United States General Accounting Office

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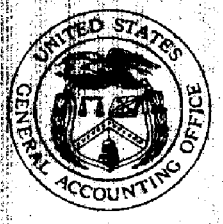
Fact Sheet for Congressional Requesters

May 1995

DEPARTMENT OF ENERGY

Information on DOE's Human Tissue Analysis Work



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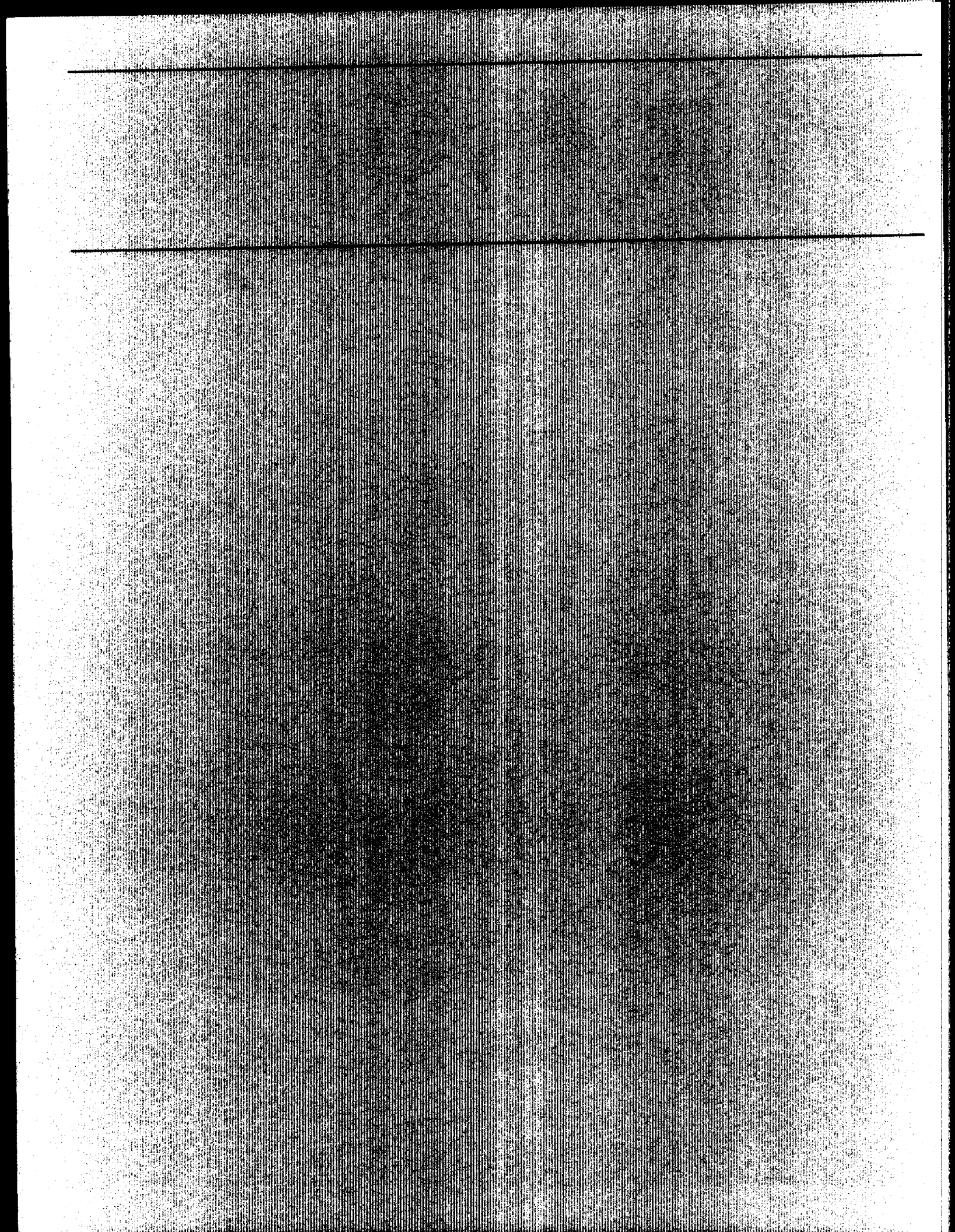

GAO

United States
General Accounting Office
Washington, D.C. 20548

Resources, Community, and
Economic Development Division

B-260777

May 24, 1995

The Honorable John Glenn
Ranking Minority Member
Committee on Governmental Affairs
United States Senate

The Honorable John D. Dingell
Ranking Minority Member
Committee on Commerce
House of Representatives

Because of congressional and public interest, the federal government through a presidential advisory committee has been attempting to catalog all government-sponsored experiments exposing humans to radiation. To accomplish this, various federal agencies are researching their files to identify any human radiation experiments carried out since 1944. The Department of Energy (DOE) or its predecessor agencies have had a major role in such experiments because of various activities primarily related to the production of nuclear weapons. DOE has also carried out various studies that analyzed tissue of individuals possibly exposed to radiation. Because many of these studies do not technically represent human radiation experiments, DOE is not including them in its overall cataloguing efforts. In response to your requests, this report identifies the studies that DOE or its predecessor agencies have conducted analyzing the tissue of individuals either intentionally or unintentionally exposed to radiation.

In general, the tissue analysis studies have sought to determine, for research purposes, the amount and distribution of radioactive material in the body. These studies ranged from examining skin samples to performing

whole body autopsies.[1] This work does not include analysis done using common hospital waste, such as respiratory mucus, or bodily fluids, such as blood samples. As agreed with your offices, we are presenting information on, among other things, the duration, number of subjects, and practices concerning informed consent for each of the various tissue analysis studies that we have identified. This information was gathered through a data search of government and private records, DOE's files, and the scientific literature generated since the 1940s. The studies that we identified may not represent a total accounting of all tissue analysis studies that were ever conducted because no central clearinghouse for such studies has ever existed.[2]

RESULTS IN BRIEF

We were able to identify 59 tissue analysis studies carried out by DOE or its predecessor agencies. A majority of these studies were conducted and terminated in the 1950s and 1960s. However, a few of them are still ongoing. One of the largest ongoing studies is the United States Transuranium and Uranium Registries, in which tissues, including whole bodies, have been analyzed to study the distribution and dose of plutonium, americium, and uranium in occupationally exposed persons. The tissues and whole bodies are currently stored for future study in a national tissue repository.

More than 15,000 subjects were involved in the 59 studies. The largest study, the strontium-90 study, procured nearly 9,000 human bone samples in an effort to determine the accumulation of this radioactive element in humans as a

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[1]There are certain exceptions to this generalization of DOE's work. For instance, in some studies, a radioactive material was intentionally combined with a drug to label and trace that drug's distribution and retention in the body. In another study--the Los Alamos National Laboratory Coroners' Cases--DOE assisted local coroners in determining various subjects' cause of death.

[2]Without any central clearinghouse for tissue analysis information, such information--to the extent it has not been destroyed--has been placed into storage at various locations across the country. Consequently, it has become a difficult task to identify with certainty all tissue analysis studies carried out since this work commenced more than 50 years ago.

result of nuclear fallout. Of the 59 studies, 43 involved fewer than 100 subjects. In addition, many of the studies used adults as study subjects. However, a few of the studies used infants, stillborn babies, aborted fetuses, or human embryos in an attempt to measure their uptake of radioactive material.

For a majority of the studies, DOE has no information on the informed consent practices that it followed.[3] According to DOE's Office of Human Radiation Experiments, the policy of DOE or its predecessor agencies on informed consent has evolved over the years. A 1947 Atomic Energy Commission memorandum stated that the signatures of two attending physicians were necessary to document that informed consent had been obtained. Thereafter, DOE acknowledges that the Department or its predecessor agencies used different policies at different times. For at least a few of the studies included in our report, officials within DOE's Office of Human Radiation Experiments said that there is little verifiable evidence that the subjects participated with knowledge of the experiment or its risk. Those studies include the Plutonium Injection Cases, in which individuals with short life expectancies received intravenous doses of plutonium to study the effects of this radioactive material on the body, and Project Gabriel, in which stillborn babies were cremated to determine the content, in their ashes, of strontium that resulted from atmospheric nuclear weapons testing.

The 59 studies we identified are listed in section 1. For each of the studies, we discuss the following: (1) study objective(s) and description, (2) duration of study, (3) performing organization, (4) number of study subjects, (5) informed consent practices followed, (6) study results, and (7) source of study data. The studies with the largest number of subjects are presented first.

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[3]According to rules initially promulgated in 1981 by the Department of Health and Human Services and adopted by DOE, several elements must be present to obtain informed consent. Those elements include a description of any foreseeable risks or discomforts to the subject and a statement that (1) participation is voluntary, (2) refusal to participate will involve no penalty or loss of benefits to which the subject is otherwise entitled, and (3) the subject may discontinue participation at any time without penalty or loss of benefits to which the subject is otherwise entitled.

AGENCY COMMENTS

We obtained written agency comments on this report. DOE said that the report presents basic information about tissue analysis projects in an informative and objective manner (see app.I). In addition, DOE said that it had no substantive comments to offer on the report. On the basis of the additional agency's editorial comments, minor technical changes were made where appropriate.

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We conducted this review from May 1994 to March 1995. To develop this report, we used diverse sources of information because of the absence of a central clearinghouse for DOE's tissue analysis information. These sources included, but were not limited to, records belonging to the Los Alamos National Laboratory, Oak Ridge National Laboratory, University of Chicago, and University of Utah; files from the DOE Offices of the History Division and Human Radiation Experiments; and scientific literature, such as articles appearing in the periodicals Health Physics and Science. Generally, we found that the amount of information available on the individual studies varied considerably. Therefore, we also discussed the studies with knowledgeable individuals, including the director of DOE's Office of Human Radiation Experiments and the executive director of the Presidential Advisory Committee on Human Radiation Experiments. We further discussed the studies with scientific researchers who had participated in the studies or had some institutional knowledge regarding the studies. For some of the studies, the researchers were able to provide us with their personal recollections of certain details, such as how informed consent had been handled. For other studies, the researchers could not recall specific details.

During our review, we did not attempt to validate the personal recollections of the researchers or the results of the studies identified. Other tissue analysis studies by DOE not identified in this report may have occurred, primarily in the 1940s and 1950s, when requirements for document retention were less stringent. In general, information on selected aspects of the studies discussed in this report has been available for many decades through the scientific literature.

As arranged with your offices, unless you publicly release its contents earlier, we plan no further distribution of this report until 30 days after the date of this letter.

At that time, we will send copies of the report to the Secretary of Energy. We will also make copies available to others on request.

Please call me at (202) 512-3841 if you or your staff have any questions. Major contributors to this report are listed in appendix II.

Victor S. Rezendes
Director, Energy and Science Issues

CONTENTS

ABBREVIATIONS

DOE	Department of Energy
GAO	General Accounting Office
ORINS	Oak Ridge Institute for Nuclear Studies
ORISE	Oak Ridge Institute for Science and Education

SECTION 1

LISTING OF DOE'S TISSUE ANALYSIS STUDIES

PROJECT SUNSHINE--STRONTIUM-90 IN MAN (BASED ON WORLDWIDE SAMPLING)

Description/Objectives: Fetuses, single bone samples, and whole skeletons of subjects who had been autopsied were procured from medical scientists worldwide. The study's objective was to determine the strontium-90 content in humans caused by fallout from nuclear weapons testing and attempt to evaluate the potential hazards.

Duration of Study: 1950s.

Performing Organizations: Primarily 17 stations worldwide, including New York City, NY; Boston, Mass.; Houston, Tex.; and Denver, Colo.

Number of Subjects: 9,000 samples of human bone were procured, including fetuses, single bone samples from individuals of all ages, and whole skeletons. Samples from 584 whole fetuses were collected between 1954 and 1959.

Informed Consent Practices Followed: Specific information on the informed consent policies and procedures that were followed was not stated in 1957 and 1960 reports on the study. The 1957 report noted, however, that medical scientists "cooperated so willingly in procuring the autopsy material." According to the Department of Energy's (DOE) correspondence on the study, the agency may have deceived some medical scientists worldwide into believing that it needed the samples to determine the natural radium content in human beings rather than to determine the strontium-90 uptake from fallout from nuclear weapons testing.

Results: According to the reports on the study, young children have 3 to 4 times more strontium-90 per gram of calcium, on the average, than adults.

Source: "Strontium-90 in Man." Science, vol. 125, 1957, pp. 219 to 225; "Strontium-90 in Man IV." Science, vol. 132, 1960, pp. 448 to 454.

LOS ALAMOS GENERAL POPULATION STUDY

Description/Objectives: Tissue was obtained during autopsies performed at various hospitals throughout the country. The study's original objective was to use these donors as a control group to determine background levels of plutonium in humans for comparison with results from the analysis of tissues from occupationally exposed individuals. Later, objectives were expanded to evaluate the possible release of plutonium from facilities such as the Rocky Flats Plant and the Savannah River Plant.

Duration of Study: 1959 to 1985.

Performing Organization: Los Alamos National Laboratory.

Number of Subjects: 1,712.

Informed Consent Practices Followed: For each hospital providing tissue, participating pathologists exercised a clause in their autopsy permit form that allowed collection of tissues for "scientific research." As a result, Los Alamos officials did not feel it was necessary to obtain their own informed consent documentation.

Results: According to a fact sheet on the study, levels of plutonium from fallout in the United States general population were small; populations near major nuclear facilities did not have significantly higher plutonium levels than those that did not live near such facilities.

Source: Los Alamos Human Studies Project Team Fact Sheet, February 1994; interviews with former project leader, Environmental Chemistry Group, Los Alamos National Laboratory.

THYROID COLLECTION PROGRAM

Description/Objectives: Thyroid glands were obtained at autopsies nationwide and sent to Oak Ridge for analysis. The study's objective was to determine if radioactive iodine introduced into the body following atmospheric nuclear detonations would interfere with contemporary diagnostic tests of thyroid function.

Duration of Study: 1954 to 1958.

Performing Organization: Oak Ridge Institute for Nuclear Studies (ORINS), now Oak Ridge Institute for Science and Education (ORISE).

Number of Subjects: 1,165.

Informed Consent Practices Followed: According to former ORISE medical staff, it is assumed that consent for autopsy was obtained by the institutions that contributed tissue for this study.

Results: According to the researchers, the estimates of radioactive iodine in human thyroids in the United States were well below threshold levels for detectable effects.

Source: Science, vol. 126, 1957, pp. 16 to 18; interview with former Assistant Director, Medical Sciences Division, ORISE.

UNITED STATES TRANSURANIUM AND URANIUM REGISTRIES

Description/Objectives: Candidates for the registries have a documented history of exposure to certain radioactive elements and have agreed to donate their tissues or whole body to the registries for scientific study. The registries originated for the purpose of acquiring and disseminating the newest and best information on the effects of plutonium on humans. The registries currently study the distribution and dose of certain radioactive elements, such as uranium, plutonium, and americium, by analyzing tissues, including whole bodies, from volunteer donors. Some tissue solutions and related materials are stored for future study in a national tissue repository.

Duration of Study: 1968 to present.

Performing Organization: Washington State University.

Number of Subjects: 726--383 living and 343 deceased.

Informed Consent Practices Followed: Registrants must sign a medical release form as well as an authorization for autopsy, a donor form for whole body or surgical specimens, and an informed consent form. The University Institutional Review Board reviews the program annually.

Results: The registries have proposed new standards to describe the retention and excretion of plutonium and americium in the human body and have developed revised risk coefficients for internal exposure to alpha radiation. Nearly 70 papers have been published in the scientific literature documenting the registries' work.

Source: United States Transuranium and Uranium Registries Annual Report, September 1993; interview with Registries' director.

TRACE ELEMENTS IN HUMAN TISSUE

Description/Objectives: Tissues and organs were collected from autopsy subjects within Africa, the Near and Far East, Switzerland, and the United States. The U.S. cities participating in the study included San Francisco, Cal.; Denver, Colo.; Miami, Fla.; Atlanta, Ga.; Baltimore, Md.; Dallas, Tex.; Richmond, Va.; and Seattle and Tacoma, Wash. The study's objective was to determine the chemical element content of many tissues and organs from members of the

general population (not occupational workers) and thus to throw light on the elemental composition of "standard man."

Duration of Study: 1950s to 1970s.

Performing Organization: University of Tennessee and the Oak Ridge National Laboratory.

Number of Subjects: 450.

Informed Consent Practices Followed: A report on the study did not include specific information on the informed consent policies and procedures that were followed. However, according to an Oak Ridge official, researchers obtained all samples through medical examiners where the laws of the city or state allowed collection of samples during autopsy.

Results: According to a report on the study, the concentration of trace elements in normal human tissues and the distribution of these elements throughout the body have been determined.

Source: "Trace Elements in Human Tissue, Part I." Health Physics, vol. 9, 1963, pp. 89 to 145, and "Trace Elements in Human Tissue, Part III." Health Physics, vol. 11, 1965, pp. 403 to 451.

TISSUE SAMPLING FOR PLUTONIUM THROUGH AN AUTOPSY PROGRAM (HANFORD)

Description/Objectives: Through the cooperation of a local hospital pathologist, this study obtained various tissue samples at autopsy from deceased persons from two groups: those who had resided locally or at some distance from Hanford (344) and those who were employed at Hanford, some of whom might have been exposed to plutonium in the course of their work (77). The study's objectives were twofold. The first objective was to provide the hospital pathologists with information on the presence of plutonium as a possible contributor to disease states or as the cause of death of the individuals involved. The second objective was to provide a basis for assessing the effectiveness of protection of plutonium workers and of plutonium effluent controls at the Hanford facilities.

Duration of Study: 1949 to 1975.

Performing Organization: Hanford Site, Richland, Washington.

Number of Subjects: 421.

Informed Consent Practices Followed: A report on the study did not include specific information on the informed consent policies and procedures that were followed. According to a Pacific Northwest Laboratory official, the study did not involve human testing;

physicians obtained tissue samples from cadavers during autopsies and informed consent was not applicable.

Results: According to a Pacific Northwest Laboratory official, knowledge of the very small concentrations of plutonium occurring in autopsy tissue samples did not prove useful to the pathologists in terms of establishing a diagnosis of disease or in determining the cause of death. The majority of Hanford workers and nearby residents had tissue concentrations of plutonium no larger than persons who lived farther away from Hanford and whose likely source of plutonium was limited to fallout from nuclear weapons testing. On that basis, although confidence is limited by the relatively small number of cases, the Pacific Northwest Laboratory official said, one could conclude that the protection of plutonium workers and controls on effluents were generally effective.

Source: "Tissue Sampling For Plutonium Through an Autopsy Program", Pacific Northwest Laboratory, September 1966; interview with staff scientist, Health Risk Assessment Department, Pacific Northwest Laboratory.

ARGONNE RADIUM STUDY

Description/Objectives: Tissue was obtained from living and deceased subjects who had been exposed to radium. The subjects included radium dial painters, individuals who had received radium as a therapeutic measure, and some radium chemists. The study's objective was to investigate the health effects of radium deposition on humans.

Duration of Study: mid-1940s to early 1990s.

Performing Organization: Argonne National Laboratory.

Number of Subjects: 293 (includes subjects who donated tissues to other radium projects that were eventually consolidated with the Argonne Radium Study).

Informed Consent Practices Followed: According to an Argonne National Laboratory official that we contacted, he could find no information on the informed consent policies and procedures that were followed during the study period before 1970. Thereafter, the official said, documents show that informed consent was obtained.

Results: According to a report on the study, the radiogenic lesions were qualitatively comparable to those seen in studies of other subjects who had been exposed to radium.

Source: "International Symposium on the Delayed Effects of Bone Seeking Radionuclides," Salt Lake City, Utah, 1969, pp. 195 to 225; interview with Associate Director, Environmental, Safety, and Health Division, Argonne National Laboratory.

LOS ALAMOS STUDY OF OCCUPATIONALLY EXPOSED WORKERS

Description/Objectives: Tissue was taken from former laboratory employees during autopsies performed at the local hospital and sent to the Los Alamos National Laboratory for analysis. The study's objective was to estimate the plutonium content in donated tissue and thereby evaluate the effectiveness of the laboratory's ability to physically protect workers from overexposure to radioactivity (plutonium); to evaluate the validity of current models used to make predictions of the internal depositions of plutonium in exposed workers using bioassay techniques (i.e., urinalysis, lung counting, etc.); and provide data for the improvement of the above models.

Duration of Study: 1959 to 1978.

Performing Organization: Los Alamos National Laboratory.

Number of Subjects: 254 (based on the recollections of the project leader).[1]

Informed Consent Practices Followed: The tissues were collected under the provisions of the hospital's autopsy consent form. As a result, Los Alamos National Laboratory officials did not feel it was necessary to obtain their own informed consent documentation.

Results: According to a fact sheet on the study, plutonium is not uniformly distributed in bone but is deposited on bone surfaces; plutonium is retained in the lung for a much longer time than early animal models had predicted; the biological retention time in the liver and skeleton (major deposition sites) is shorter than the models had predicted; and early biokinetic models for estimating exposures overestimated internal depositions by factors of 10 or more.

Source: Los Alamos Human Studies Project Team Fact Sheet, February 1994; interview with former project leader, Environmental Chemistry Group, Los Alamos National Laboratory.

LUNG CANCER IN URANIUM MINERS: A TISSUE RESOURCE--PILOT INVESTIGATION

Description/Objectives: Lung tissues taken through biopsy from uranium miners and from the general population are being analyzed and stored for future study. The study's objective is to evaluate the cellular and molecular biology of lung cancer.

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[1]Some of the subjects are also enrolled in the United States Transuranium and Uranium Registries.

Duration of Study: 1991-May 1995.

Performing Organization: New Mexico Tumor Registry, Cancer Research and Treatment Center (Albuquerque, N.M.).

Number of Subjects: 150.

Informed Consent Practices Followed: On February 15, 1994, the Institutional Review Board approved the informed consent procedures used.

Results: To be determined.

Source: DOE Listing of Research Projects Involving Human Subjects, April 1994; interview with staff member, DOE Office of Health Effects and Life Sciences Research Division.

EVALUATION OF RESIDUAL RADIOACTIVITY IN HUMAN TISSUE ASSOCIATED WITH WEAPONS TESTING AT THE NEVADA TEST SITE

Description/Objectives: The University of Utah obtained tissues at autopsy or surgery from 44 subjects in northern Utah and 31 subjects in southern Utah. For control subjects, the Los Alamos National Laboratory supplied spare tissues from its general population study. The study's objective was to determine the extent of radioactivity in human tissues as a result of weapons testing at the Nevada Test Site.

Duration of Study: 1981 to 1986.

Performing Organization: University of Utah (funded by the Defense Nuclear Agency through DOE).

Number of Subjects: 115.

Informed Consent Practices Followed: The University of Utah relied on each pathologist/medical examiner at each providing hospital/office to obtain the appropriate informed consent authorizations.

Results: According to the study, the mean concentration of plutonium in human tissue is not significantly different between Utah residents and the general population.

Source: Interview with a staff member, Environmental Radiation and Toxicology Laboratory, University of Utah.

REVIEW OF PATIENTS WITH CANCER OF THE OVARY

Description/Objectives: Tissue samples were obtained from patients who had received radioisotope treatment for cancer of the ovary. The study's objective was to analyze treatment outcomes.

Duration of Study: 1950 to 1961.

Performing Organization: ORINS, now ORISE.

Number of Subjects: 95 women, 69 of whom had received some type of radioisotope treatment.

Informed Consent Practices Followed: According to former ORISE medical staff, documentation exists which indicates that informed consent was obtained for procedures, including autopsies performed, for patients admitted to ORINS hospital during the study period. Completed consent forms reportedly are filed in individual patients' charts maintained at ORISE.

Results: According to data available on the study, 24 of 50 patients treated with radioisotopes obtained some symptomatic relief and that at least three surgical procedures to remove tumor tissue resulted in longer survival times than did more conservative approaches.

Source: ORISE Tissue Analysis Data Provided to GAO, November 1994; interview with former Assistant Director, Medical Sciences Division, ORISE.

STUDY OF BONE MARROW FIBROSIS IN CERTAIN PATIENTS

Description/Objectives: Specimens of bone marrow were obtained at autopsy from patients with bone marrow disorders. The study's objective was to evaluate pathologic changes in the specimens.

Duration of Study: 1950 to 1967.

Performing Organization: ORINS, now ORISE.

Number of Subjects: 90.

Informed Consent Practices Followed: According to former ORISE medical staff, documentation exists which indicates that informed consent was obtained for procedures, including autopsies, performed for patients admitted to ORINS hospital during the study period. Completed consent forms reportedly are filed in individual patients' charts maintained at ORISE.

Results: According to data available on the study, the marrow fibrosis observed in these cases was not attributable to the therapy received except for an increase in cell size that was attributed to the administration of a chemical (busulfan). The study improved the understanding of the nature of bone marrow disorders.

Source: ORISE Tissue Analysis Data Provided to GAO, November 1994; interview with former Assistant Director, Medical Sciences Division, ORISE.

TESTICULAR IRRADIATION OF INMATES AT OREGON STATE PRISON

Description/Objectives: Tissue samples were obtained from prison volunteers who were subjected to testicular irradiation by x-rays. The study's objective was to obtain data on the effects of ionizing radiation on human fertility and the function of testicular cells.

Duration of Study: 1963 to 1971.

Performing Organization: Pacific Northwest Research Foundation.

Number of Subjects: 67.

Informed Consent Practices Followed: Each inmate agreed to have a vasectomy at the end of his irradiation. All volunteers were required to sign statements of informed consent.

Results: According to data available on the study, complete recovery to pre-irradiated sperm concentration occurred after a certain period.

Source: Committee on Energy and Commerce, U.S. House of Representatives Report. "American Nuclear Guinea Pigs: Three Decades of Radiation Experiments on U.S. Citizens." (Nov. 1986).

TESTICULAR IRRADIATION OF INMATES AT WASHINGTON STATE PRISON

Description/Objectives: Tissue samples were obtained from prison volunteers who were subjected to testicular irradiation by x-rays. The study was reportedly proposed after a radiation accident at DOE's Hanford facility. Three Hanford employees were overexposed, and no clear scientific data were available to advise them on possible sterility effects. The study's objective was to determine the effects of irradiation on gonadal function.

Duration of Study: 1963 to 1970.

Performing Organization: University of Washington.

Number of Subjects: 64.

Informed Consent Practices Followed: Participants had to agree to vasectomies after completion of the experiment. All volunteers were required to sign statements of informed consent.

Results: According to data available on the study, man is very susceptible to temporary sterility but is very resistant to complete sterility.

Source: Committee on Energy and Commerce, U.S. House of Representatives Report. "American Nuclear Guinea Pigs: Three Decades of Radiation Experiments on U. S. Citizens." (Nov. 1986).

PROJECT GABRIEL (STILLBORN BABIES)

Description/Objectives: The bodies of stillborn babies were cremated and the amount of strontium-90 in the remains was measured. The study's objective was to determine the long-term effects of nuclear radiation fallout on humans.

Duration of Study: Early to mid-1950s.

Performing Organization: University of Chicago.

Number of Subjects: 59 stillborn babies.[2]

Informed Consent Practices Followed: According to the Vice President, Office of Government and Public Affairs, University of Chicago Hospitals, the accepted standards of the time would not have required informed consent for the use of the samples analyzed in the study. This official added that in Illinois the consent of a parent or guardian for autopsy or research use of tissues from a stillborn did not become mandatory until January 1, 1980.

Results: According to data available on the study, the residual effect of the fallout was not extensive in most humans.

Source: "Stillborn Babies Used In '50s Radiation Test," Washington Post, May 3, 1994; interview with Vice President, Office of Government and Public Affairs, University of Chicago Hospitals.

CHOLESTEROL METABOLISM IN CORONARY PATIENTS

Description/Objectives: In conducting this study, the University of Chicago hospital performed autopsies on several subjects and later provided tissue samples to the Los Alamos National Laboratory for further analysis. The study's objective was to examine the metabolism of tritium-labeled cholesterol in coronary patients to determine how the cholesterol arrives at hardened blood vessels.

Duration of Study: 1955.

Performing Organizations: Los Alamos National Laboratory and the University of Chicago.

Number of Subjects: 34.[3]

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[2]Three adult legs were also analyzed as a part of this study.

[3]This is an estimate of the number of subjects studied.

Informed Consent Practices Followed: Data available on the study did not provide specific information on the informed consent policies and procedures that were followed. According to the Vice President, Office of Government and Public Affairs, University of Chicago Hospitals, physicians carefully informed patients who were enrolled in the study about the risks and benefits associated with the study, and the patients gave their verbal consent, as was standard at the time. By the 1950s, the University's Human Subjects Committee had carefully reviewed all studies involving humans.

Results: According to data available on the study, researchers uncovered details of how cholesterol metabolizes in the body.

Source: DOE Radiation Experiments Update, June 1994; interview with Vice President, Office of Government and Public Affairs, University of Chicago Hospitals.

RADIUM CONTENT OF INDIVIDUALS (ADULTS AND STILLBORN INFANTS) WITH NO KNOWN OCCUPATIONAL EXPOSURE

Description/Objectives: Radium determinations were made on the bodies of adults and stillborn babies. The bodies were, for the most part, embalmed and had been used for instruction purposes in an anatomy course. The study's objective was to determine the value of the radium content in the body of the non-occupationally exposed human.

Duration of Study: 1950.[4]

Performing Organization: University of Rochester.

Number of Subjects: 25 adults and 6 stillborn infants.

Informed Consent Practices Followed: A report on the study did not include specific information on the informed consent policies and procedures that were followed.

Results: According to a report on the study, stillborn infants had an appreciable concentration of radium in their body ash.

Source: "Body Radium Content of Individuals with No Known Occupational Exposure," Nucleonics, vol. 7, Number 1, July 1950, pp. 46 to 59.

[4]This is an estimate based on the date of a report on the study.

NONREGISTRY URANIUM WORKERS

Description/Objectives: Tissue samples were obtained at autopsy from subjects employed at the Fernald Plant whose deaths were unrelated to their occupations and from subjects not employed at the plant who died at a neighboring hospital. The study's objective was to develop data to ensure that adequate control measures were in place to protect the health of employees and to establish exposure limits.

Duration of Study: 1956 to mid-1960s.

Performing Organization: Feed Materials Production Center, Fernald, Ohio.

Number of Subjects: 22.

Informed Consent Practices Followed: Reports on the study did not include specific information on the informed consent policies and procedures that were followed. One of the reports noted, however, that "it was most desirable for one of our own physicians to be present at autopsy to obtain specimens. This means that we must be ready to report on short notice to the coroner's facilities or to the pathology section of the hospitals."

Results: According to reports on the study, the amount of uranium found in analyses of the kidneys was well below the level at which one would expect to find kidney damage. The findings, also according to the study reports, substantiated the opinion of the researchers that the employees' deaths were in no way related to their occupations.

Source: "Studies of Human Exposure to Uranium," National Lead Company of Ohio, October 1958; "A Continued Program of Analysis for Uranium in Human and Animal Tissues," National Lead Company of Ohio, (Sept. 1963).

PLUTONIUM INJECTION CASES

Description/Objectives: Tissue samples were obtained through biopsy or autopsy from hospital patients who had been injected with plutonium. The patients, as a rule, were past 45 years of age and suffering from chronic disorders such that survival for 10 years was highly improbable. The rationale for this study was that several thousand nuclear workers were involved in handling plutonium and that accurate information was needed on the retention and excretion of internally deposited plutonium for setting safety criteria. Animal experiments had produced conflicting data that could not be extrapolated to humans. The study's objective was to provide more extensive and quantitative data on the deposition and excretion of plutonium by humans as a basis for future consideration of maximum permissible body tolerance.

Duration of Study: 1945 to 1947.

Performing Organizations: Los Alamos National Laboratory; Manhattan Engineer District Hospital, Oak Ridge, Tennessee; the University of Rochester; the University of Chicago; and the University of California.

Number of Subjects: 18 (at least 10 were biopsied or autopsied).

Informed Consent Practices Followed: According to DOE, only one subject may have provided any kind of informed consent.

Results: According to a report on the study, there was little difference in the way plutonium distributes in humans and in common laboratory animals.

Source: "Distribution and Excretion of Plutonium Administered Intravenously to Man," Los Alamos Scientific Laboratory, (Sept. 1950), Stannard, J. Newell. Radioactivity and Health: A History. Pacific Northwest Laboratory: Battelle Memorial Institute, (1988).

ABORTED FETUS STUDY

Description/Objectives: Aborted fetuses from 22 weeks old to 26 weeks old--obtained from the University of Kansas Medical Center,--were analyzed. The analyzed tissue parts included the fetal head, body, placenta, and cord. In 1981, the Nuclear Regulatory Commission was preparing guidelines to protect female employees of child-bearing age in the nuclear industry. The Commission requested that researchers from the University of Kansas Medical School submit a proposal to obtain data on the environmental levels of plutonium, americium, uranium, and thorium in fetuses.

Duration of Study: 1982.

Performing Organization: Los Alamos National Laboratory.

Number of Subjects: 17.

Informed Consent Practices Followed: According to one of the study's researchers (from the University of Kansas Medical Center), the women had signed abortion consent forms, which automatically transferred custody of the aborted bodies (including the placenta, cord, and other parts) to the hospital.

Results: According to a fact sheet on the study, small traces of plutonium, americium, uranium, and thorium were transported across the placental barrier and deposited in the fetus. Also, plutonium was inclined to concentrate in the 22- to 24-week-old fetuses. According to the researchers at the University of Kansas, this concentration would result in a risk to the fetus from 36 to 150 times greater than the risk to the mother.

Source: Fact Sheet on Analyses of Fetal Samples by the Los Alamos Tissue Analysis Program, March 1994; interview with former project leader, Environmental Chemistry Group, Los Alamos National Laboratory.

SODIUM-24 CHROMATE USED TO MEASURE RED CELL SURVIVAL TIMES IN SUBJECTS WITH LIVER DISEASES

Description/Objectives: Tissue was obtained through biopsy from patients with liver disease who were administered sodium-24. The study's objective was to measure the survival time of the patients' red blood cells.

Duration of Study: 1953.

Performing Organization: Argonne Cancer Research Hospital.

Number of Subjects: 15.

Informed Consent Practices Followed: A report on the study did not include specific information on the informed consent policies and procedures that were followed.

Results: According to a report on the study, the results indicated an abnormal red cell survival time in these patients.

Source: "Decreased Red Cell Survival Times Associated with Liver Diseases As Measured with Radioactive Sodium Chromate." Semiannual Reports to the U. S. Atomic Energy Commission, vol. 1, Parts 1-6, 1954 to 1956. Chicago: Argonne Cancer Research Hospital, pp. 42 to 46; Human Radiation Experiments: The Department of Energy Roadmap to the Story and the Records, (Feb. 1995).

AUTOPSY STUDIES OF DISTRIBUTION OF GALLIUM-72

Description/Objectives: Tissue samples were obtained at autopsy from subjects given therapeutic or tracer doses of gallium-72. The studies' objectives were to assess the treatment potential of gallium-72 for bone tumors, its ability to identify tumors, and its metabolism and distribution in the human body.

Duration of Study: 1950 to 1953.

Performing Organization: ORINS, now ORISE.

Number of Subjects: 14.

Informed Consent Practices Followed: According to former ORISE medical staff, documentation exists which indicates that informed consent was obtained for procedures, including autopsies, performed for patients admitted to ORINS hospital during the study period.

Completed consent forms reportedly are filed in individual patients' charts maintained at ORISE.

Results: According to data available on the study, gallium-72 was highly concentrated but nonuniformly distributed in tumor areas. Its usefulness as a therapeutic agent was further limited by the loss of radioactivity before high levels were concentrated in tumors, the development of undesirable side-effects at doses below therapeutic levels, and the development of chemical toxicity during long-term use.

Source: ORISE Tissue Analysis Data Provided to GAO, November 1994; interview with former Assistant Director, Medical Sciences Division, ORISE.

RADIUM-226 AND LEAD-210 IN HUMAN TEETH AND BONES

Description/Objectives: Bone and tooth materials were extracted from a group of bodies donated for anatomical study; the subjects ranged in ages from 40 to 90 years with a median age of 63. The study's objective was to determine the suitability of using measurements of certain isotopes in teeth to estimate the levels of the same isotopes in bones.

Duration of Study: mid-1960s.

Performing Organization: University of Rochester.

Number of Subjects: 13.

Informed Consent Practices Followed: Because the bone and tooth materials were taken from donated bodies to be used in anatomy work, informed consent was not an issue.

Results: According to a report on the study, the suitability of using measurements of lead-210 in teeth to predict the lead-210 level in bone is subject to large error and is more dependent on the bone type to which the tooth measurement is referred.

Source: "Radium-226 and Lead-210 in Human Teeth and Bones," Health Physics, vol. 14, 1968, pp. 549 to 555.

STRONTIUM AND CALCIUM INJECTED IN TERMINAL CANCER PATIENTS

Description/Objectives: Tissue was obtained from terminal cancer patients who had been injected with radioactive strontium or calcium. The patients were chosen because they could be autopsied fairly soon after injection. Patients ranged in age from 49 to 72. The study's objective was to compare the retention of strontium and calcium by different tissues.

Duration of Study: 1950s.

Performing Organizations: Columbia University and Montefiore Hospital in New York.

Number of Subjects: 12.

Informed Consent Practices Followed: Data available on the study did not include specific information on the informed consent policies and procedures that were followed.

Results: Information on study results was not available.

Source: Committee on Energy and Commerce. U.S. House of Representatives Report. "American Nuclear Guinea Pigs: Three Decades of Radiation Experiments on U. S. Citizens." (Nov. 1986).

LUNG AND ABDOMINAL INJECTION OF RADIOACTIVE GOLD

Description/Objectives: Tissue was obtained at autopsy from patients with tumors who had been medically treated by injecting them with radioactive gold. The study's objective was to evaluate the effectiveness of the treatment on collections of fluids in the lung and abdominal cavities caused by malignant tumors.

Duration of Study: Early 1950s.

Performing Organization: ORINS, now ORISE.

Number of Subjects: 12.

Informed Consent Practices Followed: According to former ORISE medical staff, documentation exists which indicates that informed consent was obtained for procedures, including autopsies, performed for patients admitted to ORINS hospital during the study period. Completed consent forms reportedly are filed in individual patients' charts maintained at ORISE.

Results: According to data available on the study, in selected patients, the injection of radioactive gold into the body cavities appeared to be a worthwhile measure for relieving symptoms resulting from fluid collections caused by the tumors.

Source: ORISE Tissue Analysis Data Provided to GAO, November 1994; interview with former Assistant Director, Medical Sciences Division, ORISE.

INFECTIONS IN PATIENTS FOLLOWING TOTAL-BODY IRRADIATION

Description/Objectives: Tissue was obtained at autopsy from patients who had received high doses of radiation to the whole body for the treatment of leukemias and other disseminated neoplasms. The study's objective was to examine patterns of infections in patients following exposure to such doses.

Duration of Study: Early 1960s.

Performing Organization: ORINS, now ORISE.

Number of Subjects: 12.

Informed Consent Practices Followed: According to former ORISE medical staff, documentation exists which indicates that informed consent was obtained for procedures, including autopsies, performed for patients admitted to ORINS hospital during the study period. Completed consent forms reportedly are filed in individual patients' charts maintained at ORISE.

Results: According to data available on the study, infection is an important complication of radiation therapy and low white cell counts are the most important factor in determining the likelihood of patients developing infections following radiation treatment.

Source: ORISE Tissue Analysis Data Provided to GAO, November 1994; interview with former Assistant Director, Medical Sciences Division, ORISE.

ARSENIC-76 BIODISTRIBUTION AND EXCRETION STUDIES

Description/Objectives: Tissue was obtained through either biopsy or autopsy from patients with various type of cancers who had been injected with radioactive arsenic. The study's objective was to examine the uptake, retention, distribution, and excretion of arsenic, which was being evaluated as a therapeutic agent.

Duration of Study: 1947.

Performing Organization: Argonne National Laboratory.

Number of Subjects: 12.

Informed Consent Practices Followed: A report on the study did not include specific information on the informed consent policies and procedures that were followed.

Results: According to a report on the study, arsenic rapidly distributed throughout the body, failed to localize in tumors or lymphatic tissue, and was rapidly excreted in urine and via the intestinal tract.

Source: "Arsenic-76 Preliminary Studies Progress Report." Chicago: Argonne National Laboratory, Biology Division, June 1947, pp. 1 to 16; Human Radiation Experiments: The Department of Energy Roadmap to the Story and the Records, (Feb. 1995).

BOSTON-OAK RIDGE INTRAVENOUS INJECTIONS

Description/Objectives: Tissue was obtained from patients with terminal brain tumors who had been injected with uranium. Using terminal subjects provided the "advantage," according to one scientific paper, that the distribution of uranium in the body could be determined after autopsy. This study was designed to determine any potential therapeutic value of injected uranium on neurological cancers and the distribution and excretion of uranium in the body.

Duration of Study: 1953 to 1957.

Performing Organizations: Massachusetts General Hospital (injections performed) and Oak Ridge National Laboratory (uranium solution prepared and tissue analyzed).

Number of Subjects: 11.

Informed Consent Practices Followed: Data available on the study did not include specific information on the informed consent policies and procedures that were followed.

Results: According to data available on the study, no therapeutic response to injected uranium was observed in neurological cancers. Also, apart from the bone and the kidney, there were no significant concentrations of uranium in any of the 21 tissues and organs sampled.

Source: Committee on Energy and Commerce. U.S. House of Representatives Report. "American Nuclear Guinea Pigs: Three Decades of Radiation Experiments on U.S. Citizens." (Nov. 1986).

PATHOLOGIC CHANGES IN NORMAL HUMAN THYROID TISSUE FOLLOWING LARGE DOES OF IODINE-131

Description/Objectives: Thyroid tissue was obtained from patients who had received large doses of iodine-131 as part of their medical treatment. The study's objective was to evaluate the relationship between the radiation dose to the thyroid and the total dose of iodine-131 administered, based on early histologic changes in the normal thyroid tissue of treated patients.

Duration of Study: 1950 to 1953.

Performing Organization: ORINS, now ORISE.

Number of Subjects: 10.

Informed Consent Practices Followed: According to former ORISE medical staff, documentation exists which indicates that informed consent was obtained for procedures, including autopsies, performed for patients admitted to ORINS hospital during the study period. Completed consent forms reportedly are filed in individual patients' charts maintained at ORISE.

Results: According to data available on the study, the radiation dose to the thyroid from iodine-131 was found not to be closely correlated to the total dose administered because of variations in gland size and the concentration and retention of iodine-131. In addition, the dose was not predictive of the patient's biological response.

Source: ORISE Tissue Analysis Data Provided to GAO, November 1994; interview with former Assistant Director, Medical Sciences Division, ORISE.

DEVELOPMENT OF IODINE-131 LABELED FLUORESCEIN AS A BRAIN TUMOR IMAGING AGENT

Description/Objectives: Tissue was obtained through either biopsy or autopsy from patients suspected of having brain tumors who had been injected with fluorescein, a radioisotope used to diagnose tumors of the central nervous system. The study's objective was to examine the fluorescein's rate of disappearance from the blood, rate of excretion, distribution in tissues, and comparison of concentrations in brain tumors and in normal brain tissue.

Duration of Study: 1960.

Performing Organization: Argonne Cancer Research Hospital.

Number of Subjects: 10.

Informed Consent Practices Followed: A report on the study did not include specific information on the informed consent policies and procedures that were followed.

Results: Information on study results was not available.

Source: "The Localization of Octoiodofluorescein I-131." Semiannual Reports to the U. S. Atomic Energy Commission, vol. 3, Part 101, 1961 and Parts 11 to 15, 1959 to 1961. Chicago: Argonne Cancer Research Hospital, pp. 104 to 113; Human Radiation Experiments: The Department of Energy Roadmap to the Story and the Records, (Feb. 1995).

MOLECULAR MECHANISMS IN RADIATION-INDUCED BREAST CANCER

Description/Objectives: Tissue was removed during breast reduction treatment on certain patients. The study's objective was to examine (1) the induction of instability in human breast epithelial cells irradiated in cell cultures and (2) the role of that instability in the carcinogenic process.

Duration of Study: 1993 to 1994.

Performing Organization: University of Texas, Galveston.

Number of Subjects: 10.

Informed Consent Practices Followed: On August 4, 1993, the Institutional Review Board approved the informed consent procedures used.

Results: A report is due in April 1995.

Source: DOE Listing of Research Projects Involving Human Subjects, April 1994; interview with staff member, DOE Office of Health Effects and Life Sciences Research Division.

STUDY OF THE ORIGIN OF STEROID HORMONES USING TRITIUM AND CARBON-14 LABELED COMPOUNDS

Description/Objectives: Tissue was obtained through surgery from patients who were to have their adrenal glands removed or were scheduled to have a therapeutic abortion. Aborted fetuses, removed adrenal glands, and other biopsy tissue samples were analyzed. The patients were administered a tritium labeled compound before surgery and a carbon-labeled compound during surgery. The study's objective was to evaluate the origin of steroid hormones in the body.

Duration of Study: 1955.

Performing Organizations: Argonne Cancer Research Hospital and the Los Alamos National Laboratory.

Number of Subjects: 7.

Informed Consent Practices Followed: A report on the study did not include specific information on the informed consent policies and procedures that were followed.

Results: According to a report on the study, dietary cholesterol was rapidly converted to steroid hormones, and carbon-14 was also incorporated into hormones.

Source: Biomedical Research Group of the Health Division Annual Report 1954. Los Alamos Scientific Laboratory, pp. 24 and 25;

Human Radiation Experiments: The Department of Energy Roadmap to the Story and the Records, (Feb. 1995).

LOS ALAMOS NATIONAL LABORATORY CORONERS' CASES

Description/Objectives: Tissue was obtained at autopsy from various subjects who had been declared coroners' cases. In these cases, Los Alamos provided analytical support at the request of the coroners in connection with the radioactive content of these subjects' tissues. The coroner's ultimate objective was to determine whether the subject's exposure to radioactivity was sufficient to have contributed to the cause of death.

Duration of Study: 1973 to about 1985.

Performing Organization: Los Alamos National Laboratory.

Number of Subjects: At least 5.

Informed Consent Practices Followed: Tissues were obtained under the authority of the local coroners. Informed consent documentation would be retained by each coroner's office.

Results: For these cases, amounts of plutonium, americium, uranium, or thorium in tissues were determined. In none of these cases was the exposure sufficient to have contributed to the cause of death, according to the Los Alamos researcher performing the analyses.

Source: Interview with former project leader, Environmental Chemistry Group, Los Alamos National Laboratory.

UTAH STRONTIUM-85 METABOLISM STUDY

Description/Objectives: Tissue was obtained through either biopsy or autopsy on patients who had been injected with strontium-85. The study's objective was to assimilate the uptake, retention, and excretion of strontium-85 in humans from atomic weapons testing fallout.

Duration of Study: 1956.

Performing Organization: University of Utah Radiobiology Laboratory.

Number of Subjects: 5.

Informed Consent Practices Followed: A report on the study did not include specific information on the informed consent policies and procedures that were followed.

Results: According to a report on the study, strontium cleared more efficiently than calcium from the blood and was excreted primarily in urine rather than feces.

Source: "Sr-85 Tracer Studies in Humans." Semiannual Progress Report. Salt Lake City: Radiobiology Laboratory, University of Utah, September 1956; Human Radiation Experiments: The Department of Energy Roadmap to the Story and the Records, (Feb. 1995).

UPTAKE OF TRITIATED THYMIDINE BY TUMORS IN CANCER PATIENTS

Description/Objectives: Tissue was obtained from four cancer patients scheduled for surgery who had been given tritiated thymidine, a DNA tracer. The study's objective was to analyze the rate of thymidine uptake in tumors and in normal cells. Also, the study examined the tumor cell proliferation process.

Duration of Study: 1962.

Performing Organizations: Northwestern University Medical School; Veterans Administration Research Hospital; and Argonne National Laboratory.

Number of Subjects: 4.

Informed Consent Practices Followed: Data available on the study did not include specific information on the informed consent policies and procedures that were followed.

Results: According to data available on the study, tumor cells do not necessarily proliferate faster than normal cells.

Source: DOE Radiation Experiments Update, June 1994.

DISTRIBUTION OF THOROTRAST IN THE BODY

Description/Objectives: Tissue was obtained at autopsy from patients who had been injected with thorotrast, a naturally occurring radioactive material used for medical diagnosis. The study's objective was to measure thorotrast distribution in the body.

Duration of Study: 1950s.

Performing Organizations: University of Rochester and the U.S. Naval Hospital in Bethesda, Md.

Number of Subjects: 4.

Informed Consent Practices Followed: Data available on the study did not include specific information on the informed consent policies and procedures that were followed.

Results: According to data available on the study, the calculated dose from deposited Thorotrast was highest in the liver and spleen, a factor of 10 lower in bone marrow, and still lower in the lung.

Source: Stannard, J. Newell. Radioactivity and Health: A History. Pacific Northwest Laboratory: Battelle Memorial Institute, 1988.

STUDIES OF THE DISTRIBUTION OF RADIOLABELED LEWISITE AND MUSTARD GAS ON SKIN

Description/Objectives: Tissue was obtained through biopsy from subjects who had small areas of their skin exposed to two chemical-warfare gases--lewisite and mustard gas. The study's objective was to determine the distribution of the gases in the tissue.

Duration of Study: 1947.

Performing Organization: Crocker Radiation Laboratory, University of California at Berkeley, and the University of California Medical School in San Francisco.

Number of Subjects: 4.

Informed Consent Practices Followed: A report on the study did not include specific information on the informed consent policies and procedures that were followed.

Results: According to a report on the study, lewisite was found to fix primarily in the epidermis and mustard gas fixed in both the epidermis and dermis.

Source: "Radio-Autograph Studies of the Distribution of Lewisite and Mustard Gas in Skin and Eye Tissues." American Journal of Pathology. vol. XXIII, pp. 389 to 411; Human Radiation Experiments: The Department of Energy Roadmap to the Story and the Records, (Feb. 1995).

METABOLISM OF STRONTIUM-85 IN HUMAN BEINGS

Description/Objectives: Tissue was obtained at autopsy from patients who had received tracer doses of strontium-85. The study's objective was to evaluate the metabolism of strontium-85 fallout in human tissue from atomic testing.

Duration of Study: 1955.

Performing Organization: ORINS, now ORISE.

Number of Subjects: 4.

Informed Consent Practices Followed: According to former ORISE medical staff, documentation exists which indicates that informed

consent was obtained for procedures, including autopsies, performed for patients admitted to ORINS hospital during the study period. Completed consent forms reportedly are filed in individual patients' charts maintained at ORISE.

Results: According to data available on the study, strontium-85 behaves similarly in humans and animals.

Source: ORISE Tissue Analysis Data Provided to GAO, November 1994; interview with former Assistant Director, Medical Sciences Division, ORISE.

STUDIES ON THE METABOLISM OF GLYCINE LABELED WITH CARBON-14

Description/Objectives: Tissue was obtained at autopsy from terminally ill patients who had been injected with glycine labeled carbon-14. The study's objective was to determine the tissue distribution levels of carbon-14 and the life span of red blood cells in leukemia and polycythemia rubra vera.

Duration of Study: 1952 to 1953.

Performing Organization: University of California at Berkeley.

Number of Subjects: 4.

Informed Consent Practices Followed: A report on the study did not include specific information on the informed consent policies and procedures that were followed.

Results: According to a report on the study, there is no marked concentration of carbon-14 in the bone and, with the exception of fat, which is very low in concentration, the tissue concentrations do not differ markedly.

Source: "Studies in Glycine-2-Carbon-14 Metabolism in Man. II. Tissue Distribution." Journal of Clinical Investigation. vol. 31, 1952, pp. 335 to 337; Human Radiation Experiments: The Department of Energy Roadmap to the Story and the Records, (Feb. 1995).

CARBON-14 LABELED DIGITOXIN ADMINISTERED TO PREGNANT WOMEN TO DETERMINE FETAL DISTRIBUTION

Description/Objectives: Tissue, including fetal organs, was obtained from three women who had therapeutic abortions and one woman who had delivered a baby having no brain. The women had been given carbon-14 labeled digitoxin, a drug used in the treatment of cardiac failure. The study's objective was to investigate the transfer of digitoxin across the placental barrier of pregnant women and to determine the relative concentration of the unchanged drug and its metabolic products in various fetal organs.

Duration of Study: mid-1950s.

Performing Organization: Argonne Cancer Research Hospital.

Number of Subjects: 4.

Informed Consent Practices Followed: A report on the study did not include specific information on the informed consent policies and procedures that were followed.

Results: According to a report on the study, when the total radioactivity in the maternal and fetal body was calculated on an equivalent body weight basis, it was found that the near-term fetus had almost twice the concentration of the maternal body; whereas the 11- to 12-week fetuses had from 3 to 6 times that amount.

Source: "Placental Transfer of Radioactive Digitoxin in Pregnant Women and its Fetal Distribution." Semiannual Reports to the U. S. Atomic Energy Commission, vol. 1, Parts 1-6, 1954 to 1956. Chicago: Argonne Cancer Research Hospital, pp. 26 to 30; Human Radiation Experiments: The Department of Energy Roadmap to the Story and the Records, (Feb. 1995).

DISTRIBUTION OF RADIOACTIVE CHROMIC PHOSPHATE AFTER LUNG AND ABDOMINAL ADMINISTRATION

Description/Objectives: Tissue was obtained at autopsy from patients who had received medical treatment using radioactive chromic phosphate. The study's objective was to evaluate the metabolism and distribution of the chronic phosphate after administration by pleural and abdominal injection.

Duration of Study: Early 1950s.

Performing Organization: ORINS, now ORISE.

Number of Subjects: 3.

Informed Consent Practices Followed: According to former ORISE medical staff, documentation exists which indicates that informed consent was obtained for procedures, including autopsies, performed for patients admitted to ORINS hospital during the study period. Completed consent forms reportedly are filed in individual patients' charts maintained at ORISE.

Results: According to data available on the study, chromic phosphate was suitable for therapeutic use.

Source: ORISE Tissue Analysis Data Provided to GAO, November 1994; interview with former Assistant Director, Medical Sciences Division, ORISE.

RADIUM APPLIED TO HUMAN SKIN

Description/Objectives: Irradiated tissues were surgically removed from patients who had received thorium-X to treat certain skin diseases. The study's objective was to demonstrate that the biological effects of thorium-X can be increased by using an electrical current to cause greater penetration of the skin.

Duration of Study: 1955.

Performing Organization: New York University.

Number of Subjects: 3.

Informed Consent Practices Followed: Data available on the study did not include specific information on the informed consent policies procedures that were followed or how patients were selected.

Results: Information on study results was not available.

Source: Committee on Energy and Commerce. U.S. House of Representatives Report. "American Nuclear Guinea Pigs: Three Decades of Radiation Experiments on U.S. Citizens." (Nov. 1986).

BLOOD LEVEL STUDIES WITH CARBON-14 DIGITOXIN

Description/Objectives: Tissue was obtained at autopsy from terminal patients who had been injected with digitoxin. The study's objective was to determine the distribution of digitoxin in various tissues of the body and to determine the pathway by which the drug is removed from the body.

Duration of Study: mid-1950s.

Performing Organization: Argonne Cancer Research Hospital.

Number of Subjects: 3.

Informed Consent Practices Followed: A report on the study did not include specific information on the informed consent policies and procedures that were followed.

Results: According to a report on the study, this research determined the reactions that digitoxin undergoes in humans.

Source: "Metabolic Fate of Radioactive Digitoxin in Human Subject." Semiannual Reports to the U. S. Atomic Energy Commission, vol. 1, Parts 1-6, 1954 to 1956. Chicago: Argonne Cancer Research Hospital, pp. 62 to 68; Human Radiation

Experiments: The Department of Energy Roadmap to the Story and the Records, (Feb. 1995).

IODINE-131 ANALYSIS IN FETAL AND MATERNAL THYROIDS

Description/Objectives: Thyroid tissue was obtained at autopsy from fetuses, stillborn babies, young infants, and mothers. The study's objective was to measure the iodine-131 content in thyroid glands from atmospheric nuclear weapons testing or from residing near nuclear plants.

Duration of Study: early 1960s.

Performing Organizations: Brookhaven National Laboratory, Argonne National Laboratory, Argonne Cancer Research Hospital, Donner Laboratory, University of California Medical Center, Los Alamos National Laboratory, Oak Ridge Institute for Nuclear Studies, New York University, University of Rochester, and Hanford Laboratories Operation.

Number of Subjects: The total number is unknown but at least two subjects were sampled, a mother and a full-term child, both of whom died during delivery.

Informed Consent Practices Followed: Correspondence available on the study did not include specific information on the informed consent policies and procedures that were followed.

Results: Information on study results was not available.

Source: Atomic Energy Commission Correspondence, 1962.

POLONIUM ADMINISTERED TO HUMANS

Description/Objectives: Tissue was obtained from a hospital patient with an incurable disease who had been injected with radioactive polonium. The subject died 6 days later and was autopsied to determine which organs absorbed the polonium. The study's objective was to obtain data on the human excretion of polonium to obtain a correlation with more extensive data on rats.

Duration of Study: 1943 to 1947.

Performing Organization: University of Rochester.

Number of Subjects: 1.

Informed Consent Practices Followed: Data available on the study did not include specific information on the informed consent policies and procedures that were followed.

Results: According to data available on the study, the tissue distributions of polonium in humans indicate fairly close similarity among humans, rabbits, and rats.

Source: Committee on Energy and Commerce. U.S. House of Representatives Report. "American Nuclear Guinea Pigs: Three Decades of Radiation Experiments on U.S. Citizens." (Nov. 1986).

STUDY OF PLUTONIUM METAL DEPOSITS IN SKIN

Description/Objectives: The accidental deposition of plutonium metal particles in a person's finger subsequently led to the amputation of the finger at a particular institution. The finger was sent to Oak Ridge to evaluate changes in the skin.

Duration of Study: 1966.

Performing Organization: ORISE.

Number of Subjects: 1.

Informed Consent Practices Followed: According to former ORISE medical staff, it is assumed that consent to amputate was obtained by the institution performing the amputation.

Results: According to data available on the study, the changes observed in a minute skin growth were attributed to the high irradiation dose rate of the growth's fibers.

Source: ORISE Tissue Analysis Data Provided to GAO, November 1994; interview with former Assistant Director, Medical Sciences Division, ORISE.

HUMAN SKIN DECONTAMINATION FROM RADIOACTIVE SILVER

Description/Objectives: Skin samples were obtained from a researcher after a self-induced contamination. The study's objective was to determine the depth of penetration of a solution of radioactive silver in the human skin and the effects of decontamination for removal of the radioactive material.

Duration of Study: 1963.

Performing Organization: Oak Ridge National Laboratory.

Number of Subjects: 1.

Informed Consent Practices Followed: Informed consent was not an issue because the contamination was self-induced.

Results: Information on study results was not available.

Source: Intra-Laboratory Correspondence, Oak Ridge National Laboratory, July 1963.

PLUTONIUM CONTENT OF SEVERAL INTERNAL ORGANS FOLLOWING OCCUPATIONAL EXPOSURE (ROCKY FLATS)

Description/Objectives: Various tissue samples were obtained at autopsy from a subject who had died of a heart attack at the Rocky Flats Plant and was declared a coroner's case by the County Coroner's office. One DOE report noted that Rocky Flats "asked the pathologist if we [Rocky Flats] could analyze some tissue samples for plutonium as a logical extension of the autopsy." The analysis was performed to check the accuracy of estimating plutonium in the body from urinalysis.

Duration of Study: 1967.

Performing Organization: Rocky Flats.

Number of Subjects: 1.

Informed Consent Practices Followed: According to a Rocky Flats official, because this was a coroner's case, an informed consent authorization was not required to perform the autopsy.

Results: According to a report on the study, there was about a 2.5-percent of a maximum permissible body burden of plutonium present at the time of death. This was about a factor of 5 less than that calculated using urine results.

Source: "Plutonium Content of Several Internal Organs following Occupational Exposure," American Industrial Hygiene Association Journal, July to August 1969, pp. 417 to 421; interview with senior research engineer, Health Effects Department, Rocky Flats.

COMPARISON OF THE UPTAKE OF ZIRCONIUM-95 IN TUMOR AND NORMAL TISSUE

Description/Objectives: Tissue was obtained following the midthigh amputation of the cancerous leg of a patient who had been previously injected with zirconium-95. The study's objective was to study the deposition of zirconium in a human subject.

Duration of Study: 1946.

Performing Organizations: University of California at San Francisco, and the Crocker Radiation Laboratory, University of California, Berkeley.

Number of Subjects: 1.

Informed Consent Practices Followed: A report on the study did not include specific information on the informed consent policies and procedures that were followed.

Results: According to a report on the study, the tumor was found to have had a greater uptake of zirconium-95 than the normal tissues of the body.

Source: "Comparative Deposition of Zirconium-95 in a Reticulo Endothelial Tumor to Normal Tissues in a Human Patient." Berkeley: University of California Radiation Laboratory, UCRL-68; Human Radiation Experiments: The Department of Energy Roadmap to the Story and the Records, (Feb. 1995).

INJECTION OF AMERICIUM-241

Description/Objectives: Tissue was obtained from the amputated left thigh of a patient with malignant tumors who had been previously injected with americium-241. The study's objective was to determine the distribution of the isotope.

Duration of Study: 1947.

Performing Organization: University of California at San Francisco.

Number of Subjects: 1.

Informed Consent Practices Followed: Data available on the study did not include specific information on the informed consent policies and procedures that were followed.

Results: According to data available on the study, there was a 13- to 20-percent uptake of americium-241 by the bone.

Source: Human Radiation Experiments: The Department of Energy Roadmap to the Story and the Records, (Feb. 1995).

METABOLISM OF ZINC-65 IN HUMAN LEUKEMIA

Description/Objectives: Tissue was obtained at autopsy from a patient with chronic leukemia to whom zinc-65 had been administered. The study's objective was to examine the metabolism of zinc-65 in human cancer patients and its use in investigating blood disorders.

Duration of Study: 1961.

Performing Organization: Los Alamos Scientific Laboratory.

Number of Subjects: 1.

Informed Consent Practices Followed: A report on the study did not include specific information on the informed consent policies and procedures that were followed.

Results: According to a report on the study, zinc-65 was retained less tenaciously by the leukemia patient than by normal subjects.

Source: "Metabolism of Zinc-65 in a Terminal Leukemia Case." Biological and Medical Research Group of the Health Division Semiannual Report January to June 1961. Los Alamos Scientific Laboratory, 1960, pp. 263 to 269; Human Radiation Experiments: The Department of Energy Roadmap to the Story and the Records, (Feb. 1995).

THE METABOLISM AND FATE OF TRITIATED THYMIDINE IN MAN

Description/Objectives: Tissue was obtained at autopsy from a patient with a brain tumor who had been injected with tritiated thymidine, a DNA tracer. The study's objective was to analyze thymidine metabolism in the human body.

Duration of Study: 1959.

Performing Organization: Brookhaven National Laboratory.

Number of Subjects: 1.

Informed Consent Practices Followed: A report on the study did not include specific information on the informed consent policies and procedures that were followed.

Results: According to a report on the study, there was rapid plasma clearance of tritiated thymidine.

Source: "The Metabolism and Fate of Tritiated Thymidine in Man." Journal of Clinical Investigation. vol. 39, June 1960, pp. 909 to 918; Human Radiation Experiments: The Department of Energy Roadmap to the Story and the Records, (Feb. 1995).

ANALYSIS OF RADIOACTIVITY IN ANIMAL TISSUES AND HUMAN BONE

Description/Objectives: Samples of human bone obtained at surgery or autopsy from local hospitals were analytically compared with measurements of radioactivity in animals located at the Reactor Testing Station (currently the Idaho National Engineering Laboratory). The human bone samples appear to have been analyzed for two radioactive elements, strontium and yttrium.

Duration of Study: 1954 to 1955.

Performing Organization: Idaho National Engineering Laboratory.

Number of Subjects: The number of subjects is unknown; however, five human bone samples were used.

Informed Consent Practices Followed: The hospitals providing the tissues apparently did not reveal the donor's name to the researchers. Therefore, it appears that the laboratory did not find it necessary to obtain its own informed consents.

Results: Information on study results was not available.

Source: Interview with health physicist, Assurance Division, DOE Idaho National Engineering Laboratory.

PERMEATION OF IODINE THROUGH HUMAN EPIDERMIS EXPERIMENT

Description/Objectives: Skin from amputated limbs or other surgical procedures was obtained from various hospitals. The study's ultimate objectives were to apply radioactive iodine to the human skin to evaluate the hazards caused by iodine permeation. The principal goals of the program were to establish procedures for making accurate predictions of the thyroid dose that would result from an accidental iodine exposure. Other goals were to help in selecting iodine impermeable materials for protective clothing and to develop improved decontamination procedures.

Duration of Study: 1968 to 1970.

Performing Organization: Idaho National Engineering Laboratory.

Number of Subjects: Unknown.

Informed Consent Practices Followed: The hospitals providing the tissues apparently did not reveal the donor's name to the researchers. Therefore, the laboratory did not find it necessary to obtain its own informed consents.

Results: According to a report on the study, the epidermis is significantly permeable to iodine activity.

Source: "Permeation of Iodine Through Human Epidermis", Idaho Nuclear Corporation, February 1970; interview with health physicist, Assurance Division, DOE Idaho National Engineering Laboratory.

DISTRIBUTION OF PHOSPHOROUS-32

Description/Objectives: Tissue was obtained from patients who had received phosphorous-32 to irradiate bone cancer that transferred from breast tumors. The study's objective was to evaluate the distribution of phosphorous-32 in the cancerous bone cells in order to determine the effectiveness of the treatment.

Duration of Study: 1956 to 1957.

Performing Organization: ORINS, now ORISE.

Number of Subjects: Unknown.

Informed Consent Practices Followed: According to former ORISE medical staff, documentation exists which indicates that informed consent was obtained for procedures, including autopsies, performed for patients admitted to ORINS hospital during the study period. Completed consent forms reportedly are filed in individual patients' charts maintained at ORISE.

Results: According to data available on the study, in general, the study did not indicate that phosphorous-32 would be useful in therapeutic irradiation of bone cancers from breast tumors.

Source: ORISE Tissue Analysis Data Provided to GAO, November 1994; interview with former Assistant Director, Medical Sciences Division, ORISE.

UPTAKE OF RADIOIODINE IN HUMAN EMBRYOS

Description/Objectives: Embryos were analyzed from pregnant women who were scheduled for therapeutic abortion and had been given radioiodine. The study's objective was to determine the uptake of iodine-131 in human embryo thyroids.

Duration of Study: 1953.

Performing Organization: University of Iowa.

Number of Subjects: Unknown.

Informed Consent Practices Followed: Data available on the study did not include specific information on the informed consent policies and procedures that were followed.

Results: According to data available on the study, the human embryos showed thyroid uptake at 4 weeks, nearly 1 month sooner than was previously known.

Source: DOE Radiation Experiments Update, June 1994.

POSTMORTEM STUDIES OF RADIONUCLIDES IN MAN

Description/Objectives: Tissues or organs were obtained at autopsy from patients who had received radionuclides. The studies' objective was to obtain information on the distribution and metabolism of radionuclides in human tissue.

Duration of Study: 1950s to mid-1960s.

Performing Organization: ORINS, now ORISE.

Number of Subjects: Unknown.

Informed Consent Practices Followed: A report on the studies did not include specific information on the informed consent policies and procedures that were followed. However, the report noted that the performing location "always awaited the permission of the next of kin" to perform an autopsy.

Results: A report on the studies concluded that the best radiation measurement available may be based on the distribution demonstrated by human autopsies and correlated with clinical and experimental data.

Source: "Postmortem Studies of Radionuclides in Man," Medical Radionuclides, Radiation Dose and Effects, pp. 103 to 113, 1970; interview with former Assistant Director, Medical Sciences Division, ORISE.

RADIONUCLIDE STUDIES TO DETERMINE BONE MARROW DISTRIBUTION IN MAN

Description/Objectives: Tissue was obtained through either biopsy or autopsy from hospital patients and normal volunteers, including children, who had been administered radionuclides. The study's objective was to study bone marrow distribution as a means of better understanding diseases affecting this body part.

Duration of Study: early 1960s.

Performing Organizations: Donner Laboratory and the Lawrence Radiation Laboratory, University of California at Berkeley.

Number of Subjects: Unknown.

Informed Consent Practices Followed: A report on the study did not include specific information on the informed consent policies and procedures that were followed.

Results: According to a report on the study, additional information was gained that was useful to the physician in patient management and in the understanding of the behavior of the marrow

in disease, following treatment, and under experimental conditions in animal research.

Source: "Progress in Determining Bone Marrow Distribution in Vivo." Progress in Atomic Medicine. vol. 2, 1968, pp. 65 to 84; Human Radiation Experiments: The Department of Energy Roadmap to the Story and the Records, (Feb. 1995).

STUDIES ON THE INTERACTIVE EFFECTS OF A DRUG THAT INDUCES HYPERTHYROIDISM ON X-RAY IRRADIATION

Description/Objectives: Tissue was obtained at autopsy from patients with advanced cancer who could tolerate an elevated metabolic rate caused by oral doses of triiodothyronine. The study's objective was to determine whether induced hyperthyroidism increased the sensitivity of tumors to therapeutic x-rays.

Duration of Study: late 1960s.

Performing Organization: Argonne Cancer Research Hospital.

Number of Subjects: Unknown.

Informed Consent Practices Followed: A report on the study did not include specific information on the informed consent policies and procedures that were followed.

Results: According to a report on the study, in two patients with brain metastates and unknown primary lesions, the combined therapy (drug and x-ray) was effective on the brain lesions but not on the primary lesions.

Source: "The Effect of L-triiodothyronine on Radiation Sensitivity." Semiannual Reports to the U. S. Atomic Energy Commission, vol. 3, Part 101, 1961 and Parts 11-15, 1959 to 1961. Chicago: Argonne Cancer Research Hospital, pp. 52 to 54; Human Radiation Experiments: The Department of Energy Roadmap to the Story and the Records, (Feb. 1995).

COMMENTS FROM THE DEPARTMENT OF ENERGY

Department of Energy
Washington, DC 20585

May 15, 1995

Mr. Victor S. Rezendes
Director, Energy and Science Issues
Resources, Community, and
Economic Development Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Rezendes:

The Department of Energy appreciates the opportunity to review and comment on the General Accounting Office draft report entitled "Department of Energy: Information on DOE's Tissue Analysis Work."

The report presents basic information about tissue analysis projects in an informative and objective manner. The Department of Energy has no substantive comments to offer on the report. However, minor editorial changes have been provided to the General Accounting Office under separate cover. The Department hopes that these comments will be helpful in the preparation of the final report.

Sincerely,

Joseph F. Vivona
Chief Financial Officer

APPENDIX II

MAJOR CONTRIBUTORS TO THIS REPORT

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