February 1, 1974 719563

TO: R. J. Michael Fry BIM

FROM: A. M. Brues and A. F. Stehney RER

SUBJECT: Report on the project, "Effects of Internal Radiation on Humans," for the period 1 October 1972 to 31 December 1973.

In compliance with ANL guidelines which require an annual statement, we are submitting this report to the ANL Review Committee for Research Projects Involving Human Subjects. It covers experience under the project title "Effects of Internal Radiation on Humans" from October 1, 1972 to December 31, 1973. We have continued to follow the protocol submitted on August 27, 1971, but procedures for X-ray examination and for bone scans by the Cameron method were modified to provide better diagnostic results. These changes, a short summary of experience during the past year, and an up-to-date listing of principal staff members are given below. In addition, complete exposure data on radium patients and detailed research reports are given in the Radiological and Environmental Research Division Annual Report, ANL-8060, Part II, Center for Human Radiobiology, July 1972 - June 1973; copies of this report are enclosed for your convenience.

Persons examined

There were 239 patients examined at Argonne and 78 at MIT in the period of October 1, 1972 to September 30, 1973. Frequency distributions of current body burdens of ^{226}Ra and X-ray scores are given below for persons for whom these measurements were made:

Numbers of persons examined by CHR 10/1/72 - 9/30/73

Body Burden $\mu C i Ra^{226}$	Persons at ANL	Persons at MIT	X-ray Scores	Persons at ANL	Persons at MIT
> 1	4	0	> 16	7	0
0.4 - 1.0	5	0	5 - 16	6	2
0.1 - 0.4	5	2	1 - 5	10	6
0.01 - 0.1	15	9	0	214	63
< 0.01	208	67			

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PROVENANCE

REPOSITORY:	OFFICE OF HUMAN RADIATION EXPERIMENTS (OHRE)
COLLECTION:	PLUTONIUM INJECTION INVESTIGATION FILES (OHRE 1)
BOX:	3
FOLDER:	PLUTONIUM - CHR

At Argonne, 14 persons had body burdens in excess of 0.1 μCi ^{226}Ra and 13 had X-ray scores greater than 5. At MIT, the corresponding numbers were 2 persons in each category. From October 1 to December 31, 1973, there were 49 additional persons examined at Argonne and 21 at MIT, but results on these persons are not yet completely tabulated.

In the past four years, five malignant tumors attributed to radium have appeared, all apparently carcinomas arising in the mastoid. No osteogenic tumors have been identified since 1969. Two of these, both inoperable, have come to our attention in the past year, both in persons who had refused examination.

During 1973, we began a follow-up study of 18 cases reported to have received plutonium injections in 1945-1947. A summary of this work was sent to you on December 14, 1973 with copies for members of the Review Committee. On June 11, 1973, one person, believed to be Case #Cal-3, was examined at Argonne. In-vivo measurements of radioactivity and radiochemical analyses of urine have so far not demonstrated the presence of plutonium in this person. However, these negative results are compatible with the small residual body burden of plutonium expected (less than 0.05 μCi). At present, we are conducting analyses of larger samples of urine in an attempt to confirm that the person under study is indeed the plutonium case in question.

Doses from skeletal X-ray examinations

Detailed evaluations were made of radiation doses delivered to the bone marrow of patients during skeletal X-ray examinations. Exposure conditions were those which have been used since installation of a new G.E. X-ray machine at the Health Division in February, 1972. Complete reports on the evaluation procedures and results are given in ANL-8060, Part II (pp. 115-145). Mean bone marrow doses estimated for four radium patients ranged from 56 to 180 mrad and a typical dose delivered by X-ray examination during April 1973 was 30 mrad. These values are several times smaller than the preliminary estimate (August, 1971) of 460 mrads for complete skeletal X-ray examinations made with the older X-ray machine. Differences in beam quality and in the speed of the intensifying screens and films may have contributed to these differences in dose, but the difference may also be due in great part to conservatively high values of milliampere-second values which were estimated in the earlier work on the basis of experience with other machines instead of being measured as in the present work. Present plans call for a return to Par-screen exposure conditions in order to obtain improved X-ray quality, and exposure times are expected to be approximately 30% greater than with the present Radelin STF-2 Super high speed screen and Kodak RP Royal X-omat #RP/R54 film. Doses under the new exposure conditions will be evaluated.

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Doses to the gonads produced by skeletal X-ray examinations were also estimated. In very approximate terms,doses due to projections which always include the gonads in the useful beam were about 100 mrad for both men and women, and doses from projections which may include the gonads were about 100 mrad for men and 200 mrad for women (ANL-8060, Part II, pp. 146-156). Gonadal shields substantially reduce these doses and are used whenever appropriate.

During the year, equipment was acquired on a trial basis for xeroradiography. Because of the enhancement of contrast in soft tissues, it was considered that this might prove to be helpful in examining structures adjacent to bone, e.g. in the mastoid cavity; also trabecular structure appears better defined than in conventional radiography. However, the radiation doses are substantially higher (possibly a factor of five) under the recommended exposure conditions, owing largely to higher peak voltages employed. The possibility of using other conditions, to reduce the dose, is to be examined. At present, a partial set of xeroradiographs is being made on selected patients, avoiding exposure of those areas (except skull) containing active marrow. The skull contains about 1/8 of the active marrow, but is particularly important in this study.

Some individuals have shown particular concern about radiation exposure from the skeletal survey, and may refuse to be examined if the full set is to be taken. If these persons are not considered at appreciable risk because of minimal radium burdens, they are offered the option of a "partial set" in which those areas lined out on the attached list are omitted, reducing the mean marrow dose by about 90%, yet providing information on skeletal changes that correlates well with the X-ray score on the full series.

A few females below the age of 40 are being examined, who are recent or contemporary workers. Those who are known to be pregnant are not subjected to diagnostic X-rays (none of these persons have a sufficient burden to be considered at risk from radium). Others are given a pregnancy test (urinary chorionic gonadotroplein) before medical examination, and those who show a negative reaction may be given a partial examination as above. In younger men, the gonads are shielded.

Bone scans

The number of sites scanned for measurements of bone mass by the Cameron method has been increased in order to survey trabecular and cortical bone and to test the effect of "handedness" on changes in bone (ANL-7960, Part II, pp. 72-84, ANL-8060, pp. 157-162). We are presently scanning one site on

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the middle finger and two sites on the forearm. The scans are done on both the right and left sides for a total of six scans per patient. Four passes are made across the finger and two passes across the arm at each of the sites. The total scanning time is about 30 minutes. This includes time required to position the arm or hand and to change positions. The X-ray beam of 2 mm diameter passes through flesh, or bone and flesh together for a total of about 20 minutes. Typical doses are 0.25 mrad to soft tissue and 2.5 mrad to bone for the entire scan procedure. These might vary a factor of four in either direction depending on the strength of the ^{125}I source (i.e. its age).

Changes in medical staff

On November 1, 1973, Russell P. Hall, M.D., became a full-time member of our staff in the Radiological and Environmental Research Division. Dr. Hall formerly was on half-time status in the ANL Health Division and had conducted most of the medical examinations of CHR patients since early in 1973. We also improved our "in-house" medical capabilities by engaging Israel E. Kirsh, M. as consulting radiologist. Dr. Kirsh supervises X-ray examinations of CHR patients and spends one or two days per week at CHR for the purpose of reading and interpreting X-rays and discussing his findings with Dr. Austin Brues and other members of our staff. Dr. Kirsh was formerly Chief, Diagnostic Radiology at Hines V.A. Hospital in Maywood. Dr. Margaret S. Littman changed from full-time status to two days per week as staff physician for CHR-ANL and three days per week as a pathologist for St. Joseph's Hospital in Joliet, Illinois.

Because there have been several changes in personnel and organization of CHR since August, 1972, a current list of principal staff members of CHR and of associated personnel is attached.

Advisory Committee

The Center was organized at Argonne following a recommendation to the AEC's Division of Biology and Medicine (now Division of Biomedical and Environmental Research) by a subcommittee of its Advisory Committee for Biology and Medicine. As part of its recommendation, the subcommittee specified that an Advisory Committee for the Center for Human Radiobiology (ACCHR) should be formed. This committee was organized in 1972 to provide the Center with guidance on policy and advice on specific problems.

The members of the ACCHR are:

Robley D. Evans, Ph.D., Chairman
Professor, Physics Department (Emeritus)
Massachusetts Institute of Technology

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Louis H. Hempelmann, M.D.
Strong Memorial Hospital
Rochester, New York

George B. Hutchison, M.D.
Department Epidemiology
Harvard School of Public Health

Chester R. Richmond, Ph.D.
Director, Biomedical Research Group
Los Alamos Scientific Laboratory

Arthur C. Upton, M.D.
Dean, School of Basic Health Sciences
State University of New York, Stony Brook

A. F. Stehney

AFS:jt
Atts.

cc: R. J. M. Fry, M.D. (8 w/attachment)
A. M. Brues, M.D.
M. H. Chalfen, M.D. - MIT
R. D. Evans - ACCHR
R. P. Hall, M.D.
M. S. Littman, M.D.
J. H. Marshall
R. E. Rowland
J. Rundo
M. M. Shanahan - MIT
F. W. Strehl, M.D. - H.D.
CHR-RR

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DATE OF BIRTH _____ DATE OF FILMS _____

	AREA	POSITION	FILM SIZE	KV	MA	BUCKY	BACK UP TIME	PHOTO TIME
1.	CHEST	PA	14X17	110	300	NO	3/10	3/4
2.	CERVICAL SPINE	LAT	10X12	74	"	"	1/10	
3.	RT. & LT. LOWER ARM INCL. ELBOW	AP	10X12	50	"	"	1/40	
4.	RT. & LT. WRIST & HAND	PA	10X12	44	"	"	1/40	
5.	CERVICAL SPINE	AP	8X10	74	"	YES	?	N
6.	~~THORACIC OR DORSAL SPINE~~	~~AP~~	~~14X17~~	~~80~~	~~"~~	~~"~~	~~1 1/4~~	~~N~~
7.	~~LUMBAR SPINE~~	~~AP~~	~~14X17~~	~~80~~	~~"~~	~~"~~	~~1 1/4~~	~~N~~
8.	~~PELVIS~~	~~AP~~	~~14X17~~	~~80~~			~~1 1/4~~	~~N~~
9.	SKULL	AP	10X12	80	"	"	1 1/4	1/2
10.	RT. & LT. SHOULDER & HUMERUS	AP	11X14	60	"	"	2	1/4
11.	~~RT. & LT. FEMUR~~	~~AP~~	~~14X17~~	~~74~~	~~"~~	~~"~~	~~?~~	~~N~~
12.	RT. & LT. KNEE & LOWER LEG	AP	14X17	56	"	"	1/40	
13.	RT. & LT. ANKLE	AP	10X12	50	"	"	1/40	
14.	~~LEFT THORACIC (DORSAL) SPINE~~	~~LAT~~	~~14X17~~	~~80~~	~~"~~	~~YES~~	~~1 1/4~~	~~?~~
15.	~~LUMBAR SPINE~~	~~LAT~~	~~14X17~~	~~80~~	~~"~~	~~"~~	~~1 1/4~~	~~?~~
16.	SKULL MOD, WATERS	PA	10X12	80	"	"	1 1/4	1/2
17.	SPHENOID OR SUB MENTAL VERTEX	PA	10X12	80	"	"	1 1/4	3/4
18.	SKULL	LAT	10X12	80	"	"	1 1/4	1/2
19.	RT. & LT. MASTOIDS (LAW'S VIEWS)	LAT	8X10	80	"	"	1 1/4	3/4
20.	STENVERS OR POSTERIOR MAST.	PA	8X10	80	"	"	1 1/4	1/2
21.	MANDIBLE	AP	8X10	80	"	"	1 1/4	1/2
22.	RT. & LT. FOOT	LAT	10X12	50	"	NO	1 1/4	
23.	RT. & LT. FOOT	AP	10X12	46	"	"	1/40	

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