegible] of the [illegible] and contiguous [illegible] of the [illegible] [illegible] ulcerating area approximately [illegible] [illegible] portion of the mandible was exposed in the depth of [illegible] [illegible] of both the [illegible] and the [illegible] [illegible] [illegible] and hard. [illegible] [illegible] [illegible] [illegible]

[illegible] of the chest revealed a [illegible] lesion in the [illegible] [illegible] examinations were [illegible] negative [illegible] [illegible]. The [illegible] and [illegible] were negative. [illegible] [illegible] from the excised tumor were diagnosed as epidermoid [illegible] [illegible] surgery was performed on April 12, 1945 and April 2[illegible], [illegible] at 9:17 AM the patient was given an intravenous injection [illegible] of plutonium as a citrate salt in 0.9 per cent saline [illegible] [illegible] volume of the injection was 0.0[illegible] cc. The patient [illegible] [illegible] August, 1945 when he complained of pain in the chest [illegible] [illegible] of the pulmonary metastases was found. He expired on [illegible]

[illegible] findings were weight, 1[illegible] pounds ([illegible] kg.). An extensive [illegible] [illegible] of the epidermoid carcinoma of the mouth was [illegible] [illegible] carcinomatous invasion of the [illegible] of the [illegible] [illegible]. Bilateral pulmonary metastases were present. [illegible] [illegible] thrombosis, cavitation and abscess formation [illegible] [illegible] bronchopneumonic process in the lower lobe of the [illegible] [illegible] was noted on gross examination of the kidneys. [illegible] [illegible] "a mild focal interstitial nephritis, probably a [illegible] [illegible] are only moderately [illegible] [illegible] degeneration [illegible] marked and a few [illegible] [illegible] casts [illegible]

PRIVACY ACT MATERIAL REMOVED

Chicago Case #2
RER 12/19/72

Case No. 2

A fifty-five year old white female was admitted to the Billings Hospital in December, 1945 for diagnosis and treatment. Six months previously (June, 1945), she had noted generalized lymphadenopathy. Two months later (August, 1945), pain, aggravated on motion, developed in the trunk. On admission to the Billings Hospital in December, 1945 the essential physical findings were the presence of bilateral non-tender, moderately enlarged lymph nodes in the cervical, axillary, and inguinal regions and generalized tenderness to pressure over the ribs. X-ray examination of the chest, pelvis, skull, and spine revealed many small, rounded areas of decreased density scattered throughout the bones examined. In addition, [illegible] collapse and wedging of the last thoracic and first and second lumbar vertebrae with some associated calcification was noted.

[illegible] examinations were essentially negative except for a moderate hypochromic anemia and leukocytosis. [illegible] and [illegible] were negative. Study of sections of the tumor excised from the skull and left axilla revealed carcinoma-[illegible] tissue. It was felt that the carcinoma probably originated in the left breast.

The patient's general condition was poor at the time of admission and deteriorated [illegible] throughout the period of hospitalization. On December 27, 1945 at [illegible] [illegible] micrograms of 4 6 plutonium citrate were injected intravenously. The [illegible] was contained in 4.4 cc of an isotonic saline solution 0.01 M in citrate at pH 6.2. The clinical course was not visibly altered following the injection. The patient expired on January 13, 1945.

The major autopsy findings were: (1) an adenocarcinoma probably arising in [illegible] left axillary breast tissue with metastases to the liver, mesentery of the small intestine, lumbar vertebrae, ribs, skull and pelvis. Numerous healing pathological fractures of the ribs were found. (2) A lymphoblastoma involving the axillary, inguinal, peribronchial, periaortic, and pelvic lymph nodes. Thus the patient had two coexisting presumably independent tumors, an unusual finding. The weight at autopsy was recorded as 85 pounds (38.6 kg.).

Histologically, the bone marrow in all places examined was almost entirely [illegible] by tumor. The spleen showed a marked myeloid metaplasia. The kidneys showed [illegible] convoluted tubules filled with hyaline casts. The tubular epithelium showed [illegible] of degeneration and repair. Comparison of the biopsy sections with the post mortem sections shows no evident difference in the character of the tumor following the injection of plutonium. The cells characteristic of lymphoblastoma are also present in the biopsy sections.

II. METHODS

[illegible] control period in Case I was one week long and was used primarily to [illegible] the approximate daily urinary output available for analytical purposes. [illegible] the control period was somewhat shorter and was used for the same purpose.

In both cases the specimens were collected in the usual urinals and [illegible] material being transferred in the case of the urine, to a gallon bottle [illegible] cc of concentrated hydrochloric acid had been added. The addition of the [illegible] minimize the likelihood of adsorption of plutonium by the container. The [illegible] were transferred to "leak-proof" cardboard containers.

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PRIVACY ACT MATERIAL REMOVED

In Case II because of the condition of the patient, adequate separation of the urine and fecal specimens was not always possible. As a result adequate fecal excretion data could not be obtained.

Hematological studies made at frequent intervals in both cases included: hemoglobin in grams per ml; erythrocytes, leucocytes, platelets per cubic mm; reticulocytes in per cent; leucocyte differential; sedimentation rate (Westergren); and hematocrit reading. Liver function tests were performed in Case II by S. Schmarts using the cephalin flocculation and thymol turbidity tests and bilirubin determinations.

Pathology: The autopsies were performed by members of the Pathology Department of the School of Medicine of the University of Chicago. The specimens were placed in 95 per cent alcohol as experience elsewhere had shown that the usual ten per cent formalin preservative tends to leach plutonium out of the specimen. Insofar as possible the specimens were placed in individual containers.

RESULTS

Case I

Excretion of Plutonium in the Urine: For forty-eight hours following intravenous injection of the plutonium solution, each specimen of urine was collected and analyzed separately. The first voiding was approximately six hours after the injection. The results of the analyses are given in Tables I, II and III and Figure I. It is interesting to note that there is very little difference in the percent of the plutonium excreted in the third through the twelfth specimens though the unit concentration of plutonium in the urine varies widely. After forty-eight hours, the specimens voided in each 12 hour period were pooled for ten days, followed by pooling of specimens for each twenty-four hour period for the duration of the experiment. The results are given in Tables III and IV. The twenty-four urine volumes ranged from 1500 ml to 3600 ml. There was little correlation between urinary volume and quantity of plutonium excreted.

The urinary excretion of plutonium in the first 24 hour period is very nearly 36 per cent of the total excreted in the urine throughout the entire period of observation, and is 36 per cent of the total excreted in both urine and feces. The rapidity with which the rate of excretion diminishes is remarkable. Within 48 hours, the excretion level had fallen to approximately one-hundredth of that found during the first six hours. In approximately two weeks the excretion rate had fallen to approximately 0.004 times the initial rate.

Table I.

Percent of Plutonium Excreted in Urine in the First 38 Hours.
(Individual Specimens)

Specimen No.	Volume of Specimen (cc)	c/m per 100 ml urine	% of injected plutonium excreted
1 (6 hours)	152	6550	2.23
2	218	355	0.175
3	325	45	0.033
4	245	65	0.036
5	414	57	0.035
6 (24 hours)	182	78	0.052
7	100	136	0.039
8	122	137	0.052
9	73	95	0.020
10	97	92	0.029
11	148	67	0.024
12 (48 hours)	160	100	0.024

Table II.

Percent of Plutonium Excreted - 2nd to 8th Day.
12 Hour Urinary Output Analyzed

Days after Injection	Volume of Specimen (cc)	c/m per 100 ml urine	% of Injected Plutonium Excreted
2.4	258	77	0.045
3	415	41	0.139
3.5	630	54	0.055
4	540	39	0.039
4.5	515	30	0.032
5	430	29	0.020
5.5	660	15	0.020
6	485	16	0.027
6.3	600	10.5	0.015
7	380	11	0.0174
7.5	920	6.5	0.023
8	895	5	0.0095

Table III.

Percent of Plutonium Excreted - 9th to 155th Day.

Days after Injection	Volume of Specimen (cc)	c/m per 100 ml urine	% of Injected Plutonium Excreted
9	2510	5	0.007
10	2250	4.7	0.006
11	3275	6.5	0.009
12	2520	5.2	0.007
13	1450	5.4	0.008
14	2635	5.7	0.004
15	2130	4.7	0.005
16	2520	2.1	0.002
17	2650	4.5	0.006
18	2520	4.6	0.006
19	2300	2.1	0.015
20	3060	5.6	0.020
21-30 avg.	2723	3.2	0.015
31-40 avg.	3018	1.9	0.012
41-50 avg.	3346	2.2	0.017
51-60 avg.	3020	3.3	0.021
61-100 avg.	2505	2.9	0.015
101-125 avg.	2125	1.7	0.013
126-138 avg.	----	2.0	0.010
139-155 avg.	----	1.7	0.008

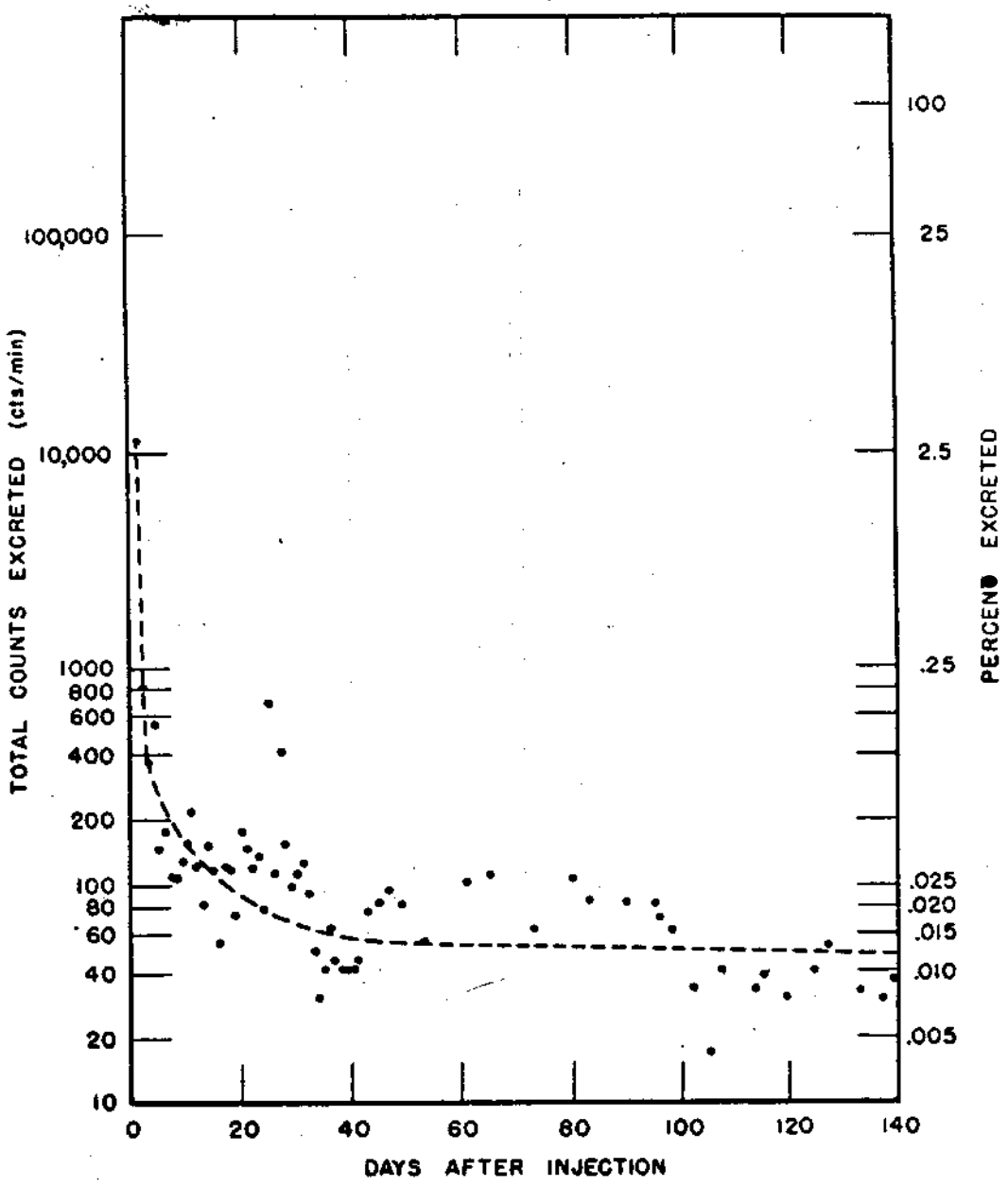


Figure I

Urinary excretion of plutonium in a sixty-eight year old white male following the injection of 6.50 micrograms of plutonium citrate.

Fecal Plutonium Excretion. During the first four days after injection seven individual fecal specimens were collected and analyzed for plutonium. Following this period the samples were collected at 24 hour intervals for several months and then 24 hour specimens were taken every four days until death. The results are given in Tables IV and V and Figure II.

Table IV.

Fecal Plutonium Excretion
Individual Fecal Specimens Collected in First 96 Hours.

Sample No.	Time of Collection after Injection	Weight of Specimens (gms)	c/m per gm of feces	% of Injected Plutonium Excreted
1	6 hours	13.0	26.0	0.076
2	28 hours	189.5	3.7	0.157
3	40 hours	45.5	16.2	0.361
4	51 hours	106.9	11.2	0.270
5	not recorded	141.5	6.2	0.195
6	not recorded	318.7	3.7	0.264
7	96 hours	76.2	9.1	0.154

Table V.

Fecal Plutonium Excretion
Daily Specimens from the 5th to the 136th Day

Days after Injection	Weight of Specimen (gms.)	c/m per gram feces	% of Injected Plutonium Excreted
5	49.5	19.3	0.214
6	57.0	8.7	0.100
7	54.2	6.3	0.076
8	64.4	7.3	0.105
10	278.3	3.2	0.200
11	129.9	2.8	0.082
12	144.7	1.2	0.040
13	70.1	2.8	0.045
14	166.7	1.0	0.040
15	122.7	1.1	0.039
16	232.1	0.6	0.031
17	166.9	0.9	0.037
18	130.0	0.53	0.034
19	112.4	0.59	0.0343
20	115.5	0.29	0.0253
21	123.0	0.18	0.0233
22	143.6	0.21	0.0243
23	68.2	0.16	0.0231

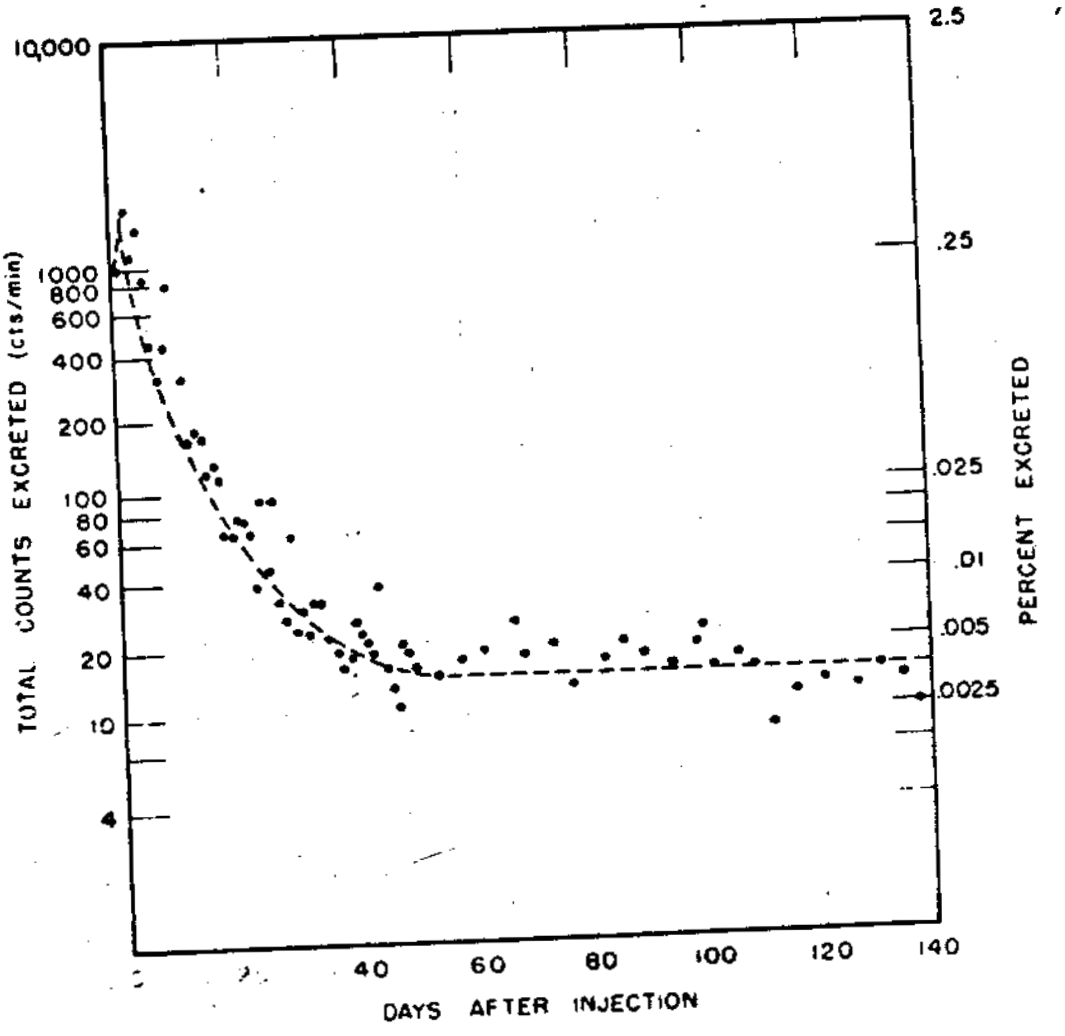


Figure II

Excretion of plutonium in the feces of a sixty-eight year old white male following intravenous injection of 6.50 micrograms of plutonium citrate.

Total excretion of plutonium for 138 days is estimated as 8.18 percent of the injected dose. The urinary excretion is estimated as 5.24 percent of the injected dose, the fecal excretion as 2.90 percent of the injected dose. The average excretion figures are multiplied by the appropriate factor in arriving at the above estimates, since average figures only are given throughout much of the period of study.

Clinical Studies of Peripheral Blood. No changes were observed in the hematological constituents of the peripheral blood which could be attributed to the action of the isotope administered. These data are recorded in Table VI and in Figures III, IV and V.

Table VI.

Blood Findings - Case I

cu. mm.	PMN %	PMN Absolute	Lymphocytes %	Lymphocytes Absolute	Monocytes %	Eosinophils %	Basophils %	Sed Rate 60m (uncorrected) (Westergren)
2,400	77	7238	17	1593	4	1	1	106
4,000	77	8085	15	1550	6	1	1	
2,200	69	5741	27	2403	7	2	1	106
ograms of platinum								
0,700	79	10191	15	1935	4	1	1	100
	81	7857	15	1455	4	1	1	
	64	4256	21	1366	8	2	1	113
3,100	66	6323	23	1506	11	9	1	
2,000	63	4221	28	1875	5	6		
1,200	63	3959	24	1377	6	7		
3,700	70	5550	20	1500	3	6	1	115
	75	4832	24	835	6	4		
0,300	70	5100	23	1703	5	2		
4,800	68	6533	15	1870	1		1	
	70	5355	27	1300	7	6		60
5,200	64	4026	18	1152	6	11	1	
	60	4000	25	5020	5	9		93
0,900	62	4237	28	1715	5	7		109
1,800	61	3355	35	2103	3		1	94
1,500	55	4813	20	2575	7	13	1	103
1,400	66	4485	23	2020	4	6	1	99
1,400	80	8120	13	1319	5	2	1	76
1,900	62	4043	20	1530	6	12	1	84
1,600	65	6337	20	2027	4	2		83
1,800	72	5254	20	1554	6	1	1	85
2,800	55	3085	33	2516	5	2		80
1,700	69	6053	23	2015	5	1	1	110

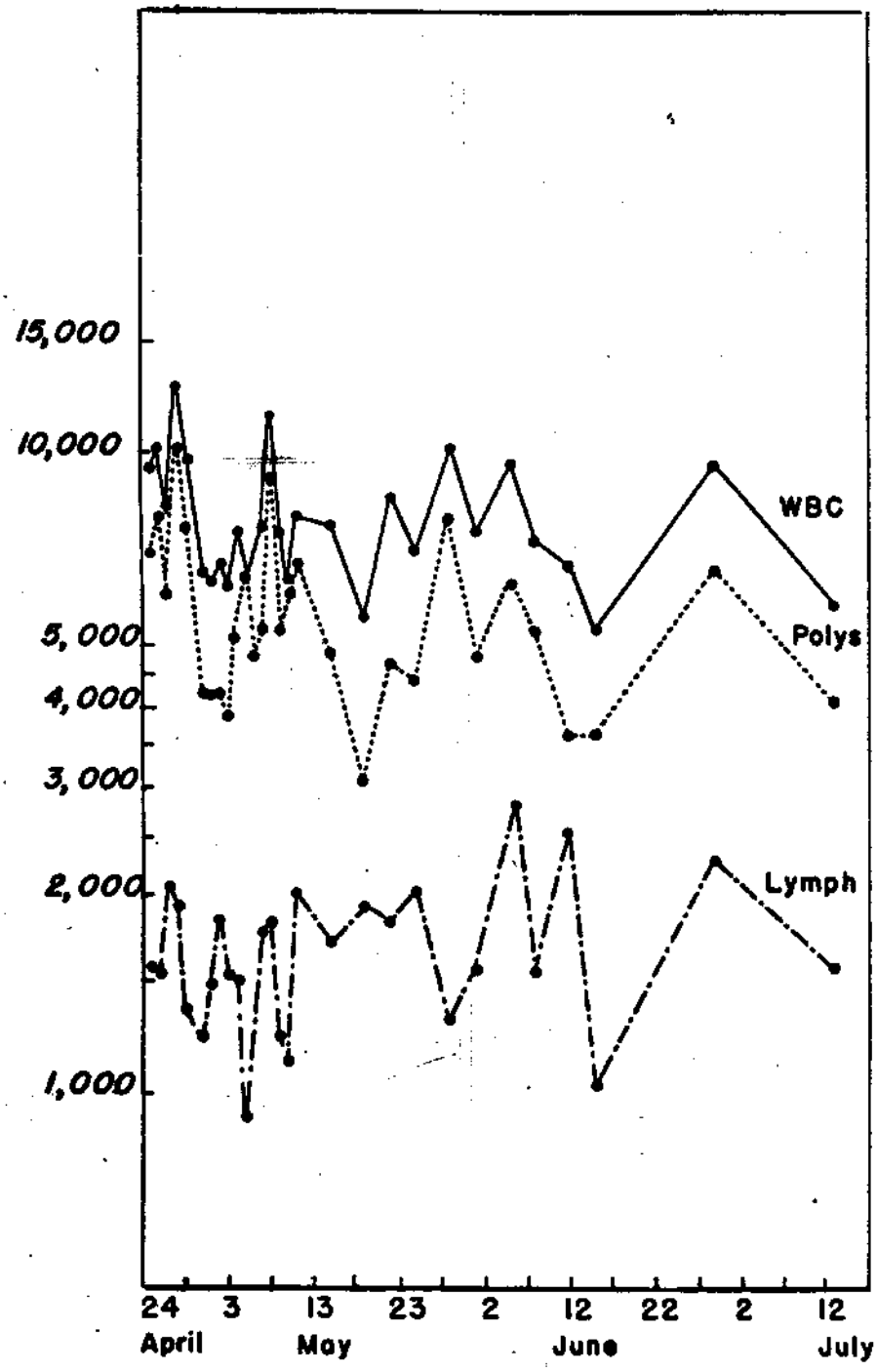


Figure III

Total white blood cell, polymorphonuclear cell, and lymph cell counts per cubic millimeter, in Case I.

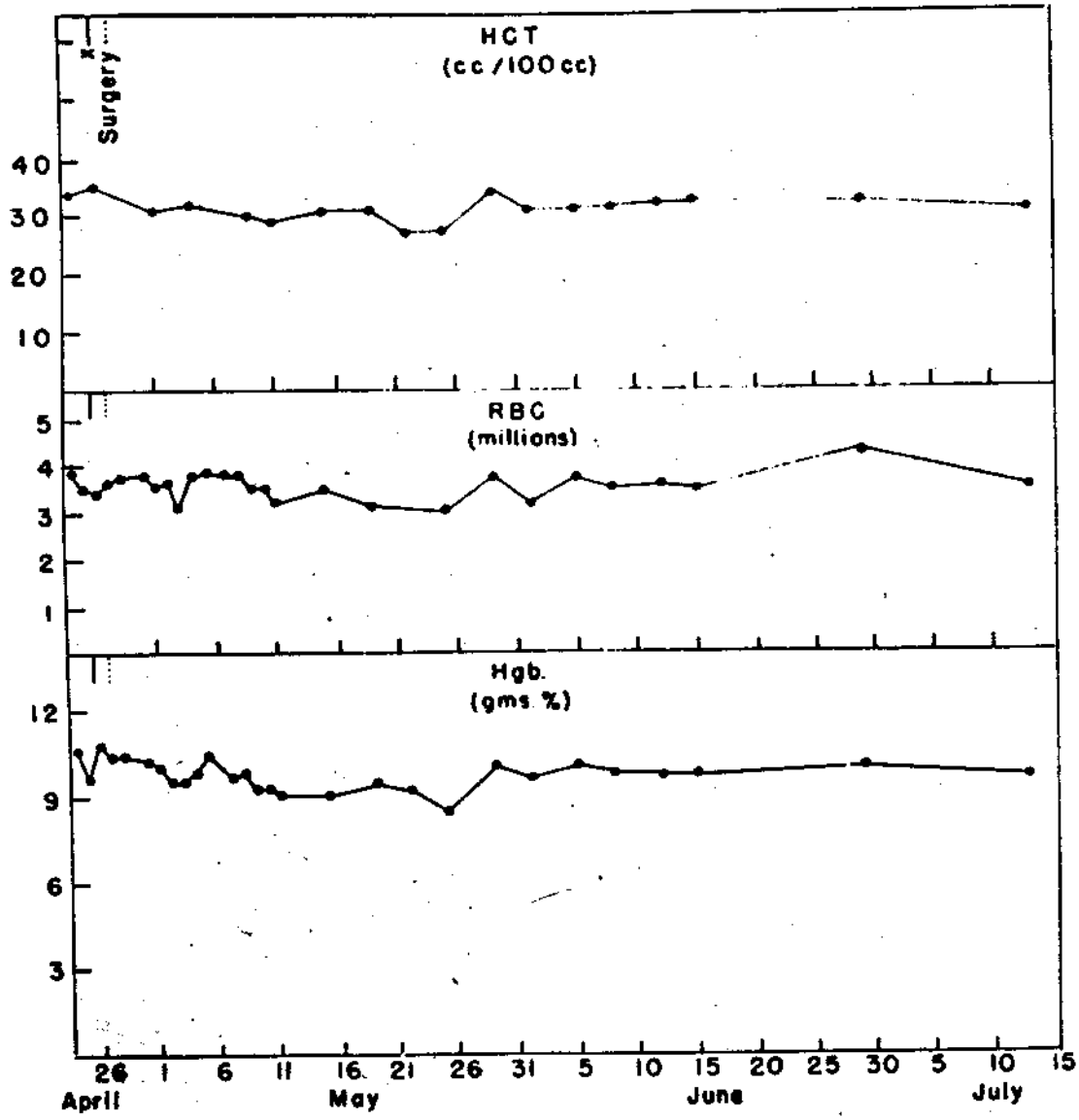
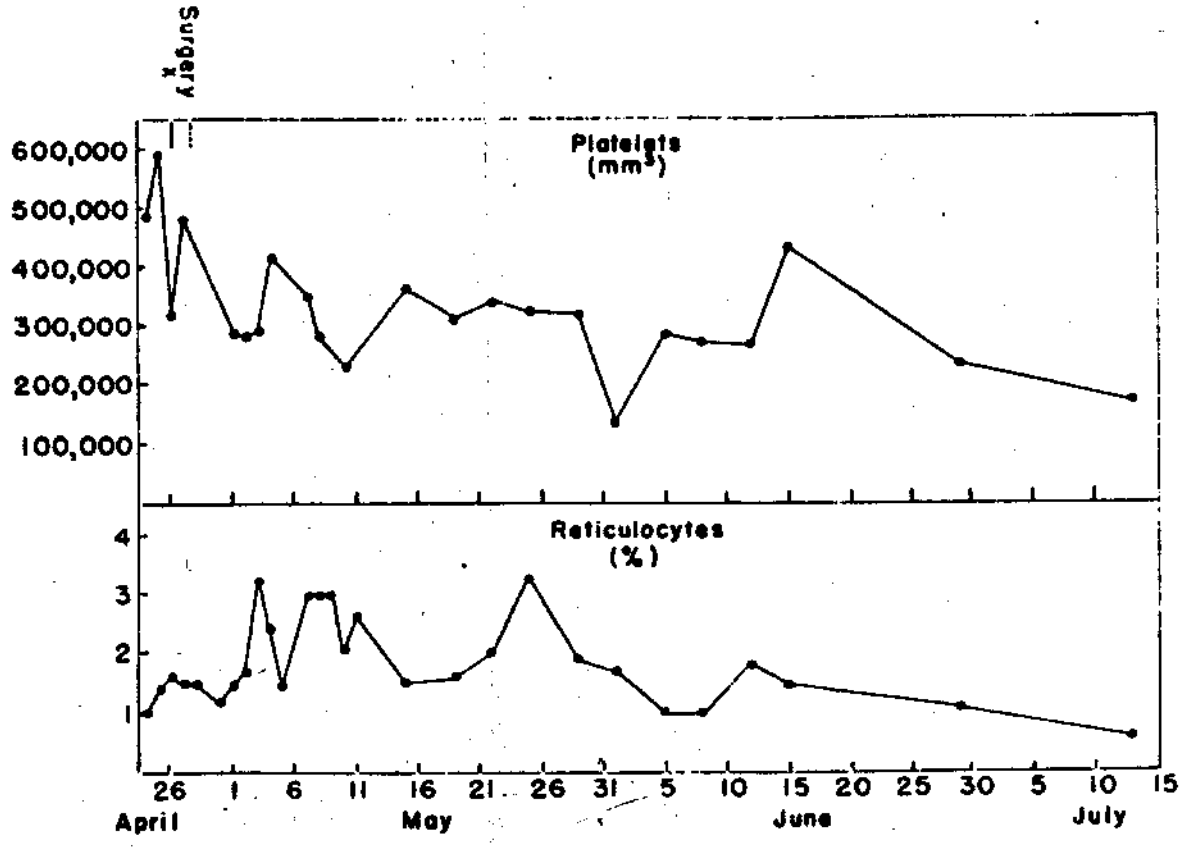


Figure IV

Hematocrit reading, red blood cell count, hemoglobin determination in Case I. The injection was given on April 26, 1945.

Figure V

Platelet and reticulocyte counts in Case I.



Post Mortem Findings. The patient died 155 days after the injection of plutonium. The analytical data is recorded in Table VII. The specimen of marrow and spicules showed the greatest activity per gram of tissue. The plutonium content per gram of liver was nearly as great. The activity of the cortex of the rib was one-tenth that of the bone marrow. No activity could be detected in the sample of bile analyzed. The effects of plutonium on normal and tumor tissue was looked for in the post mortem material by H. Lisco. He found no changes which he felt could be attributed to the action of the plutonium.

Table VII.

Distribution of plutonium in tissues of Case I, 155 days after the injection of 6.5 microgram of plutonium.

Tissue	Weights of Organs (gms)	Gms of Tissue Analyzed	Observed Counts per/min.	Cts/gm of Tissue per/min.	ug/gm of Tissue ($\times 10^{-3}$)	Relative Affinity for Plutonium*
Marrow + Spicules		0.8292	58.8	70.9	1.043	10.13
Liver	2050	34.11	2040.0	59.8	0.880	8.54
Sternum		4.38	111.1[1]	20.6	0.303	2.94
Parietale (rib)		0.1215	2.12	20.0	0.299	2.86
Spleen	260	32.12	3[illegible].9	11.1	0.164	1.59
Lung Tumor		2.03	14.8	7.4	0.109	1.06
Cancer Tissue		2.87	20.9	7.2	0.106	1.03
Rib (cortex)		1.0125	6.06[1]	7.0	0.103	1.00
L. Nodes (aortic)		0.63	4.17	6.7	0.099	0.96
Lungs	1950	15.39	40.7	2.6	0.038	0.37
Testicle (gl. portion)		4.3425	10.0	2.3	0.034	0.33
Kidneys	340	27.35	53.3	1.7	0.025	0.24
Heart		4.9435	6.0	1.2	0.018	0.17
Diaphragm		35.73	33.3	1.0	0.015	0.14
Fat (abd.)		17.05	3.4	0.2	0.003	0.03
Bile		8 cc	2.6	?	0.000	----

* Counts per gram/counts per gram assuming uniform distribution of plutonium.
1 90% correction factor applied to observed counts to give actual counts/gm.

Case II.

Excretion Studies. The urinary excretion data is listed in Table VIII and plotted in Figure VI. Unfortunately no comparison of fecal and urinary excretion can be made in this case. The collection of separate urine and stool samples was impossible. In fact the graph of urine excretion in Figure VI might with greater truth be called the graph of total product excretion.

The 24 hour excretion rate was 0.152 percent of the amount injected. This represents an excretion of 0.144 micrograms of the 94.9 micrograms injected. Following the initial 24 hour period the excretion rate was comparable to that in the other cases studied. The total known excretion was 0.684 percent of the amount injected, or 0.69 micrograms.

Table VIII.

Daily Plutonium Urinary Excretion, Case II.

Days after Injection	24-hour Volume	Alpha Counts/min/ 100 cc.	% of Injected Dose Excreted
1	1660 ml	594	0.152
2	1725	622	0.167
3	1750	250	0.067
4	1150	186	0.033
5	2020	134	0.042
6	1300	207	0.042
7	1190	132	0.0243
8	1500	110	0.0264
9	1400	89	0.019
10	1280	154	0.030
11	1120	108	0.019
12	940	100	0.014
13	875	251	0.034
14	630	99	0.009
15	330	124	0.016
16	150	164	0.004

Studies of the Peripheral Blood: No alterations in the hematological constituents of the peripheral blood occurred following the administration of 97.2 micrograms of plutonium which could be attributed to the presence of the element. The interpretation of changes in the thymol turbidity and cephalin flocculation tests, and in the amount of bilirubin in the blood serum was not possible because of the terminal state of the subject. These data are presented in Table IX and in Figure VII.

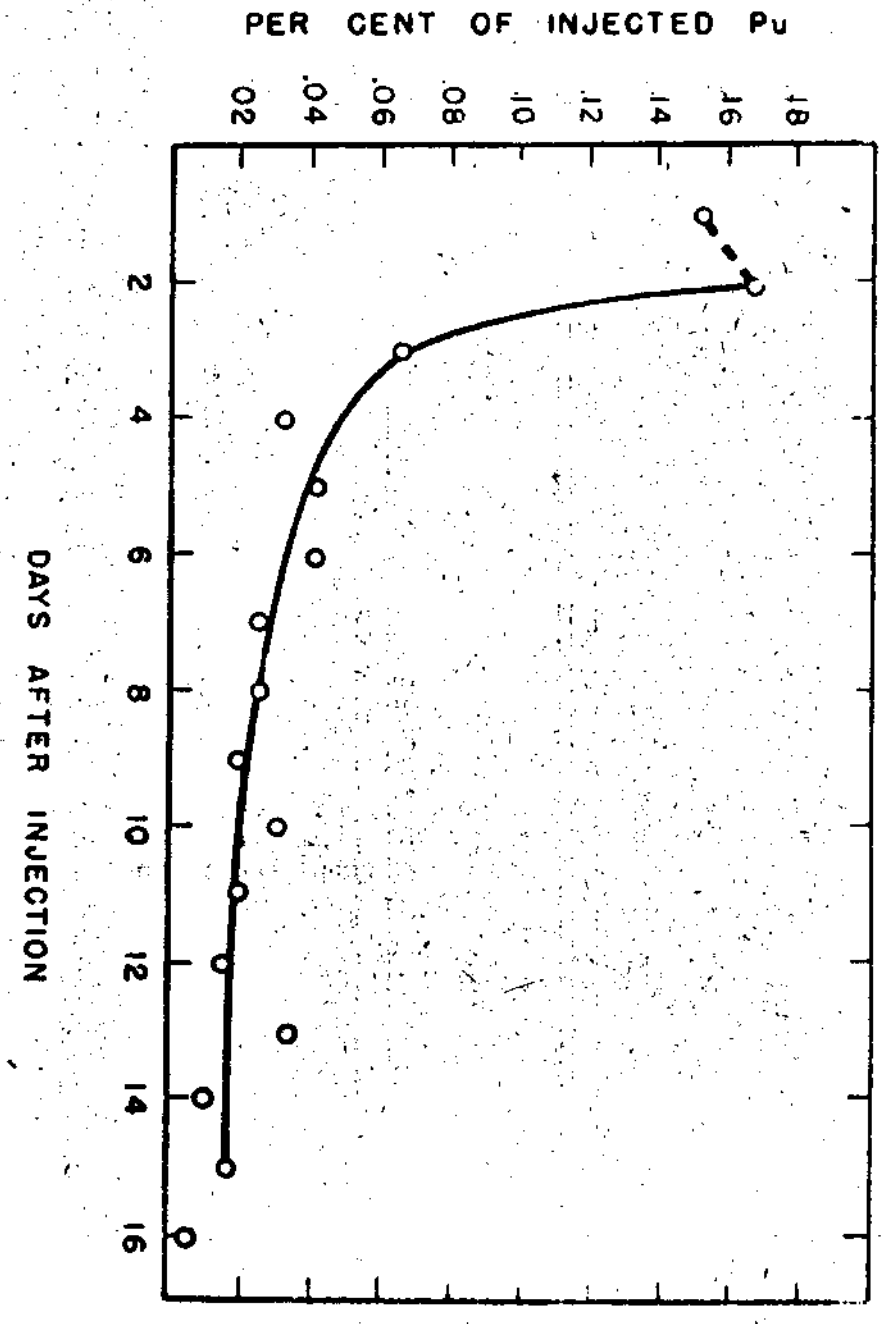


Figure VI

Excretion of plutonium in the urine following the injection of 94.9 micrograms of plutonium citrate.

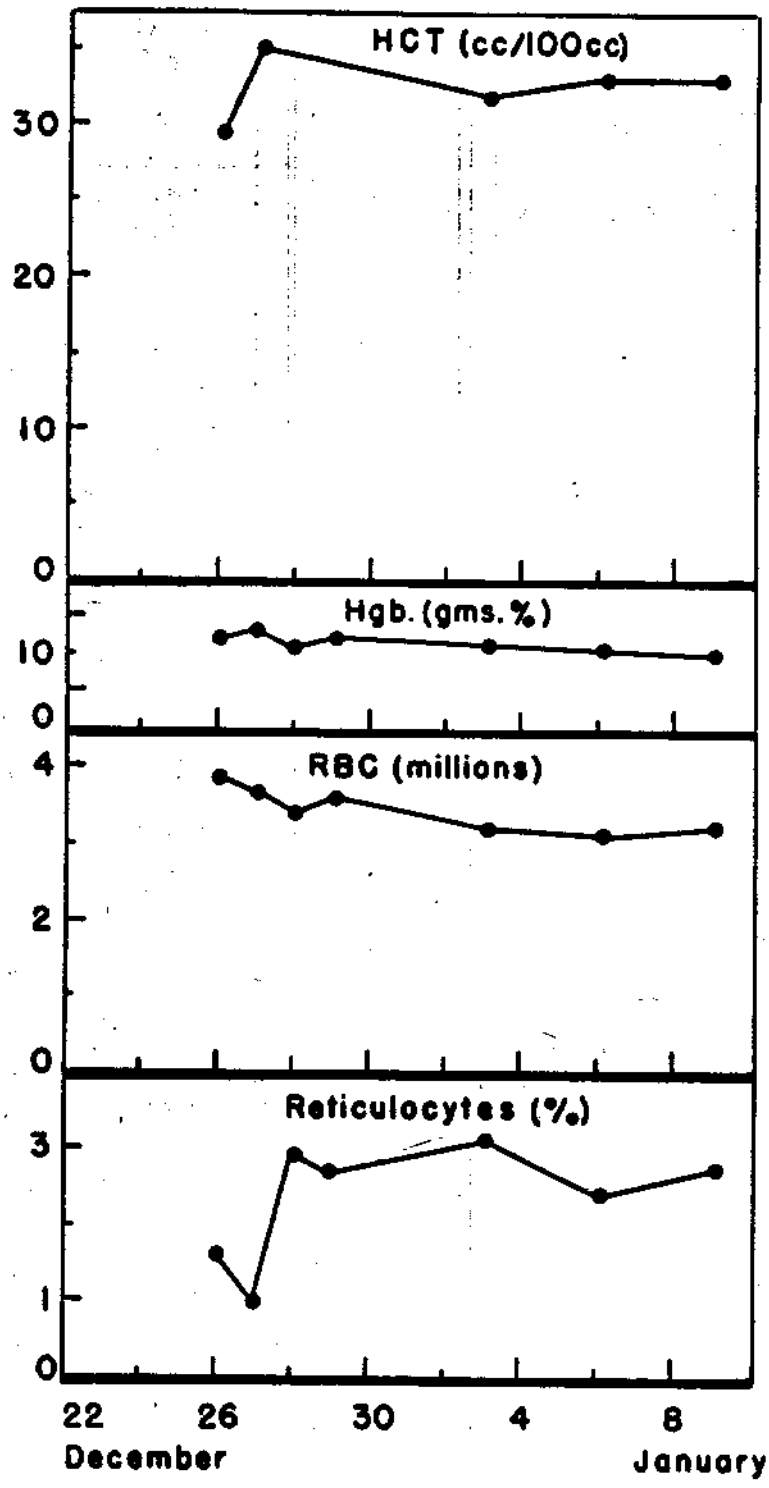


Figure VII

Hematocrit, hemoglobin, red blood cell and reticulocyte findings in Case II.

Table IX

Blood Findings in Case II

Date	12/26/45	12/27/45*	12/28/45	12/29/45	1/2/46	1/5/46	1/8/46	1/12/46
Hb	12.1	12.9	11.8 gm	12.8 gm	11.[illegible]	11.0	10.5	11.0
RBC	3.96	3.72	3.47	3.65	3.37	3.25	3.32	3.36
Hematocrit	29	35			32	33	33	33
WBC	17,250	20,950	16,550	18,300	17,900	18,950	20,500	20,950
Reticulocytes	1.6%	1.0	2.9%	2.7%	3.2	2.4	2.8	1.9
Sed Rate	115	101			59		58	57
Neutrophiles, %	83	75	77	71	81	82	80	85
Neutrophiles, No.	14,276	15,675	12,705	12,993	14,499	15,498	16,400	17,765
Eosinophiles, %	5	2	4	3	2	1	2	12
Basophiles, %			1					
Lymphocytes, %	12	15	11	15	10	13	13	12
Lymphocytes, No.	2,064	3,135	1,815	2,745	1,790	2,457	2,665	2,508
Monocytes, %	2	8	7	10	7	4	5	3
Stabs				1%	2			
Metamyelocytes, %			sl.	sl.	sl.	sl.	sl.	sl.
Polychromasia								
Hypochromasia	sl.	sl.	sl.	sl.	sl.	sl.	sl.	sl.
Anisocytosis	sl.	sl.						2
Normoblasts								x
Polys. toxic	x							
Cephalin Flocculation		1+	2+	1+	1+	1+	2+	1+
Serum Bilirubin								
15 min.		0.48	0.42	0.42	0.63	0.36	0.58	0.38
Total		1.0	0.72	0.76	1.04	0.56	1.00	0.64
Thymol Turbidity		90	88	89	89^2	89^1	86^2	90

* Injection of plutonium on this day following the withdrawal of blood for study.

Distribution of Plutonium in the Tissues. The Plutonium content of the tissues analyzed is listed in Table X. The marrow and rib specimens showed the highest specific activity, as would be expected from the animal work. The plutonium content per gram of liver tissue was roughly one-tenth that of the bone marrow. The specific activities per gram of muscle and fat were respectively one-twentieth and one-thirty-fifth that of the bone marrow. H. Lisco reviewed the histological material for evidence of changes similar to that attributed to plutonium in the experimental animals. No such change was observed. It should be pointed out that the amounts per gram of body weight were greater in the animals in which changes were seen.

Table X.

Plutonium Distribution in Tissue 16 Days after Injection.

Tissue	Weight of Organ (gms)	Weight of Sample (gms)	Total Counts[1] in Sample	Counts[1]/ gm of Tissue	Micrograms Plutonium/ gram of tissue ($\times 10^{-3}$)	Relative Affinity for Plutonium[2]
Marrow (Rib)		0.2065	289	1399	20	8.49
Rib (Cortex)		0.430	558	1299	18.6	7.83
Callus and Bone		0.1933	160	828	11.2	5.02
Callus (bone free)		0.262	140	534	7.7	3.17
Kidney	190	6.00	2162	360	5.1	2.18
Thyroid		2.64	597	226	3.2	1.37
Contents (lower bowel)		10.05	1833	183	2.6	1.11
Liver	1110	8.70	1405	162	2.3	1.00
Pancreas	60	6.045	893	148	2.1	0.90
Periosteum		0.461	57	123	1.7	0.75
Lung	490	14.40	1533	107	1.5	0.65
Fat, Mesenteric		5.850	560	96	1.2	0.53
Spleen	85	10.850	1021	94	1.2	0.57
Tumor (Liver)		1.970	140	71	1.0	0.43
Heart	250	9.40	660	70	1.0	0.42
Ovary, L.		1.975	122	63	0.90	0.38
Lymph Node (abd.)		1.53	73	48	0.70	0.29
Intestines (small)		3.40	151	45	0.64	0.27
Intestines (large)		6.87	291	43	0.60	0.26
Muscle (Str.)		15.32	613	40	0.57	0.24
Blood (Heart Clot)		1.835	40	22	0.31	0.13

1 - Alpha counts per minute from plutonium.

2 - Counts/gram found divided by counts/gram assuming equal distribution of the plutonium.

DISCUSSION

It must be emphasized that the data discussed above, while obtained on humans, may not be applicable to the population with which we are mostly concerned. The majority of occupationally exposed persons are in the 20-40 year age group and are in good general health. The persons discussed above both had carcinomas, one of which had widespread metastases. In case #2, the injection was made but seventeen days before death and the terminal state may have influenced the metabolic behavior of the element. In case #1 no gross evidence of other than local disease, except for the metastasis to the lung, was noted at the time of injection. Thus, barring alterations due to age, the early distribution of the plutonium was presumably a "physiological" one. However, it must be pointed out that we have no information on the early distribution pattern of the plutonium in this case. The data given in TableVII represents the distribution of the injectate 155 days later, after profound metabolic disturbances, causing his death, had occurred. It is impossible to say what influence this may have had in altering the early distribution pattern.

As is well-known, the biological behavior of a given agent varies greatly from one species of mammal to another. Hence, experience with humans injected with plutonium was vital to any interpretation of the data obtained from animals. The rate of plutonium excretion in rats(2), mice(2), rabbits(3) and dogs(4) varies widely. The route of excretion varies from species to species(2,4). Since our estimate of the body content, and hence ultimately of the desirability of removing a given worker from his job, depended upon the excretion rate of plutonium in the human, it became necessary to determine that rate directly in the species concerned. Knowledge of the distribution of the element as well as its rate and route of elimination from the human body provided information which could be correlated with the more extensive experimental investigation in animals and provided information which made possible the estimation of the amount of plutonium already deposited in the workers by the determination of the daily plutonium excretion rate of the individual concerned.

Clinical Picture. Insofar as can be determined the clinical course in neither of the two cases was influenced by the injection of plutonium. In Case #1, the concentration of that material was 0.085 micrograms per kilogram of body weight immediately following the injection. In the second case the concentration of plutonium was 2.46 micrograms per kilogram of body weight.

That the amount of plutonium injected in these subjects produced no appreciable clinical effect is likely in view of the fact that the amount of plutonium necessary to produce damage is far greater. Table XI lists some of the experimental values(2).

Table XI.

Comparison of Dose Levels of ^{239}Pu Plutonium in Animals and Their Effects.

	ug/kg	Effects	Time
Rats	700 - 1000	LD 50%in	30 Days
Rats	200 - 600	LD 50%in	150 Days
Rats	10	None	420 Days

It will be seen that the level of 10 micrograms per kilogram is approximately 117 times the dosage level in Case I and 4 times the dosage level in Case II.

Hematological Studies. No hematological changes of the peripheral blood were observed in either subject. In view of the very slow excretion rate and long half-life of deposited plutonium it might be assumed however that a condition comparable to that described by Hartland(5), Castle(8) and Bomford and Rhoads(9) in individuals with chronic radium poisoning (severe anemia, leukopenia and thrombocytopenia with or without bone sarcoma) might well develop in either case were it possible to observe subjects over extended periods of time. The difficulty which arises in attempting to extrapolate from the radium damage data on the human to the expected effect of plutonium is, among other things, due to the difference in the excretion pattern and the impossibility of estimating what the ingested dose might have been in the individuals who have succumbed to radium poisoning. While bone sarcomas have been reported in individuals with a total of 0.5 μg of radium in the body at death, little information is available as to the amount which was in the body initially and this initial dose may be the critical amount.

Case I

Excretion Studies. The fact that the rate of excretion of plutonium apparently had not reached a constant even 100 days after injection deserves emphasis. The rate of fall is slight but definite. This point deserves emphasis as it may indicate that the excretion rate 1000 days after exposure may be even less than the average of 0.012 per cent found after 150 days in this case. Evidence for continued diminution in the excretion rate of plutonium 238 (isotope of plutonium 239) is found in the patient studied by the University of California group which is described in the biology volumes of this report. In this patient, 158 days after injection, the daily excretion rate is approximately 0.0015 per cent of the injected dose(6), a figure definitely lower than our figure of 0.012 per cent one hundred and fifty days after injection.

Should the lower figure prove to be the more correct one the difficulty of detecting tolerance concentrations of plutonium by means of the urinary excretion of that element is materially increased.

It is interesting to note the totals of urinary and fecal excretion for the time periods of 0-24 hours, 2-10 days, and 11-100 days. Table XII gives these data for Case I in terms of per cent of the injected dose:

Table XII

Summary of Plutonium Excretion for Indicated Time Periods, Case I

Time	Urine	Stool	Total
0-24 hours	2.53%	0.233%	2.764%
2-10 days	0.638%	1.748%	2.386%
11-100 days	1.902%	0.767%	2.669%

It is apparent that the total excretion is roughly equal for each of the various periods. One might speculate that the next order of magnitude, that is 101-1000 days, might also show a total plutonium excretion of approximately 2.5 percent. If this percentage excretion for the 101-1000th days period is subsequently borne out by experimental observation, it would paint a rather discouraging picture from the point of view of the normal excretion rate for plutonium.

The fecal excretion pattern is similar to that described for the excretion in the urine. No sharp early peak in the excretion rate is noted however. On the other hand, the rapidity with which the rate falls is not so marked. Indeed, the total plutonium excreted from the second to the tenth day is greater in the feces. However, as pointed out above, the fecal excretion after the twentieth day is distinctly less than the urinary excretion.

It will be noted that throughout this paper the excretory rate is given as "percent per day of the injected dose". It would be more accurate to speak of the percent per day of the amount in the body. Because of the low rate of excretion of plutonium the correction factor is small and it is felt that the small inaccuracy introduced by this practice is justifiable, particularly in preliminary studies.

Distribution of plutonium in the Body. It may be useful to compare the relative concentrations of plutonium in the various organs in the two cases. It is recognized that such comparisons cannot be pushed too far because of the many uncontrolled variables.

For ease of comparison, the values from Case I in Table XIII are adjusted to an injection amount of 94.91 micrograms, the amount injected in Case II, assuming the same distribution would occur with the larger dose.

In both cases the bone marrow shows the greatest concentration of plutonium per gram of tissue. On the basis of animal experimentation it is felt that the plutonium probably initially localizes in the osteoblastic and collagenous tissue surrounding the spicules, forming the endosteum. Since the proportion of this tissue is greatest in the marrow specimen, it shows the highest activity. It is of interest also to note the much higher proportional activity of the bone cortex in Case II, where the cortex shows almost as much activity as the marrow. The decalcification of the bones noted in this case would result in a greater proportion of plutonium-containing tissue than found in the comparable specimens in Case I, where the calcium content of the bones was apparently normal. The specimen of callus from the rib in Case II did not show as high concentration as the cortex or marrow specimens do. Since the callus represents a healing pathologic fracture, it is entirely possible that the uptake of plutonium was abnormally low.

Table XIII

Comparison of the concentration of plutonium per gram of tissue. For ease of comparison the values from Case I are adjusted to an injection amount of 94.91 micrograms, the amount injected in Case II.

Tissue	Case I Gm Pu/gr tissue ($\times 10^{-3}$)	Case II Gm Pu/gm tissue ($\times 10^{-3}$)
Bone Marrow + Spicules	15.2	20.0
Bone Cortex	1.50	18.6
Kidney	0.36	5.1
Liver	12.8	2.3
Lung	0.55	1.7
Fat	.04	1.5
Spleen	2.39	1.2
Tumor	1.59	1.0
Heart	0.26	1.0
Ovary		0.90
Testicle	0.50	
L. Nodes	1.44	0.70
Muscle, striated	0.22	0.57

The amounts in the livers are of considerable interest. The reasons for the wide discrepancy shown are not known at the present time. In Case I the liver content at death, some 150 days after injection, constituted approximately one-third of the injected amount. This value is far higher than the data from experimental animals would lead one to anticipate(2). It is true that early values comparable to the one listed here may be found in the experimental animal. Amost uniformly, however, the initial high value has dropped by a factor of five or ten by the hundredth day(2). Why, in this instance, the liver should have retained plutonium so tenaciously is not understood. Indeed, it must be admitted that we cannot rule out the possibility that the amount in the liver was at one time lower than the final value. Liver biopsies would be extremely useful in following the plutonium content of that organ over a wide time range.

In Case II the content of plutonium in the liver was approximately one-sixth of the amount noted in Case I and constituted approximately one percent of the amount injected. This figure is, if anything, somewhat lower than one would expect the concentration in the liver to be on the 16th day after injection, judging again from the results of animal experiments.(2)

The concentration of plutonium in the spleen in Case I, which showed some congestion but no other evidence of pathologic change, was distinctly greater than the concentration in the spleen in Case II where a marked myeloid metaplasia was observed. The relative concentration of plutonium in the spleen observed in these two cases given here are distinctly less than those observed in experimental animals, particularly in dogs(4). In most instances the plutonium concentration in the spleen compares favorably with that of the bone marrow. Certainly the difference noted between the results in the two human cases are far less than the difference between species(2,4). Again no explanation for this fact can be given at this time.

It is interesting to note that in both cases the primary tumors, two carcinomas and a lymphosarcoma, did not concentrate plutonium to a significant degree. While it is impossible to generalize from two cases, it seems unlikely that plutonium will be of any value in the treatment of carcinomas in humans. As a general principle any radioactive agent injected for therapeutic purposes must concentrate to a greater degree in the tumor than elsewhere.

There is a marked difference in the concentration of plutonium in the kidneys of the two cases. The higher value is found in Case II. Two factors may reasonably be expected to operate in the direction of producing a higher concentration of plutonium in this case. First, and probably more important, is the fact that the death occurred shortly after the injection. The data obtained from animal experiments indicates that the kidney concentration is higher shortly after injection(2). In both cases evidence of degenerative changes in the tubules of the kidneys was noted in the tissue sections. In addition, in Case I changes suggestive of a pyelonephritic lesion were noted. It is possible that the urinary excretion data will be found subsequently to be too low because of the presence of disease in the kidneys. Evidence obtained elsewhere, however, would indicate that the figures for urinary excretion given here are not seriously in error(7).

The lack of plutonium in the bile is of considerable interest. Within the limits of the method (approximately 10^{-4} micrograms of plutonium per gram of tissue) none was found. Similar findings were noted in the plutonium injected dogs(4).

The relative activity of the contents of the lower bowel in Case II are higher than would be anticipated from the results of the analysis of the feces. Further, the value is four times higher than that obtained for specimens of the tissue of the large and small intestine in this case. If the assumption is made that the amount of plutonium in the bile was negligible as in Case I, it would seem then that plutonium is being excreted by the large or small intestine. Since other heavy metals are excreted by the large intestine it seems reasonable to tentatively assume that plutonium is also excreted by this route. The assumption cannot be verified until further experimental data is available.

In general the relative amount of plutonium per gram of tissue tends to be higher in Case II than in Case I. It is possible that the explanation lies in the comparative lack of fatty tissue in Case II so that the organs and tissues studied tend to have a greater proportion of plutonium than was noted in Case I. The total fat is difficult to estimate from the data at hand and therefore the total amount of plutonium absorbed in the fat. In spite of the lower unit concentration in the fat in Case I, it may be that the proportional amount of plutonium in the total fat was greater in Case I than in Case II.

Summary and Conclusions. Distribution and excretion studies have been made of plutonium 239 -6 citrate in two human subjects given total intravenous doses of 5 and 94.91 micrograms of plutonium respectively. No clinical effect was noted which could be attributed to the biological action of the element in 155 and 16 days of observation respectively. Such changes as occurred in the hemotological picture and in liver functions can be attributed to the terminal state of the subject, to the underlying disease, or both.

It is difficult to make other than very tentative generalizations because of the considerations mentioned above and because of the fact that only two cases are reported here. From what is known from the cases reported here (and from other

cases reported elsewhere) the following tentative conclusions may be drawn. It must be recognized clearly that these are not in the true sense of the word conclusions but are only working hypotheses that must be confirmed and elaborated upon by subsequent investigations.

(1) The urinary rate of excretion of plutonium in humans is exceedingly low. The best evidence available at this time would indicate that the "chronic" (150th day) excretion rate does not exceed 0.01 percent per day of the amount fixed in the body.

(2) The fecal rate of excretion of plutonium fixed in the body is lower than the urinary rate by a factor of approximately three. What evidence we have would indicate that the rate of fecal excretion does not exceed 0.003 percent per day of the amount in the body.

(3) The highest concentration of the plutonium fixed in the body is found in the bone marrow. The liver concentration has varied so widely in the two cases here reported that it is impossible to predict on a reasoned basis what the general picture might be.

(4) The concentration of plutonium in the neoplastic tissue of these cases was not high.

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THE DISTRIBUTION AND EXCRETION OF PLUTONIUM IN TWO HUMAN SUBJECTS

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By: E. R. Russell and J. J. Nickson, M.D.

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J. J. Nickson, M.D.
E. R. Russell

Table of Contents

1. Introduction

Following the discovery of plutonium, the determination of its half life as 24,300 years, and the fact that the material is alpha active, it became obvious that elaborate precautions were necessary if the worker was to be protected from harm. Experience in the radium industry had indicated clearly that very small amounts of the radium element deposited in the body were capable of producing serious illness or death. As a result of these considerations, the conditions under which plutonium is handled in the laboratory have been ringed about with elaborate protective regulations and devices.

In addition, however, it seemed highly desirable, if not essential, to know as precisely as possible the amount of plutonium in the individual worker. Animal experimentation indicated that the plutonium content of the urine and feces would be a useful guide to the total amount of plutonium in the body. It was decided to use urine for the routine determination[3] primarily because of the greater ease in handling urine samples. As will be discussed below, it appears that in humans the amount of plutonium excreted per day is greater in the urine than in the feces.

Initially, a tentative maximum permissible body content of plutonium was established on an arbitrary basis. From purely physical considerations it seemed that plutonium,

weight for weight, should be approximately one-fiftieth as toxic as radium. Since the tolerance amount of radium is generally accepted as 0.1 microgram in the body, the plutonium tolerance value was initially set at 5.0 micrograms in the body.

In order that one might estimate the plutonium content of the body through analysis of the urine, it was necessary first to establish the excretion rate. Preliminary experiments[1] with rabbits indicated that after the first two or three weeks of plutonium intake, approximately 0.01% of that retained in the body is excreted in a 24-hour urine specimen. Many excretion experiments with other animals and man have shown that this is nearly the correct value for the sub-acute excretion rate. Recent work discussed elsewhere indicates that this figure may be greater than the true excretion rate of plutonium which has been in the body for a year or more. It is possible that the figure of 0.01% may have to be reduced in the future.

If 5 micrograms is to be the body threshold, and 0.01% excretion is assumed, then analytical procedures capable of detecting 28 alpha counts per minute (plutonium) in a 24-hour urine specimen, or 2 counts per minute in a 100 ml specimen should be adequate. An adsorption procedure, described later, was designed specifically to assay 100 ml specimens. Any specimen showing less than 2 alpha counts per minute was not considered significant. This procedure

served its purpose well. However, when it became apparent that the factor of fifty between radium and plutonium toxicity was too high, it was evident the method was not sufficiently sensitive. Comparative toxicity studies with these two elements showed that a factor of ten would be much safer and therefore the plutonium tolerance threshold was lowered to one microgram.

If the tolerance threshold is 1.0 microgram, the analytical procedure should detect at least 0.2 micrograms in the body, therefore 0.2×10^{-4} microgram in a 24-hour urine specimen would be significant. Since the average urine specimen used in Chicago is approximately 1/3 of a 24-hour sample, the method must then be sufficient to detect 0.7×10^{-5} microgram or 0.4 alpha counts per minute of plutonium. Smaller samples present an even more difficult problem.

The problem of detecting such small quantities of plutonium was mainly one to be solved by the development of adequate counters. Dr. Jesse and associates have produced counters with backgrounds of less than 0.1 count per minute. With such counters 0.2 counts per minute can be detected with fair accuracy. Counting times are long, of course.

It should be pointed out that contamination is one of the greatest sources of error in the determination of low alpha activity. This will become quite clearly in the results of the survey of project personnel. It is necessary that collection, handling and assaying of the

urine be carried out under "sterile" conditions.

It is the purpose of this chapter to present a detailed description of the methods used in the detection of plutonium in humans and to briefly discuss the results. In closing, suggestions are given for the establishment and operation of a laboratory for the detection of plutonium in individuals working with or in areas contaminated by the element.

2. Estimation of Plutonium in the Body

2.1 Methods of Urine Analysis: A survey of the analytical methods for plutonium used by the chemistry division revealed that with certain modifications some of these might be used to assay urine. A direct lanthanum fluoride precipitation from a small volume of acidified urine is adequate for many purposes. Where the volume is large and the concentration of plutonium is exceedingly small, such a method is not applicable as too large a quantity of lanthanum is required. In addition, certain salts in the urine may cause difficulty.

In the development of analytical methods applicable to urine analysis the time element as well as manpower requirements to assay a given number of samples were considered. It was felt that an adsorption procedure would offer the greatest possibility of routinely assaying daily the largest number of specimens with a minimum of personnel. As was

It was previously mentioned that plutonium is eliminated from the body in the urine at a fairly constant rate--the rate being approximately 0.01% per day. This figure was proposed on the basis of some very preliminary excretion studies on rabbits[1]. Subsequent experiments on mice, rats, and dogs showed that the excretion rate may vary by a factor of five in the different species[11] It was felt necessary to establish independently the excretion rate of humans.

The fecal plutonium excretion, however, varied as much as a thousand fold from species to species. This made it difficult to assign any rate for human fecal plutonium excretion.

4.1 Results of Human Excretion Studies:

Urinary excretion of plutonium. Three experiments were begun within a few weeks (one at Chicago) in which plutonium was injected into a human and the plutonium excretion followed daily. During the first 15 days of the experiments there was less than 10% difference between the daily urinary plutonium excretion of the individual studied by Dr. W. Langham and associates at Los Alamos and the individual studied by Dr. J. J. Nickson, E. R. Russell and associates at Chicago. The individual studied by Dr. J. G. Hamilton at Berkeley showed a slightly lower excretion but not by a factor of 2. Following the initial period where a rapid decrease in the excretion rate is observed, there was a slight divergence in the results obtained from the three subjects. The individual

studied at Los Alamos showed an average daily excretion of slightly less than 0.02%, the one at Chicago slightly above 0.012% and the individual at Berkeley slightly less than 0.006%. These values persisted over a 100-day period. Since these experiments were completed, two additional studies have been made at Chicago. The excretion rate of one of these individuals after the first two weeks has remained between 0.010 and 0.015% per day. The other individual was not available for further study after the 16th day.

In view of the fact that the majority of the urinary plutonium excretion studies on humans have indicated that a sub-acute excretion rate of 0.01% per day is very nearly correct, this value appears to be at this time a reasonable one to use in determining the concentration of plutonium in the body of workers. It may be pointed out that the urinary plutonium excretion of dogs[13] parallels that of man.

Fecal excretion of plutonium. In addition to following the urinary excretion of plutonium of the above individuals, the plutonium content of the daily fecal specimens was also determined. It has been predicted by several workers on the basis of animal excretion studies, that the plutonium fecal excretion rate would be greater than the urinary excretion rate. It therefore appeared that stool determinations would be easier to interpret. All of the human studies that have been made have failed to confirm this thesis. Plutonium in

a 24-hour fecal specimen is from 2 to 4 times less than that in a corresponding 24-hour urine specimen.

The average daily fecal plutonium excretion for the four cases studied is 0.003% ranging from 0.001% to 0.006% of that contained in the body. From the difficulties encountered in detecting 2×10^{-5} micrograms of plutonium, it would appear that surveys of personnel through fecal analysis would be difficult.

4.2 Distribution of Plutonium in the Body: The development and understanding of any satisfactory means of plutonium therapy is dependent upon a knowledge of the distribution of the element in the organism. Since nearly 90% of the plutonium finding its way in the body is retained there for many years it is vitally important that we week some means of increasing the excretion rate. The first step in devising means of therapy is to learn in what organs the plutonium is concentrated.

There have been many experiments involving animals in which plutonium was injected and at some later date its distribution determined. The majority of these tests have shown that the liver, spleen, bone marrow, and lymph nodes are the principle sites of deposition. The same general distribution has been found for the one fairly normal human which was studied. The distribution data is given in Table I. In addition the distribution of plutonium in a female containing

approximately 90 micrograms was determined (see Table II.) This individual had many abnormally functioning organs and therefore the distribution may not be representative. It is interesting to note that even under these conditions the marrow and bone are among the principle sites of deposition.

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Table I

Distribution of Plutonium in a 68-year, White Male (155 days after injection of 6.5 ug of plutonium as the citrate)

Tissue	Grams of tissue analysed	*Cts/gram of tissue	#Relative Affinity for Plutonium
Marrow (rib)	0.8292	70.9	10.13
Liver	34.11	59.8	8.54
Sternum	5.38	20.6	2.94
Periosteum	0.1215	20.0	2.86
Spleen	32.12	11.1	1.59
Tumor (lung)	2.03	7.4	1.06
Cancer Tissue	2.87	7.2	1.03
Rib (cortex)	1.0125	7.0	1.00
L.Nodes (aorta)	0.63	6.7	0.96
Lung	15.39	2.6	0.37
Testicle (glandular)	4.3425	2.3	0.33
Kidney	27.35	1.7	0.24
Heart	4.9435	1.2	0.17
Diaphragm	35.73	1.0	0.14
Abdominal Fat	17.05	0.2	0.03
Bile	8 cc	?	---

* = cts/gram found ÷ cts/gram assuming equal distribution throughout the body.

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Table II

Distribution of Plutonium in a 54-year, White Female
(16 days after injection of 94.91 µg of plutonium citrate)

Tissue	Grams of tissue Analysed	cts/gram of tissue	*Relative Affinity for Plutonium
Marrow (rib	0.2065	1399	8.49
Rib (cortex)	0.430	1299	7.88
Callus and bone	0.1933	828	5.02
Callus (bone free)	0.262	534	3.17
Kidney	6.00	360	2.18
Thyroid	2.64	226	1.37
Contents (lower bowel)	10.05	183	1.11
Liver	8.70	162	1.00
Pancreas	6.045	148	0.90
Periosteum (rib)	0.461	123	0.75
Lung	14.40	107	0.65
Fat	5.850	96	0.58
Spleen	10.850	94	0.57
Tumor (liver)	1.97	71	0.43
Heart	0.40	70	0.42
Ovary (l.)	1.975	63	0.38
L. Node (abd.)	1.53	48	0.29
Intestine (small)	3.40	45	0.27
Intestine (large)	6.87	43	0.26
Muscle (striated)	15.32	40	0.24
Blood (heart clot)	1.835	22	0.13

* = cts/gram found ÷ cts/gram assuming equal distribution throughout the body.

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14 bone specimens
Radius head
patella
rib whole
rib cortex
vertebrae
sternum

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TABLE 3

DISTRIBUTION OF PLUTONIUM IN HUMAN TISSUES FOLLOWING INTRAVENOUS INJECTION OF PLUTONIUM SALTS

Tissue[2]	Subject[1] and % of Injected Dose/g of Tissue								Rel. Pu	Org.	Calc.
	Hp-5	Hp-9	Hp-11	Chi. I	Chi. II	Hp-12	Cal. I	Av. %/g	Affinity[3]	Wt./g[4]	%/Organ
Bone Marrow	--	--	.0096	.0153	.0210	--	.0290	.0187	13.3	3,000	(56.1)[6]
Radius (Frag. head)	--	--	--	--	--	.0167	--	--	--	--	--
Liver	.0320	.0144	~~.0052~~	.0139	~~.0084~~	--	--	.0136	9.7	1,700	23.1
Rib (Cortex)	--	--	--	.0015	.0196	--	.0170	.0127	9.1	--	--
Patella	--	--	--	--	--	.0109	--	--	--	--	--
Vertebra	.0071	.0080	.0070	--	--	--	--	.0073	5.2	SKELETON	--
Sternum	.0070	--	.0100	.0044	--	--	--	.0071	5.1	10,000	65.7[5]
Rib (Whole)	.0050	.0038	.0068	--	--	--	--	.0052	3.7		--
Periosteum (Rib)	--	--	--	.0043	.0019	--	.0048	.0037	2.6	--	--
Spleen	.0007	.0015	.0048	.0024	.0014	--	.0019	.0021	1.5	200	0.4
Kidney	.0002	.0002	.0015	.0004	.0054	--	--	.0015	1.0	300	0.4
Thyroid	.0001	--	.0009	--	.0034	--	--	.0014	1.0	30	--
Adrenal	.0004	--	.0022	--	--	--	--	.0013	1.0	14	--
Lung	.0005	--	.0016	.0006	.0016	--	--	.0011	0.8	950	1.0
Pancreas	.0002	.0002	--	--	.0022	--	--	.0009	0.6	65	--
Gonads	.0003	--	.0012	.0005	.0009	--	--	.0007	0.5	--	--
Lymph Node	--	--	--	.0014	.0001	--	--	.0007	0.5	700	0.5
Teeth (Av. of 7)	--	--	--	--	--	.0003	--	--	--	--	--
Heart	.0000	.0000	--	.0003	.0011	--	--	.0003	0.2	350	0.1
Large Intestine	.0002	--	.0004	--	.0001	--	--	.0002	0.1	2,300	0.5
Small Intestine	.0001	--	.0005	--	.0001	--	--	.0002	0.1	--	--
Muscle and Skin	.0000	--	.0002	.0002	.0001	--	--	.0001	0.1	38,500	3.9
Blood	--	--	--	--	--	--	--	--	--	5,400	0.2[8]
Balance	--	--	--	--	--	--	--	.0001[7]	--	9,600	0.9
Total	--	--	--	--	--	--	--	--	--	70,000	96.7

(1) The various subjects received the following doses of plutonium: Hp-5 = 5 μg; Hp-9 = 6.3 μg; Hp-11 = 6.5 μg; Chi. I = 6.5 μg; Chi. II = 94.9 μg; Hp-12 = 4.7 μg; Cal. 1 = 103 μg.

(2) Tissues were obtained at the following times after injection: Hp-5 151 days; Hp-9 456 days; Hp-11 5 days; Chi. I 155 days; Chi. II 16 days; Hp-12 5 days; Cal. I 4 days.

(3) Calculated by dividing %/g of tissue by %/g of body weight if a unit dose of Pu was equally distr. in a 70 Kg. man.

(4) Hermann Lisco, Memorandum to AEC, July 21, 1947, Project Standard Man.

(5) Assumption made that vertebra, sternum and whole rib represent average bone of skeletal system.

(6) Bone marrow not included in total recovery because bone samples were not freed of marrow before analysis.

(7) Balance assumed to have same Pu content as muscle.

(8) Value for blood taken at 30 day point, Fig. 3.

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Table 1 (1 ; 2)

Material balances of soft tissues and excreta. Six persons injected i.v. with Pu(IV) citrate, Pu(VI) nitrate, or Pu(VI) citrate

	Pu(IV) Citrate			Pu(VI) Citrate			Pu(VI) Nitrate		
	Chi-1; 160 days p.i.			Chi-2; 17 days p.i.			Cal-1; 4 days p.i.		
	Male, 68 yr.			Female, 55 yr.			Male, 58 yr.		
	76.4 kg			38.6 kg			58 kg		
	% Pu/g[g]	wt (g)	Calc. (%) dose	% Pu/g[g]	wt (g)	Calc. (%) dose	% Pu/g[g]	wt (g)	Calc. (%) dose
Liver	0.0135	2,050[b]	27.8	0.0024	1,110	2.70		1508	-
Spleen	0.0025	260[b]	0.65	0.0012	85[b]	0.10	0.0019	167[b]	0.32
Kidney	0.00038	340[b]	0.12	0.0054	190[b]	1.03			
Lung	0.00058	1,950[b]	1.13	0.0016	490[b]	0.78			
Pancreas				0.0022	60[b]	0.13			
Intestines				0.00065	555	0.36			
Testes	0.00052	66	0.034						
Thyroid				0.0034	14	0.048			
Adrenals									
Muscle	0.00025[c]	30,560	8.98	0.0006	11,310	6.79	0.0004[c]	23,200	9.28
Skin		5,348		0.0006[c]	2,320	1.39	0.00058	4,550	2.64
Heart	0.00028	382	0.11	0.00105	250	0.26			
Diaphragm	0.00023								
Lung tumor	0.0017	32	0.054						
Lymph node	0.0015	764	1.16	0.00074	390	0.29			
Ovaries				0.00094	10	0.009			
Omentum							0.0004		
Subcutaneous tissue							0.0004		
Scar tissue							0.0011		
Residual soft tissue	0.00012[d]	23,800	2.98	0.0003[d]	14,700	4.41	0.0002[d]	16,690	3.34[h]
Blood									5.66
Excreted[e]			6.74			0.70			1.19
Total accounted for			49.8			19.0			25.7
Skeleton (calc.)		9,428	50.2		7,125[i]	81.0		9,428[i]	(mid-range 42.5)

Footnotes to Table I

[a] Body weight estimated to be the mean weight of six male cases whose body weights were recorded.

[b] Measured tissue weight.

[c] Pu concentrations in muscle and skin (when not measured) were estimated to be the average of other measured soft tissues such as heart, pancreas, etc.

[d] Pu concentration of residual soft tissue was estimated to be one-half the concentration in skin and muscle.

[e] Measured totals are used when available. Excretion between the cessation of collections and deaths of HP-5 and HP-9 was estimated from extrapolation of the last available measurements and the slopes of the U and F curves of persons followed for longer times. Excreta from HP-11 were estimated to be the mean for all the other Pu(IV) citrate-injected cases.

[f] Includes 7.95%, the average Pu content of blood of the two sickest persons (HP-4 and HP-10), from whom blood samples were obtained at this time.

[g] %/g of Pu recalculated from original data.

[h] Includes 3.25% estimated from the tissues of Chi-2, and HP-11.

[i] Chi-2 was emaciated; her skeleton was assumed to be the average reported by Mechanik[66] for slightly built females. Cal-1 had lost 15 lb during his illness; his skeletal weight was calculated from his body weight in good health, 64.8 kg.

APPENDIX 5

Reconstruction of whole rib from divided samples. Original data were consulted and computational and typographic errors corrected.

Case No.	Sample	Pu conc (%/g)	Sample weight (g)	% dose in sample
Chi-1	Sternum	0.0047	4.38	
	Rib, cortex	0.0016	1.0125	0.0016
	Periosteum	0.0046	0.1215	0.00056
	Marrow & spicules[a]	0.0160	0.8292	0.0133
	Whole rib (calculated)	0.0079	1.963	0.0155
Chi-2	Rib, cortex	0.0210	0.43	0.0090
	Marrow	0.0196	0.2065	0.0040
	Whole rib (calculated)	0.020	0.6365	0.0013
Cal-1	Rib, cortex	0.0072	9.0	0.065
	Periosteum	0.0048	0.445	0.00216
	Trabeculae	0.0319	0.84	0.0269
	Marrow	0.0190	-	0.019
	Whole rib (calculated)	0.0081	140[b]	0.113

[a] Origin of marrow sample noted as rib in Russell and Nickson (Ref. 47).

[b] Whole rib sample weighed before division into four separate samples.

TABLE 6

INDIVIDUAL URINARY EXCRETION VALUES OF PLUTONIUM FOLLOWING INTRAVENOUS ADMINISTRATION TO HUMAN SUBJECTS (EXPRESSED AS PER CENT OF DOSE EXCRETED PER DAY)

DAYS POST INJECTION	PER CENT OF INJECTED DOSE EXCRETED PER DAY														
	Hp-1	Hp-2	Hp-3	Hp-4	Hp-5	Hp-6	Hp-7	Hp-8	Hp-9	Hp-10	Hp-12	Chi-1	Chi.-2	Chi.-3(2)	Cal.-1(3)
1	.181	.472	.569	.440	.296	-	.217	.377	.160	.414	.101	.857	2.531*	.152	.480
2	.146	.294	.289	.236	.166	.216	.212	.232	.085	.330	.103	.182	.153	.167	.150
3	.114	.174	.112	.221	.077	.127	.137	.128	.069	.218	.088	.063	.184	.067	.120
4	.094	.123	.107	.152	.052	.111	.096	.140	.066	.170	.078	.077	.133	.033	.031
5	.069	.118	.078	.116	.030	.076	.069	.083	.047	.089	.068	.026	.032	.042	.037
6	.066	.061	.043	.119*	.020	.057	.059	.078	.052	.060	.044	.0256	.029	.042	-
7	.062	.062	.043	.077	.033	.044	.045	.066	.050	.079	.069	.0234	.024	.024	-
8	.055	.048	.049	.081	.026	.043	.037	.057	.032	.065	.080	.0227	.023	.025	.016
9	.051	.046	.022	.095*	.027	.032	.033	.047	.032	.051	.043	-	.027	.019	.069
10	.045	.038	.027	.081*	.022	.031	.023	.050	.035	.044	.038	.0082*	.034	.030	.026
11	.040	.048	.027	.075*	.021	-	.018	.044	.026	.041	.038	.0097	.047	.019	.036
12	.038	.039	.015	.072*	.026	.024	.019	.023	.030	.038	.027	.0095	.047	.014	.029
13	.034	.045	.020	.067*	.023	.023	.019	.037	.027	.029	.030	.0236	.018	.034	-
14	.035	.036	.020	.058*	.018	.020	.013	.035	.030	.029	.039	.007	.034	.009	-
15	.034	.039	.026	.050	.015	.022	.012	.035	.030	.025	.029	.0059	.026	.016	.013
16	.026	.024	.024	.033	.020	.017	.012	.036	.049*	.021	.023	.0109	.012	.004	.016
17	.027	.027	.021	.032	.020	.013	.011	.032	.038	.023	.029	-	.028	-	.0056
18	.026	.020	.017	.037	.020	.015	.011	.029	.027	.021	.026	-	.026	-	.010
19	.025	.019	.018	.032	.018	.015	.010	.031	.029	.017	.029	.0022	.015	-	.006
20	.017	.021	.012	.025	.021	.013	.008	.032	.029	.018	.032	.0093	.038	-	.0048
21	.017	.017	.019	.029	.020	.012	.010	.029	.032	.022	.025	.0076	.032	-	.0017
22	.018	.015	.014	.035	.018	.012	.013	.021	.032	.016	.025	.0145	.027	-	.0050
23	.025	.018	.014	.014	-	-	.008	.021	.032	.019	.039	.0151	.029	-	.0091
24	.021	.014	-	-	-	-	.008	.025	.032	.016	.023	.0128	.020	-	.0076
25	.013	.014	-	.011	-	-	.008	.023	.029	.016	.021	.0128	.148*	-	.011
26	-	.017	-	.011	-	-	.007	.022	.032	.016	.023	.0175	.024	-	.0022
27	-	.008	-	.008	-	-	.008	.028	.032	.014	.017	.0151	.043*	-	.0044
28	-	.009	-	-	-	-	.008	.023	.024	.013	.024	.0197	.034	-	.0074
29	-	.009	-	-	-	-	.008	.019	.025	.014	.023	.0138	.022	-	.0043
30	-	.008	-	-	-	-	.006	.021	.023	.014	.021	.0151	.024	-	.0069
31	-	.007	-	-	-	-	.005	.017	.025	-	.021	.010	.027	-	.0077
32	-	.007	-	-	-	-	.007	.016	.024	-	.012	.010	.020	-	.0063
33	-	.009	-	-	-	-	.006	.015	.022	-	.037*	.017	.011	-	.0073
34	-	.009	-	-	-	-	.008	.015	.020	-	.020	.0139	.008	-	.0084
35	-	-	-	-	-	-	.006	-	.022	-	.026	.0127	.009	-	.0069
36	-	-	-	-	-	-	.006	.015	.022	-	.018	.0165	.015	-	.0079
37	-	-	-	-	-	-	.006	.011	-	-	.023*	.0111	.011	-	.0063
38	-	-	-	-	-	-	-	.016	-	-	.018	.0174	.009	-	.0085
39	-	-	-	-	-	-	-	.012	-	-	.021	.0112	.009	-	.0064
40	-	-	-	-	-	-	-	.017	-	-	.019	.0072	.009	-	.0072
41	-	-	-	-	-	-	-	.019	-	-	.013	.0092	.011	-	.0080
42	-	-	-	-	-	-	-	.014	-	-	.013	.0127	-	-	.0081
43	-	-	-	-	-	-	-	.018	-	-	.015	.0095	.017	-	.0076
44	-	-	-	-	-	-	-	.014	-	-	.015	.0031	-	-	.0055
45	-	-	-	-	-	-	-	.013	-	-	.017	.013	.018	-	.0063
46	-	-	-	-	-	-	-	.015	-	-	-	.012	-	-	.0072
47	-	-	-	-	-	-	-	.014	-	-	.015	-	.020	-	.0059
48	-	-	-	-	-	-	-	.014	-	-	.017	.0084	-	-	.0059
49	-	-	-	-	-	-	-	.018	-	-	.015	.0083	-	-	.0063
50	-	-	-	-	-	-	-	.014	-	-	-	.0054	.018	-	.0078
51	-	-	-	-	-	-	-	.013	-	-	-	.007	-	-	.0082
52	-	-	-	-	-	-	-	-	-	-	.035	.0073	-	-	.0098
53	-	-	-	-	-	-	-	.013	-	-	.019	.0023	-	-	.0074
54	-	-	-	-	-	-	-	.013	-	-	.043	-	-	-	.0077
55	-	-	-	-	-	-	-	.015	-	-	.043*	.0073	.014	-	.0096
56	-	-	-	-	-	-	-	.013	-	-	.036	.003	-	-	.0064
57	-	-	-	-	-	-	-	.012	-	-	.018	.0075	-	-	.0050
58	-	-	-	-	-	-	-	.013	-	-	.036	.0094	-	-	.0058
59	-	-	-	-	-	-	-	.012	-	-	-	.011	-	-	.0098
60	-	-	-	-	-	-	-	.011	-	-	-	.0083	.022	-	.0067
61	-	-	-	-	-	-	-	.012	-	-	-	.0063	-	-	.0066
62	-	-	-	-	-	-	-	.010	-	-	-	.0092	-	-	.0053
63	-	-	-	-	-	-	-	.009	-	-	-	.0054	-	-	.0077
64	-	-	-	-	-	-	-	.012	-	-	-	.0071	-	-	.0042
65	-	-	-	-	-	-	-	.011	-	-	-	.0099	.024	-	.0042
66	-	-	-	-	-	-	-	-	-	-	-	.014	-	-	.0047
67	-	-	-	-	-	-	-	-	-	-	-	.014	-	-	.0054
68	-	-	-	-	-	-	-	-	-	-	-	.011	-	-	.0063
69	-	-	-	-	-	-	-	-	-	-	-	.011	-	-	.0070
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71	-	-	-	-	-	-	-	-	-	-	-	.0096	-	-	.0072
72	-	-	-	-	-	-	-	-	-	-	-	.0089	.014	-	.0082
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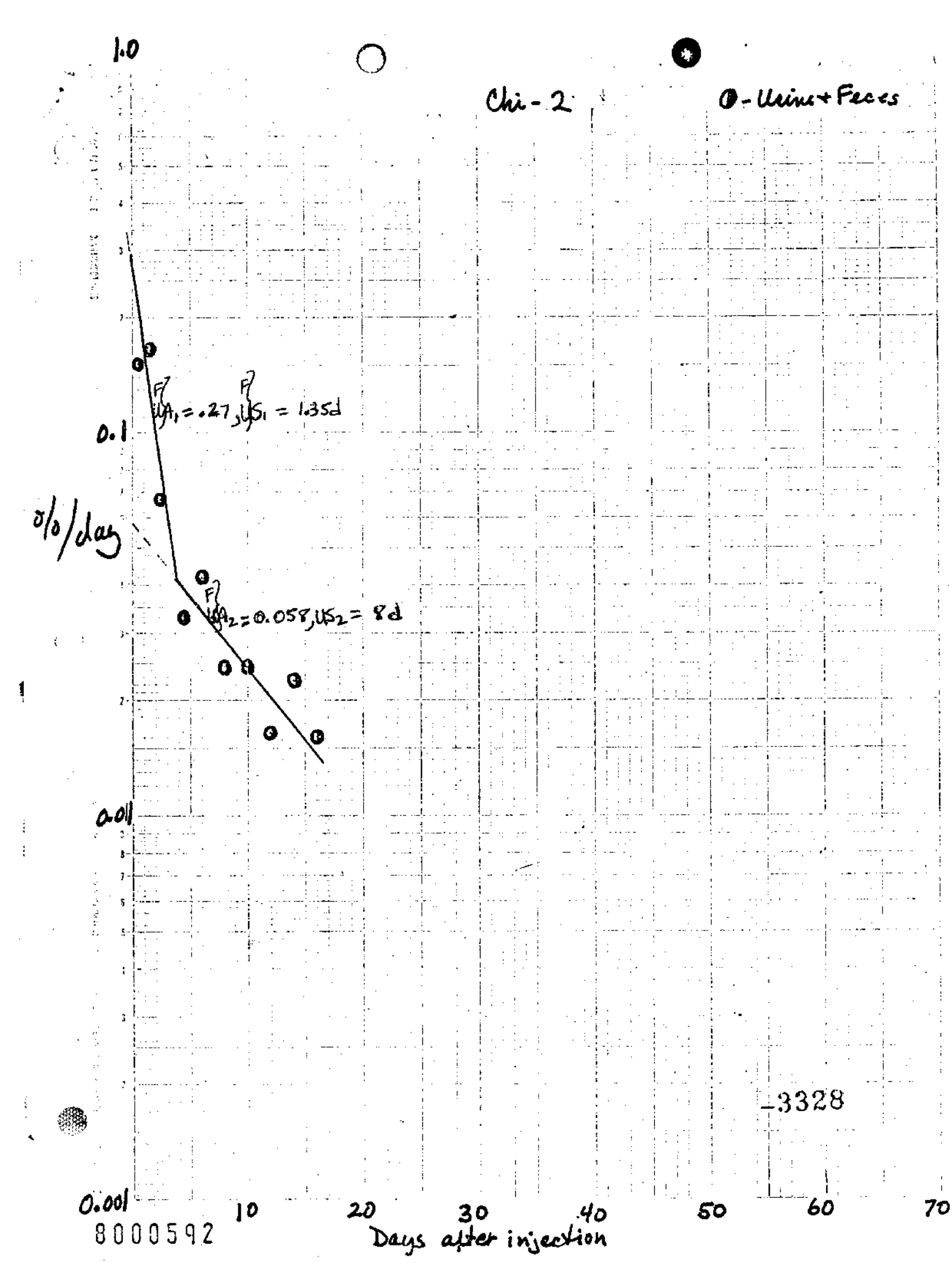
Ch-3e07 Ch-3e9



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J.E. Rose, Associate Section Chief

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REPORT FOR MONTH OF JANUARY 1946

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000594

January 19, 1946

To: Dr. R.S. Stone

From: Dr. J.J. Nickson

Subject: Monthly Summary for Section H-III

I. Routine Urine Survey for Plutonium Activity

A. Urine Specimens received

Chicago	80
Other	10

B. Backlog of specimens

Chicago	51
Other	28

C. Specimens analyzed

Chicago	69
Other	38

Of the Chicago specimens analyzed, 7.3 per cent showed a body content of plutonium greater than 0.1 µg, 32 per cent showed negative counts (maximum being less than 0.1 count per minute) and the remainder showed less than 0.1 µg retained in the body.

The laboratory which was designed to be dust-free in order to avoid outside contamination has not met the specifications. However, control urines have been run quite frequently and none have shown counts in excess of 0.1 count per minute per 1000 ml sample.

Special Urines: Two humans were injected with 94.91 µg of plutonium on December 27, 1945. The composition of the injected solution and the volume injected is given in Table I. The urinary plutonium excretion for the male subject is given in Table II and for the female in Table III.

Table I

Composition of Solution

Plutonium concentration	21.57 μg/ml
Volume injected (each)	4.4 ml
pH	6.5
Sodium citrate	0.01 M
Isotonic Saline	

Table II

Daily Plutonium Urinary Excretion (Halo)
HK-200

Days after injection	24 hour volume	Specific gravity	Percent of injected dose excreted
1	1130 ml	1.014	0.857
2	1425 ml	1.013	0.182
3	940 ml	1.012	0.063
4	1400 ml	1.012	0.077
5	1160 ml	1.012	0.026
6	1270 ml	1.014	0.0256
7	1290 ml	1.012	0.0234
8	940 ml	1.012	0.0227
9	550 ml	1.012	0.0082
10	535 ml	1.012	0.0097
11	650 ml	1.010	0.0097
12	640 ml	1.010	
13	640 ml	1.010	

Table XII

Daily Plutonium Urinary Excretion (Female-UK-300)

Days after injection	24-hour volume	specific gravity	percent of injected dose excreted
1	1660 ml	1.012	0.152
2	1725 ml	1.010	0.167
3	1750 ml	1.012	0.067
4	1150 ml	1.012	0.033
5	2020 ml	1.010	0.042
6	1300 ml	1.010	0.042
7	1190 ml	1.010	0.0249
8	1900 ml	1.010	0.0254
9	1400 ml	1.010	0.019
10	1280 ml	1.010	0.030
11	1320 ml	1.010	0.019
12	940 ml	1.010	0.014
13	975 ml	1.010	
14	690 ml	1.010	
15	820 ml	1.010	

Plutonium Therapy: Studies are being completed on the effect of pH and citric acid concentration on the diffusibility of Pu(IV) through collophane membranes using low pressure ultrafiltration techniques. A report summarizing the results obtained in preliminary studies of Pu therapy is being prepared.

Results of ultrafiltration to date show that a pH of about 2.5 immediately precedes a steep drop in the extent of Pu(IV) which is diffusible, thus indicating, it is presumed, the onset of definite colloidality. At a pH of 7.3 and in the presence of varying amounts of citric acid, it is found that:

(a) As little as 0.0001 M citric acid appreciably increases the diffusibility of Pu.

(b) A minimum in the diffusability of Pu occurs at .005 - .006 M citric acid. This phenomenon, if confirmable, may be

H.G. Russell Report

No. #ERR-129 N-L

This document consists of 3 pages and 0 figures. No. 1 of 3 copies, Series A.

[redacted]

11 January 1946

To: Dr. J. J. Nickson

From: E. R. Russell

In Re: Abstract of Work for the Month Ending January 11, 1946 for Plutonium activity

I. Routine Urine Survey - 249-MLH-3501

A. Urine Specimens Received

Chicago	80
Other	10

B. Backlog of Specimens

Chicago	51
Other	28

C. Specimens Analysed

Chicago	69
Other	38

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For the Atomic Energy Commission
RAYMOND A. CARPENTER for the
Chief, Declassification Branch

Of the Chicago specimens analysed, 7.3% showed a body content of plutonium greater than 0.1 ug, 32% showed negative counts (maximum being less than 0.1 count per minute) and the remainder showed less than 0.1 ug retained in the body.

The laboratory which was designed to be dust-free in order to avoid outside contamination has not met the specifications. However, control urines have been run quite frequently and none have shown α counts in excess of 0.1 count per minute per 1000 ml sample.

Special Urines: Two humans were injected with 94.91 ug of plutonium on December 27, 1945. The composition of the injected solution and the volume injected is given in Table I. The urinary plutonium excretion for the male subject is given in Table II and for the female in Table III.

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8000598

Table I

Composition of Solution

Plutonium Concentration. . .	21.57 ug/ml
Volume injected (each) . . .	4.4 ml
pH	6.5
Sodium citrate	0.01 M
Isotonic Saline	

Table II

Daily Plutonium Urinary Excretion (Male)

MX-200

Chicago Core #3 RER 12/19/72

Days after Injection	24-hour volume	Specific Gravity	% of injected dose excreted
1	1130 ml	1.014	0.857
2	1425 500	1.013 010	0.182
3	940 400	1.012 010	0.063
4	1400 290	1.012 010	0.077
5	1160 120	1.012 010	0.026
6	1270 940	1.014	0.0256
7	1290 875	1.012 010	0.0234
8	9940 030	1.012 010	0.0227
9	550 930	1.012 020	0.0082
10	535	1.012	0.0097
11	650	1.010	0.0097
12	640	1.010	
13	640	1.010	

0000599

Table III

RER 12/19/72

Daily Plutonium Urinary Excretion
(Female-WX-300)

Chicago Case #2

Days after Injection	24-hour volume	Specific gravity	% of Injected dose excreted
1	1660 ml	1.012	0.152
2	1725	1.010	0.167
3	1750	1.012	0.067
4	1150	1.012	0.0335
5	2020	1.010	0.042
6	1300	1.010	0.042
7	1190	1.010	0.0243
8	1500	1.010	0.0254
9	1400	1.010	0.019
10	1280	1.010	0.030
11	1120	1.010	0.019
12	940	1.010	0.014
13	875	1.010	
14	630	1.010	
15	830	1.010	

Plutonium Therapy: Studies are being completed on the effect of pH and citric acid concentration on the diffusibility of Pu(IV) through cellophane membranes using low pressure ultrafiltration techniques. A report summarizing the results obtained in preliminary studies of Pu therapy is being prepared.

Results of ultrafiltration to date show that a pH of about 2.5 immediately precedes a steep drop in the extent of Pu(IV) which is diffusible, thus indicating, it is presumed, the onset of definite colloidality. At a pH of 7.3 and in the presence of varying amounts of citric acid, it is found that:

(a) As little as 0.0001 M citric acid appreciably increases the diffusibility of Pu.

(b) A minimum in the diffusability of Pu occurs at .005-.006M citric acid. This phenomenon, if confirmable, may be related to the neutralization of a positively charged Pu colloid by the negatively charged citrate ion. Migration experiments are planned to study the sign on the Pu colloid and complex directly.

Outside
Medical

Name [redacted] Age 55 Occup. High School Teacher No. 6670

Institution Billings Memorial Hospital 371183

Clinical Diagnosis Carcinomatosis from axillary breast tissue

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PRIVACY ACT MATERIAL REMOVED

MAR 4 1977

Att. Phys. Dr. George Dick Post-mortem by Dr. E. P. Benditt

Date and Hour of Death 1-13-46 at 1:30 PM Date and Hour of Post-mortem 1-13-46 at 3:30 PM

ANATOMICAL DIAGNOSIS:

(Dual malignancy). Adenocarcinoma (mixed mucinous and scirrhous types), arising in ectopic left axillary breast tissue, metastatic to liver, mesentery of the small intestine, lumbar vertebrae, ribs, skull and pelvis. Adenofibroma of left breast. Same in right breast with degeneration. Lymphoblastoma. Healing pathologic fractures of ribs 3, 4, and 5 on the right. Left obliterative pleuritis. Pulmonary emphysema and edema. Calcification in the anterior left 4th intercostal space. Double ureter, right kidney. Marked aortic and coronary atherosclerosis. Thrombosis of the pelvic veins. Small fibroma, right ovary.

EXTERNAL APPEARANCE: The body is that of an emaciated 55 year old white female who appears 10 years older than the stated age. She is 61 inches in length and weighs 85 pounds. The body is pale with little dependent cyanosis. On the head is a large quantity of graying red hair. There are no obvious scars on the scalp. The eyes are centered and the pupils dilated and slightly irregular. The sclerae are clear. The nose is not obstructed. The teeth are in good repair. The buccal mucosa is pale with no obvious lesions. The oral mucosa and tongue are covered with a dark dry brown coating. The trachea is in the midline and no masses are grossly palpable in the neck. The chest is symmetrical. Beneath the margin of the right anterior axillary fold at the levels of the 3rd, 4th and 5th ribs there is a slight palpable depression in the bony thorax, with some irregularity of the ribs. The breasts are of moderate size and show no irregularity in outline. In the left upper outer quadrant of the left breast is a palpable nodule approximately 1 cm. in diameter and above this a larger area of slight firmness and induration. Just beneath the anterior axillary fold in the left axilla is a large firm mass approximately the size of a small lemon and over this is an incision along the anterior axillary fold measuring approximately 5 cms. in length. The incision appears recent. In the right axilla several almond to walnut sized nodes are palpable. In the right groin just lateral to the tubercle of the pubis is a firm smooth rounded mass approximately the size of a walnut. The abdomen is scaphoid and without scars. The upper and lower extremities are symmetrical. There is no pitting edema.

PRIVACY ACT MATERIAL REMOVED

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ABDOMINAL CAVITY: The peritoneal surfaces are smooth and glistening. The bowel is collapsed throughout. Its peritoneal surface is normal. The liver extends a few cms. below the costal margin in its medial portion only. The other abdominal viscera appear normal. The abdominal fat pad measures 2 cms. in thickness and the musculature is thin but of a good color. Careful sections through the left breast reveal only a nodule 1 cm. in diameter with a smooth white capsule and a central caseous slightly yellowish center. This is 2 cms. above and approximately 2 cms. lateral to the nipple. The upper outer quadrant of this breast shows only fatty tissue and nothing to account for the externally palpable induration. The right breast is entirely normal except for a small nodule about 8 mms. in diameter which is well encapsulated and consists principally of whorls of white fibrous tissue with a little central softening of a caseous nature. This lies several cms. above the nipple. In the left axilla is a hard cone-shaped mass with its base in the axillary skin and its apex attached to the second rib in its lateral portion. On section the mass is composed of matted lymph nodes, several of which are large, pale, slightly tan and rather soft. Several others are infiltrated with firm white nodules. A few small vessels appear thrombosed. Approximately in the center of the mass is a small white scirrhous area measuring about 3 mms. in its broadest portion, 2 cms. long in its central portion and fraying out at both ends in white fibrous strands.

PLEURAL CAVITIES: The right pleural cavity has a smooth glistening surface and no excess fluid. The left pleural cavity is completely obliterated by rather thick fibrous tissue. In the anterior portion of the 4th intercostal space in the left is a plaque measuring 1 - 2 cms. in cross section, the exterior portions of which appear slightly calcified; the center is composed of pale yellowish cheesy material.

PERICARDIAL CAVITY: This contains a few ccs. of yellowish fluid. Its surfaces are smooth and glistening. It is not otherwise remarkable.

MOUTH AND PHARYNX: See External Appearance.

ESOPHAGUS: Normal.

THYROID AND THYMUS: The thymus is not visible in the anterior mediastinal fat. The thyroid is of normal size, not nodular.

HEART, AORTA AND VESSELS: The emptied heart weighs 250 gms.. Its pericardial surface is normal. The musculature has a normal color. The left ventricle measures 12-13 mms. in thickness, the right 3 mms. in thickness. The valve cusps all appear normal. The tricuspid measures 10.5 cms., pulmonary 7 cms., mitral 8.5 cms., and aortic 6.5 cms. in circumference. The coronary circulation has normal configuration. It shows a rather marked degree of atherosclerosis. The aorta has a normal configuration. It shows marked sclerosis with calcification which is most extreme in the inferior abdominal portion.

LUNGS: The right lung weighs 240 gms., the left 250 gms.. The right has a smooth grayish pink external surface mottled with black. It is crepitant throughout. On section it shows a similar color and no excess fluid can be expressed from the cut surface. The pleural surface of the left lung is thick and has a shaggy reddish exterior. The lung is crepitant throughout. On section it is entirely similar to the left lung.

PERIBRONCHIAL LYMPH NODES: These are small, grayish black and soft. On section the centers are grayish with a thick peripheral black rim and not otherwise remarkable.

LIVER AND GALL BLADDER: The liver weighs 1110 gms.. The capsular surface is smooth, glistening and reddish brown, studded with round rather sharply demarcated white firm nodules with umbilicated centers. These nodules vary in size from 1 - 4 cms. in diameter. On section the surface is a similar reddish brown with essentially normal lobular markings and this same studding with numerous round white nodules with slightly softened centers in many instances. In the medial and apical portion of the left lobe is one very large hard white nodule measuring 3 x 4 cms. in cross section. The gall bladder is relatively small and thin-walled. Bile can be expressed with ease through the papilla of Vater. Its mucosa is not remarkable.

SPLEEN: The spleen weighs 85 gms.. It has a smooth capsule. On section it is a reddish purple with moderately prominent follicles and is not otherwise remarkable.

PANCREAS: This is small, weighing 60 gms.. It has a normal color and shows a very slight fatty infiltration.

GASTRO-INTESTINAL TRACT: The stomach is normal. The small bowel is thin and collapsed. Along the mesenteric border of the small bowel are scattered small white firm nodules measuring from 3-4 mms. to 1 cm. in diameter. In the upper portion of the ileum, immediately adjacent to the mesenteric border of the bowel, is a large mass measuring 2 x 2 x 1 cms. in size and composed of similar firm white tumor tissue. The large bowel down to and including the rectum is quite normal. The appendix is small and not abnormal.

KIDNEYS: The right kidney weighs 80 gms., the left 110 gms.. Their capsular surfaces are smooth. The capsules strip with ease. On section there is a slight bulging of the cut surface. The cortices are of normal thickness and an extremely pale slightly yellowish color. They are sharply demarcated from the medullary portions which appear normal. The left kidney has a double pelvis.

URINARY TRACT: The right ureter is of normal size, contains a little thin yellowish white material and empties normally into the bladder. The left ureter is double arising, as mentioned above, from two pelves in the left kidney. The two ureters proceed independently to within 0.5 cm. of the bladder where they join and there a slightly dilated single ureter enters the bladder normally. The bladder is

small, containing a few ccs. of thin yellowish white material. The mucosal surface of the bladder is not remarkable except for a little reddening in the region of the trigone.

GENERATIVE ORGANS: The introitus is virginal, the cervix nulliparous. The uterus is normal, as are the Fallopian tubes. The left ovary is small and fibrosed. The right ovary is small and pale and white. Attached to its upper pole is a nodule measuring about 8 mms. in diameter, which is firm and white on cross section.

LYMPH NODES IN GENERAL: The retroperitoneal lymph nodes surrounding the inferior portion of the aorta and the lymph nodes extending along the iliac vessels down to the inguinal ligaments are markedly enlarged. They measure from 1 cm. to 4 cms. in diameter. Those along the aorta are elongated to several cms. in length. They have a smooth outline, show a little matting together where they are contiguous and a very pale tan. They are soft and on section show a peripheral pale rim with a slightly browner central area. The lymph nodes of the left axilla have been described. Those in the right axilla are moderately enlarged measuring 1.5 x 1 cm. in cross section and resemble the nodes just described in the pelvis.

BRAIN, MENINGES AND SPINAL CORD: Not examined.

MUSCULAR SYSTEM: The muscles are thin, somewhat pale and poorly developed.

SKELETON: The right 3, 4 and 5th ribs and their antero-lateral portions show depressed fractures with some evidence of healing. The 12th thoracic vertebral body is completely replaced by a yellow cheesy material and the vertebra is collapsed to one-third its normal thickness. The 1st and 2nd lumbar vertebrae are infiltrated by rather firm white tissue which shows a little central yellowish degeneration. The left ilium is not remarkable.

CLINICAL HISTORY: This 56 year old white female school teacher entered AMBH on December 3, 1945. The complaints were pain in the ribs, sternum and sacro-iliac regions and enlarged tender lymph nodes (especially the left axillary) of five months' duration. She had been extremely ill at 20 with tuberculosis of the spine and lungs. She made a complete recovery in 4 years and since that time had been well excepting recurrent attacks of pan-sinusitis. In August, 1945, she experienced pains in the right sacro-iliac region and chest, accompanied by generalized lymphadenopathy. In October she came to Chicago and consulted a hematologist. The diagnosis was: Infectious mononucleosis. The pains persisted and have been associated with 12 pounds weight loss, evening fever, anorexia and thirst. Physical examination revealed enlarged cervical, axillary and inguinal nodes; pain, tenderness and deformity of the dorsal spine; pain and tenderness of the thoracic cage; slight enlargement of the left breast with a soft fluctuant mass in the anterior axillary line; and apical systolic murmur. was negative. Urinalysis was sp. gr. 1010 with 3-4 WBC/hpf in catheterized specimen. The blood count revealed:

RBC 4.6, WBC 9,100, Hb. 14.6, neutrophils 82% and lymphocytes 18%. Blood chemistry showed NPN 60, alkaline phosphatase 17.2, total proteins 7.32, albumin 4.62, blobulin 2.70 and urea clearance 13. X-ray reported minimal hilar and adjacent pulmonary parenchymal calcified tuberculosis; old fused, calcified tuberculosis of L 1-2 and T 12; multiple areas of decreased density in ribs, thoracic and lumbar spine, both ilia, and skull; normal gall bladder, atrophic right kidney with faint visualization on both sides. A diagnosis of multiple myeloma or carcinoma with multiple metastases to bone was made. The tuberculin test was negative. No Bance-Jones protein was found in the urine. A biopsy of the left axillary mass and skull established a diagnosis of carcinoma of aberrant breast tissue with metastasis. The patient was started on U medication. However, she began to vomit and could take nothing by mouth after the time of the biopsy. She became progressively worse and died January 1, 1946.

HISTOPATHOLOGY

Left axilla: All fibrous connective tissue is infiltrated with tumor cells having large hyperchromatic nuclei and cytoplasm wither scanty or filled with large vacuoles. In some areas, particularly one small lymph node the cells are signet rings with definite mucin in the cytoplasm. The tumor has largely replaced the lymph nodes which are present. In these the growth is in multicellular cords with moderate amounts of stroma. (The architecture of the lymph nodes is described below). No definite single focus of origin is evident in these sections. A few mitoses are present.

Ribs: The marrow is almost entirely replaced by tumor. The bone shows some thinning of its cortex plus definite new bone formation. Bone from the pelvis and 4th lumbar vertebrae is similar.

Bone marrow: All places examined are largely replaced by the tumor. What remains is active with a marked relative increase in the numbers of eosinophilic myelocytes and mature forms. Erythroblastic activity is not prominent.

Spleen: There is moderate passive hyperemia and a marked hemosiderosis. The lymph follicles appear active and not abnormal. Red pulp shows a marked myeloid metaplasia with many eosinophiles and a moderate number of mature polymorphs.

Lymph nodes: (Peribronchial, axillary, periaortic, pelvic). All are similar in their basic architecture. The fibrous trabeculae remain. There are no follicles evident, nor any sinusoidal structure. The node is uniformly filled with small lymphoblasts. These have invaded through the capsule in many places and lie in the adjacent fatty connective tissue.

Liver: Both sections show several small metastases of rather cellular tumor. The liver cells contain some fine droplet and scattered focal accumulations of large droplet fat. Hepatic cells all contain yellow perinuclear pigment. There is hemosiderin in many Kupffer cells.

Pancreas: Moderate fatty infiltration is present.

Adrenal: Not remarkable.

Thyroid: Normal.

Ovary: Atrophy with no evident ova. At the upper pole is a small hyalinized fibroma.

Uterus: Atrophy and arterial sclerosis.

Breast: Atrophic. Small intracanalicular adenofibroma with marked hyalinization is present in right breast. Section from left breast. Cystic structure filled with fatty debris containing many cholesterol slits. A mass of lipophages bordered by an area of fibrous tissue containing many hemosiderinophages is present at one edge, and the adjacent capsule also contains many hemosiderinophages.
Kidney: Scattered fibrosed glomeruli are present. Many convoluted tubules are filled with bluish hyaline casts. Tubular epithelium shows evidence of degeneration and repair.
Heart: Moderate diffuse fibrosis of the left myocardium.
Aorta: Marked atherosclerosis with beginning calcification.
Coronary arteries: Moderate atherosclerosis with calcification.
Lungs: Emphysema with thin walled alveoli is present diffusely. There is scattered focal edema and hyperemia with hemorrhage in a section from the lower lobe. One curious area with thick walled alveoli taking a marked bluish stain is present immediately adjacent to an ordinary area of emphysema. In this peculiar area edema is marked.
Large intestine: Normal mucosa with a little pseudo melanin pigment. The mesentery is heavily infiltrated with tumor.

Comment: Comparison of the biopsy sections with the post mortem sections shows no evident difference in the character of the tumor despite "U" therapy. Also present in the biopsy section of lymph node is the lymphoblastoma. This rules out the possibility that it was induced by the medication. Moreover there appears to be no obvious difference between the sections taken before and after medication was begun.

PRIVACY ACT MATERIAL REMOVED

THIS IS A NON-RESIDENT DEATH, PLEASE ALLOCATE TO PLACE OF RESIDENCE OF DECE...

N.R.

FILL IN THIS FORM (except signat...) WITH TYPEWRITER OR LEGIBLE PRINTING

STATE OF ILLINOIS — ORIGINAL

DEPARTMENT OF PUBLIC HEALTH—DIVISION OF VITAL STATISTICS

CERTIFICATE OF DEATH

1. PLACE OF DEATH. County of COOK

Registration ——— Dist. No. ———

CHICAGO {*Village *City} *Township *Road Dist. Primary Dist. No.

*(Cancel the three terms not applicable—Do not enter "R. R.," "R. F. D.," or other P. O. address)

Registered No. ——

Street and Number, No. 950 E. 59TH St. 5TH Ward A.M. BILLINGS (Consecutive No.) Hospital

(If death occurred in a hospital or institution, give its NAME instead of street and number.)

LENGTH OF TIME AT PLACE WHERE DEATH OCCURRED? 0 yrs. 1 mos. 10 ds.

2. PLACE OF RESIDENCE: STATE ILLINOIS County COOK Township LYONS Road Dist. ——
(Usual place of abode—Do not enter "R. R.," "R. F. D." or other P. O. address)
City or Village — Street and Number —

19. LIST NO. 50

3 (a) PRINT FULL NAME

3 (b) If veteran, name war None — 3 (c) Social Security No. UNKNOWN

4. Sex FEMALE — 5. Color or race WHITE — 6 (a) Single, widowed, married, divorced SINGLE

6 (b) Name of husband or wife — 6 (c) Age of husband or wife if alive — years

7. Birth date of deceased (Month) (Day) (Year)

8. AGE: Years 56 Months 11 Days 18 — If less than one day — hr. — min.

9. Birthplace CINCINNATI OHIO (City, town, or county) (State or foreign country)

10. Usual occupation TEACHER

11. Industry or business

FATHER 12. Name — 13. Birthplace CINCINNATI OHIO (City, town, or county) (State or foreign country)

MOTHER 14. Maiden name — 15. Birthplace MADISON INDIANA (City, town, or county) (State or foreign country)

16. INFORMANT Marilyn Fletcher (hosp. rec.) (personal signature with pen and ink)

P. O. Address 950 E. 59th Street

17. PLACE OF BURIAL, Cremation or Removal ... (b) DATE 1-15 1946

(a) Cemetery. — Location Westchester (Township, Road Dist., Village or City)

County Cook State Ill

18. Funeral director — ADDRESS 170 ...

(personal signature with pen and ink) — License No. 4560 — (firm name, if any)

MEDICAL CERTIFICATE OF DEATH

20. Date of death: Month JANUARY day 13 year 1946 hour 1 minute 30 PM

21. I hereby certify that I attended the deceased from 12/5 1945 to 1/13 1946; that I last saw her alive on 1/13 1946, and that death occurred on the date and hour stated above.

Immediate cause of death: METASTATIC CARCINOMA OF ABERRANT BREAST TISSUE — Duration 5 MO.

Associated diseases.

Other conditions (Include pregnancy within 3 months of death)

Was an operation performed? YES Date of 12/20/46

For what disease or injury? C.A. OF ABERRANT BREAST

Was there an autopsy? YES

Findings? METASTATIC C.A. OF BREAST – LIVER, MESENTERY + BONES.

22. If a communicable disease; where contracted? NONE

Was disease in any way related to occupation of deceased? NO

If so, specify how:

(Signed) Norman B. McCullagh M.D.

Address Norman B. 950 E 59 St. Chgo Ill

Date 1-14 1946 Telephone

*N. B.—State the disease causing death. All cases of death from "violence, casualty, or any undue means" must be referred to the coroner. See Section 18 Coroner's Act.

23. Filed 1-14-46 [signature] 19 Registrar.

P. O. Address — 1946 JAN 14 PM 10 66 Ill.

THIS COPY FOR SCIENTIFIC RESEARCH PURPOSES ONLY — ILLINOIS DEPARTMENT OF PUBLIC HEALTH

PRIVACY ACT MATERIAL REMOVED

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ARGONNE NATIONAL LABORATORY — CENTER FOR HUMAN RADIOBIOLOGY

PROPOSAL FOR EXHUMATION	Proposed by AFS (JEH)	Date 4/1/73

PRIVACY ACT MATERIAL REMOVED PROSPECTIVE CASE DATA

Name	Case No.	Date of birth
CH1-11	40--005	

Date of death	Place of death	Autopsy?	Remains
1/13/46	CHICAGO	__ Yes X No	__ Normal X Cremains

RADIOACTIVITY DATA

EXPOSURE:	Company, Hospital, M.D., etc. (18) BILLINGS HOSP. CHICAGO		Type Pu 45
INTAKE:	Radionuclide, Amount (if known) ^{239}Pu (IV) citrate 5.8 μCi	Dates From DEC. 27, 1945	To
RESIDUAL:	Nuclide Amt. Date Lab	Nuclide Amt. Date Lab	

REASONS FOR POST-MORTEM STUDIES

X Unknown body burden — X Priority group — __ Known intake — __ Medical
__ Calibration comparison — __ Ra-228/Ra-226 — X Distribution — __ Other

EXPLANATION ^{239}Pu

PROPOSED ANALYSES Radiochem. for % retention of injected dose. Pu autos, Path. micros and X-rays.

REVIEW AND AUTHORIZATION

Number of known relatives	Estimated number of consents needed	Court action anticipated
		__ Yes X No

Cemetery	Address	Cooperative?
	WESTCHESTER, Ill.	__ Yes __ No X Never used
Funeral Home	Address	__ Yes __ No X Never used

Prognosis of suitable remains	Reason:	By JEH
X Good __ Fair __ Poor	Expect burial was in vault	Date 4/3/75

Comments:

PRIVACY ACT MATERIAL REMOVED

RECOMMENDATION: __ Yes __ No __ Cannot say _____ Scientific Reviewer _____ Date

Comments: Authorized for exhumation in AFS memo to MMS 3/24/73

Assignment of responsibility for permits

APPROVAL? __ Yes __ No __ Defer _____ Director of CHR _____ Date

0190008

[redacted]

8000611

file type = PDS

PRIVACY ACT MATERIAL REMOVED

Description	Case #									
metastatic carcinoma of abdominal breast tissue DC	@M, 42-005	@A,T, 0401	M, 20141	E, 0000	F, 0000	D, 4601C	;
plutonium injection	@M,	@A,T, 0001	M, 1908	E,	F,	D, 4550J	;
adenocarcinoma (mixed mucinous and ductal) -	@M,	@A,T, 0403	M, 8483	E,	F,	D, 4601A	;
L breast (adipose axillary soft tissue)	@M,	@A,T,	M,	E,	F,	D,	;
metastases - liver	@M,	@A,T, 0000	M, 2436	E, 0000	F, 0000	D,	;
- mesentery of small intestine	@M,	@A,T, 6021	M,	E,	F,	D,	;
- lumbar vertebrae	@M,	@A,T, 1125	M,	E,	F,	D,	;
- ribs	@M,	@A,T, 1155	M,	E,	F,	D,	;
- skull	@M,	@A,T, 1110	M,	E,	F,	D,	;
- pelvis	@M,	@A,T, 1138	M,	E,	F,	D,	;
adenocarcinoma - L breast. Same as R breast	@M,	@A,T, 0401B	M, 9010	E,	F,	D,	;
- [illegible]	@M,	@A,T,	M,	E,	F,	D,	;
lymphoblastoma	@M,	@A,T, 0800 1956R	M, 9633 12.5[illegible]	E, 0000	F, 0000 0000	D,	;
healed pathologic fractures: R 3rd rib	@M,	@A,T, 1956R 1957R	M, 1280 1250	E, 0000	F, 0000	D, 4601A 4601C	;
4th	@M,	@A,T, 1957R 1958R	M, 1280 1250	E, 0000	F, 0000	D, 4601H	;
5th	@M,	@A,T, 1958R	M, 1280	E,	F,	D,	;
L obliterative pleuritis	@M,	@A,T, 2920	M, 4833	E,	F,	D,	;
pulmonary emphysema	@M,	@A,T, [illegible]	M, [illegible]	E,	F,	D,	;
edema	@M,	@A,T, 3800	M, 3482	E,	F,	D,	;

PRIVACY ACT MATERIAL REMOVED

Abstracted by [illegible] Date 6/1/80 Coded by [illegible] Date 6/1/80

8000612

Filename - SNOP
File type = PDS

escription	Case #									
abdication in ant. L 4th intercostal space	@M,	40-005	@A,T,	Y210L	M,	5541	E,	0000	F,	0000	D,	4601A ;
bubble nucleo - R kidney	@M,		@A,T,	7301	M,	8301	E,		F,		D,	;
atherosclerosis - aorta	@M,		@A,T,	4200	M,	5220	E,		F,		D,	;
" coronary arteries	@M,		@A,T,	4500	M,	5220	E,		F,		D,	;
thrombosis - pelvic veins	@M,		@A,T,	4380	M,	9700	E,		F,		D,	;
fibroma - R ovary	@M,		@A,T,	8761	M,	8810	E,		F,		D,	;
metastases - bone marrow	@M,		@A,T,	0600	M,	8486	E,		F,		D,	;
passive hyperemia - spleen	@M,		@A,T,	0700	M,	8311	E,		F,		D,	;
hemosiderosis	@M,		@A,T,	0700	M,	5131	E,		F,		D,	;
myeloid metaplasia - red pulp	@M,		@A,T,	0704	M,	7786	E,		F,		D,	;
fatty infiltration - pancreas	@M,		@A,T,	5900	M,	5521	E,		F,		D,	;
atrophy - ovaries	@M,		@A,T,	8200B	M,	1100	E,		F,		D,	;
" - uterus	@M,		@A,T,	8200	M,	7100	E,		F,		D,	;
antecal sclerosis - uterus	@M,		@A,T,	2200	M,	5200	E,		F,		D,	;
hyaline casts - convoluted tubules	@M,		@A,T,	3130	M,	8501	E,		F,		D,	;
diffuse fibrosis - L myocardium	@M,		@A,T,	3301L	M,	4800	E,		F,		D,	;
emphysema	@M,		@A,T,	2800	M,	8430	E,		F,		D,	;
constriction	@M,		@A,T,	0001	M,	7050	E,		F,		D,	;
recent incision - L axilla	@M,		@A,T,	Y810L	M,	1512	E,		F,		D,	;

Abstracted by rd Date 8/4/87 Coded by rd Date 8/4/87

880613

file type = PDS

PRIVACY ACT MATERIAL REMOVED

Page 5 of 4

Description		Case #			M		E		F		D	
double pelvis - L kidney	@M,	40-005	@A,T,	7202	M,	2303	E,	0000	F,	0000	D,	4601A	;
pain - ribs, hist of	@M,		@A,T,	1199	M,	0000	E,		F,	7530	D,	4546P	;
- sternum	@M,		@A,T,	1132	M,		E,		F,		D,		;
- sacroiliac region, hist of	@M,		@A,T,	Y141	M,		E,		F,		D,		;
enlarged, tender lymph nodes, hist of (cerv & axillary)	@M,		@A,T,	0800	M,	7200	E,		F,	7530	D,		;
tuberculous - spine, hist of	@M,		@A,T,	1120	M,	0000	E,	1751	F,	9492	D,	0946	;
- lungs	@M,		@A,T,	2800	M,	0000	E,	1751	F,	9492	D,	0946P	;
pansinusitis, hist of	@M,		@A,T,	2200	M,	4000	E,	0000	F,	0000	D,	1346P	;
lymphadenopathy - cervical	@M,		@A,T,	0820	M,	7200	E,		F,		D,	4546R	;
- axillary	@M,		@A,T,	0871	M,		E,		F,		D,		;
- inguinal	@M,		@A,T,	0881	M,		E,		F,		D,		;
pain + deformity - dorsal spine	@M,		@A,T,	1124	M,	3380	E,		F,	7530	D,		;
pain - thoracic cage	@M,		@A,T,	Y210	M,	0000	E,		F,	7530	D,		;
sl enlargement of L breast c mass	@M,		@A,T,	0403	M,	7200	E,		F,	0000	D,		;
in ant. axillary line	@M,		@A,T,	Y810L	M,	7210	E,		F,	0000	D,		;
apical systolic murmur	@M,		@A,T,	5500	M,	0000	E,		F,	7051	D,		;
hilar and pulm. parenchymal calcified TB	@M,		@A,T,	2800	M,		E,		F,	9495	D,		;
old fused calcified TB - 1.1.2	@M,		@A,T,	1922 1923	M,	0000	E,	0000	F,	9495 9495	D,		;
T 12	@M,		@A,T,	1921	M,		E,		F,	9495	D,		;

PRIVACY ACT MATERIAL REMOVED

Abstracted by cA Date 9/4/77 Coded by cD Date 9/4/77

8000614

file type = PDS

Description		Case #											
areas of dec density - ribs	@M,	40-005	@A,T,	1133	M,	9976	E,	0000	F,	0000	D,	4546R	;
- thoracic spine	@M,		@A,T,	1124	M,		E,		F,		D,		;
- lumbar spine	@M,		@A,T,	1125	M,		E,		F,		D,		;
- ilia	@M,		@A,T,	1134B	M,		E,		F,		D,		;
atrophic R kidney	@M,		@A,T,	7101	M,	7100	E,		F,		D,		;
biopsy - L axillary mass	@M,		@A,T,	Y8101	M,	1099	E,		F,		D,		;
	@M,		@A,T,		M,		E,		F,		D,		;
	@M,		@A,T,		M,		E,		F,		D,		;
	@M,		@A,T,		M,		E,		F,		D,		;
	@M,		@A,T,		M,		E,		F,		D,		;
	@M,		@A,T,		M,		E,		F,		D,		;
	@M,		@A,T,		M,		E,		F,		D,		;
	@M,		@A,T,		M,		E,		F,		D,		;
	@M,		@A,T,		M,		E,		F,		D,		;
	@M,		@A,T,		M,		E,		F,		D,		;
	@M,		@A,T,		M,		E,		F,		D,		;
	@M,		@A,T,		M,		E,		F,		D,		;
	@M,		@A,T,		M,		E,		F,		D,		;
	@M,		@A,T,		M,		E,		F,		D,		;

Abstracted by CA Date 9/4/77 Coded by CA Date 9/4/77