



Bone Cancer and Exposure to Ionizing Radiation

Summary: There is moderate evidence that bone cancer may be associated with exposure to ionizing radiation. This evidence includes studies of nuclear workers exposed to ionizing radiation. Bone cancer is designated as a “specified” cancer under the Energy Employees Occupational Illness Compensation Program Act.

What is Bone Cancer?

Cancer that arises in the bone is called primary bone cancer. Bone cancer is not the same disease as cancer that spreads to the bone from another part of the body. Primary bone cancer is rare, with approximately 2,500 new cases each year in the United States. More commonly, bones are the site of tumors that result from the spread of cancer from another organ, such as the breasts, lungs, and prostate. The most common type of bone cancer is osteosarcoma, which develops in new tissue in growing bones. (National Cancer Institute)

Findings of Human Health Research Studies

Human health research studies compare the patterns of disease among groups of people with different amounts of exposure to a suspected risk factor. Below are results reported from such studies of bone cancer among people exposed to ionizing radiation.

These studies found increases and possible increases in bone cancer among certain groups of exposed individuals, in some cases followed over time. Statistically significant is a term used to mean that the connection between the health outcome and the exposure was strong enough that it was unlikely to be due to chance. An asterisk (*) was placed by statistically significant findings. Making interpretation of the findings difficult is the rarity of bone cancer. The research included incidence studies, which look at new cases of cancer. Incidence studies can track health more quickly and accurately than mortality studies of deaths due to cancer. The Zia study of LANL workers suggested positive findings and needs to be revisited.

Studies of Los Alamos National Laboratory (LANL) Workers

Research conducted of LANL workers provides the most direct evidence about possible relationships between a health problem and workplace exposures at LANL.

Zia Study (unpublished): Possible increased deaths due to bone cancer were observed in a study of 4,942 males who were monitored for radiation while employed by Zia between 1946 and 1978, and followed through 1984. Two of the four cases of bone cancer were Hispanic men who were monitored for plutonium.

As of November 1991, a total of seven cases of bone cancer had occurred among former Zia employees. Three were angiosarcoma of bone, “a very rare tumor.” LANL researchers wrote:

“Additional work needs to be done to verify diagnoses, explore the potential for non-radiation occupational exposures, and determine whether this collection of cases of angiosarcoma of the bone is a mere curiosity or reflective of some identifiable problem.”¹

The study was never completed. No further investigation is known to have taken place.

- **UC & Zia Employees:** Possible increased incidence of bone cancer in Anglo males who were employed at least one year between 1969 and 1978. But this finding was based on just one case.²



- **Manhattan Project Workers:** One of the 26 workers in this small study developed bone cancer (osteosarcoma) at age 64 in 1988 and died two years later. His body burden, as measured by urine samples, was reportedly on the order of 15 to 20 nanocuries (a measure of radiation exposure) of plutonium.³

Studies of Other Nuclear Workers in the United States

The next most relevant evidence comes from studies of workers in similar occupations with the same types of exposures. Listed below are studies that looked at bone cancer and workplace exposures among nuclear workers in other parts of the United States.

- **Oak Ridge K-25, Tennessee (unpublished):** Increased deaths due to bone cancer was found in a study of workers employed between 1945 and 1984, and followed through 1984.^{4 *}
- **Portsmouth, Ohio (unpublished):** Possible increased deaths due to bone cancer was found in a study of 8,887 workers employed between 1954 and 1991.¹⁸
- **U.S. Transuranics Registry:** One osteosarcoma was identified among 260 USTR plutonium worker autopsies.⁵

Studies of Other Nuclear Workers Worldwide

Below are studies of nuclear workers outside of the United States that looked at bone cancer in connection with radiation exposures.

- **Mayak, Russia:** Increased deaths were observed due to bone cancer in a study of workers with large body burdens (over 200 nanocuries – a measure of radiation exposure) of plutonium who were hired between 1948 and 1958.^{6 *} A smaller increase in deaths due to bone cancer was observed in workers who were not monitored for plutonium.⁺
- **Obninsk, Russia (I.P.P.E.):** Increased incidence of tumors of bone, connective tissue, skin and breast combined were observed in a study of 5,644 nuclear workers who were hired before 1981 and still employed between 1991 and 1997.^{7 *}

Studies of Other Ionizing Radiation Exposures

Studies among other groups of people who were not nuclear workers can also be significant as evidence of possible increases in bone cancer among those who have been exposed to ionizing radiation. Most other research has been conducted of people exposed to atomic bombs.

- **Atomic Bomb Survivors:** Possible increasing deaths were observed due to bone cancer with increasing doses of radiation in a study of 86,572 A-bomb survivors.⁸

Other Research and Policy Findings

Is the Bone Sensitive to Radiation?

Undetermined. The National Research Council's BEIR V Committee did not address the issue of bone's sensitivity to radiation, probably because these tumors are so rare.⁹



The National Research Council advises the U.S. government on scientific matters. Their Committee on Biological Effects of Exposure to Ionizing Radiations (BEIR) V reviewed sensitivity of parts of the body to radiation. Their findings are based mostly on studies of cancer among atomic bomb survivors, as well as on some of the available information on the biology of the body, animal studies, and other evidence. The greatest risk is at high exposure levels.

Is Bone Cancer a “Specified” Cancer Under the Energy Employees Occupational Illness Compensation Program Act (EEOICPA)?

- **Yes.** Bone cancer is a “specified” cancer under the EEOICPA consideration of Special Exposure Cohorts.

Policy makers have identified certain types of cancer among energy employees at nuclear facilities, including those employed at Los Alamos National Laboratory, as being potentially related to occupational exposures under the EEOICPA.

What Are Other Risk Factors for Bone Cancer?

In considering the cancer risk from exposure to ionizing radiation at work, it is important to understand other risk factors. The following is a list of other possible risk factors for bone cancer.

- Children and young adults who have had radiation or chemotherapy treatments for other conditions are at greater risk.
- Adults with Paget’s disease, a condition where new bone cells do not develop normally, may be at increased risk.
- A small number of bone cancers are due to heredity.

These factors may add to any risk due to workplace exposure to ionizing radiation. Bone cancers occur more frequently in children and young adults. Smoking is not believed to be related to bone cancer.

Rates of Bone Cancer In Exposed Counties

Bone cancer is so rare that the New Mexico Tumor Registry does not routinely report statistics.

¹ Galke WA, Johnson ER, Tietjen GL. Mortality in an ethnically diverse radiation exposed occupational cohort. unpublished draft. Los Alamos, NM: Los Alamos Scientific Laboratory; 1992 November 24.

² Acquavella JF, Wilkinson GS, Wiggs LD, Tietjen GL, Key CR. An Evaluation of Cancer Incidence Among Employees at the Los Alamos National Laboratory. Los Alamos, NM: Los Alamos National Laboratory; 1983 January. Report No.: LA-UR-83-62.

³ Voelz GL, Acquavella JF. A 42-year medical followup. Health Physics 1991.

⁴ Alvarez R. The Risks of Making Nuclear Weapons: A Review of the Health and Mortality Experience of U.S. Department of Energy Workers. Washington, D.C.: Government Accountability Project; January 2000.

⁵ Gold B, Kathren RL. Causes of death in a cohort of 260 plutonium workers. Health Physics 1998;75(3):236-240.

⁶ Koshurnikova NA, Gilbert ES, Sokolnikov M, Khokhryakov VF, Miller S, Preston DL, et al. Bone cancers in Mayak workers. Radiation Research 2000;154:237-245.



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- ⁷ Ivanov VK, Tsyb AF, Rastopchin EM, Gorsky AI, Maksyutov MA, Vayzer VI, et al. Cancer incidence among nuclear workers in Russia based on data from the Institute on Physics and Power Engineering: a preliminary analysis. *Radiation Research* 2001;155:801-808.
- ⁸ Pierce DA, Shimizu Y, Preston DL, Vaeth M, Mabuchi K. Studies of the mortality of atomic bomb survivors. Report 12, part 1. Cancer: 1950-1980. *Radiation Research* 1996;146:1-27.
- ⁹ Committee on the Biological Effects of Ionizing Radiation. Health Effects of Exposure to Low Levels of Ionizing Radiation; BEIR V. Washington, D.C.: National Academy Press; 1990.
- ¹⁸ Alvarez R. The Risks of Making Nuclear Weapons: A Review of the Health and Mortality Experience of U.S. Department of Energy Workers. Washington, D.C.: Government Accountability Project; January 2000.