



Non-Hodgkin's Lymphoma (NHL) and (Lymphosarcoma and reticulum cell sarcoma) Exposure to Ionizing Radiation

Summary: Some evidence has been recorded of a possible connection between non-Hodgkin's lymphoma and exposure to ionizing radiation. There is possible evidence from studies conducted at Los Alamos National Laboratory. Studies of nuclear workers at other sites who have been exposed to ionizing radiation and persons exposed to the atomic bomb show an increase risk of developing non-Hodgkin's lymphoma. The National Research Council's BEIR V committee did not address the issue of radiation-induced non-Hodgkin's lymphoma. Non-Hodgkin's lymphoma is designated as a "specified" cancer under the Energy Employees Occupational Illness Compensation Program Act. Historically, non-Hodgkin's lymphoma incidence and mortality have been among the highest in the state for Los Alamos County. Non-Hodgkin's lymphoma incidence and mortality in Rio Arriba County is less than most counties in New Mexico. Incidence means new cases of cancer, while mortality means deaths due to cancer.

What is Non-Hodgkin's Lymphoma?

Lymphoma is a general term for cancers that develop in the lymphatic system. The lymphatic system is part of the body's immune system. It helps the body fight disease and infection. Hodgkin's disease is one type of lymphoma, all others may be grouped together and referred to as Non-Hodgkin's Lymphoma. Lymphosarcoma or reticulum cell sarcoma can be other names for Non-Hodgkin's Lymphoma. Lymphomas account for about 5 percent of all cases of cancer in this country. Because lymphatic tissue is present in many parts of the body, non-Hodgkin's lymphoma can start almost anywhere in the body. This type of cancer can spread to almost any part of the body, including the liver, bone marrow, and spleen. (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 non-Hodgkin's lymphoma among people exposed to ionizing radiation.

All of these studies found possible increases of non-Hodgkin's lymphoma among certain groups of exposed workers. 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. Note that some of the findings were based on only a few cases. The research included incidence studies, which look at new cases of cancer. These can track health more quickly and accurately than mortality studies of deaths due to cancer.

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.

- **UC & Zia Employees:** A possible increased incidence of lymphosarcoma and reticulosarcoma was found in a study of Anglo males who were employed for at least one year between 1969 and 1978. The finding was based on just four cases.¹⁶
- **Mortality Study up to 1991:** Possible increased deaths were found to be due to lymphosarcoma in an analysis of 3,775 males who were monitored for plutonium while employed between 1943 and 1977. Based on just one case, which occurred in a worker with body burden greater than 2 nanocuries (a measure of radiation exposure).²¹



- **Zia Study (unpublished):** Possible increased deaths were found in an analysis of 564 females employed by Zia Company between 1946 and 1978 who were monitored for either plutonium or external radiation. Findings were based on just one case.¹⁵

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 non-Hodgkin's lymphoma and workplace exposures among nuclear workers in other parts of the United States.

- **Hanford, Washington:** A possible increase in deaths to "lymphomas" was found in a study of 35,000 males who were employed between 1943 and 1972, and then followed through 1972.⁵¹
- **Savannah River Site, South Carolina:** A possible increase in deaths in the category of lymphomas that includes NHL was found among white male hourly employees who were hired before 1955.⁴⁴
- **Rocky Flats, Colorado:** A possible increased deaths due to lymphosarcoma and reticulum cell sarcoma was observed in a study of 5,413 men employed for at least two years between 1952 and 1979 (This study assumed a latent period of 2 or 5 years). Findings were based on just one case.²⁸
- **Portsmouth, Ohio:** Possible increased deaths were seen due to lymphoreticulosarcoma in a study of 8,887 workers employed for at least one day between 1954 and 1991, followed through 1992.¹⁸

Studies of Other Nuclear Workers Worldwide

Below are studies of nuclear workers outside of the United States that looked at non-Hodgkin's lymphoma in connection with radiation exposures.

- **Sellafield, England:** A possible increase in non-Hodgkin's lymphoma deaths was observed in a study of 5,203 plutonium workers who were employed between 1947 and 1975, and then followed through 1992, when compared to non-radiation workers and to other radiation (non-Pu) workers.³
- **Atomic Energy Establishment of U.K.:** A possible increase was found in non-Hodgkin's lymphoma deaths in a study of radiation workers who were employed between 1946 and 1979, and then followed through 1986.⁶

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 non-Hodgkin's lymphoma among those who have been exposed to ionizing radiation. Most other research has been conducted of people exposed to atomic bombs.

- **Atomic Bomb Survivors:** A possible increase has been observed in non-Hodgkin's lymphoma deaths in A-bomb survivors who were followed through 1978.^{71*}

Other Research and Policy Findings

Is Non-Hodgkins Lymphoma Considered Radiation-Sensitive?

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.

- The National Research Council's BEIR V committee did not comment on the radiation-relatedness of non-Hodgkin's lymphoma.

Is Non-Hodgkins Lymphoma a "Specified" Cancer Under the Energy Employees Occupational Illness Compensation Program Act (EEOICPA)?

- **Yes.** Non-Hodgkin's lymphoma, Lymphosarcoma and reticulum cell sarcoma are 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 Non-Hodgkin's Lymphoma?

In considering the cancer risk from exposure to ionizing radiation at work, it is important to understand other risk factors. Below is a list of other possible risk factors for Non-Hodgkins Lymphoma.

- **Drinking water contamination.** Contamination of drinking water with nitrate, a chemical found in fertilizers, may be associated with an increased risk of non-Hodgkin's lymphoma (NHL), particularly in agricultural areas, a National Cancer Institute (NCI) study suggests.
- **Chemical exposures.** People who work extensively with or are otherwise exposed to certain chemicals, such as pesticides, solvents, or fertilizers, have a greater chance of developing non-Hodgkin's lymphoma.
- **Poor Immune System.** Non-Hodgkin's lymphoma is more common among people with inherited immune deficiencies, autoimmune diseases, or HIV/AIDS, and among people taking immunosuppressant drugs following organ transplants.
- **Viruses.** Human T-lymphotropic virus type I (HTLV-1) and Epstein-Barr virus are two infectious agents that increase the chance of developing non-Hodgkin's lymphoma.

These factors may add to any risk due to workplace exposure to ionizing radiation. The likelihood of getting non-Hodgkin's lymphoma increases with age and is more common in men than in women. Smoking is not a risk factor.

Rates of Non-Hodgkin's Lymphoma Cancer in Exposed Counties

Los Alamos County

Rates of non-Hodgkin's lymphoma incidence and mortality were very high in Los Alamos County. Los Alamos County:

- Ranked first highest in incidence of non-Hodgkin's lymphoma and
- Ranked third highest in mortality among the 33 counties in New Mexico from 1970 to 1996.
- In the early 1970's the rate in Los Alamos County was considerably higher than New Mexico or the U.S..³²
- From 1970 to 1990, it was up to twice the expected rate.³⁵
- In recent years, about three to four cases have occurred annually.

Rio Arriba County



Rates of non-Hodgkin's lymphoma incidence and mortality in Rio Arriba County were among the lowest third of counties. Rio Arriba County:

- Ranked 25th in incidence of non-Hodgkin's lymphoma and
- Ranked 23 in mortality for NHL among the 33 counties in New Mexico from 1970 to 1996.

The findings suggest that more needs to be done to prevent, diagnose and treat non-Hodgkin's lymphoma in Los Alamos County.

- ³ Omar RZ, Barber JA, Smith PG. Cancer mortality and morbidity among plutonium workers at the Sellafield plant of British Nuclear Fuels. *British Journal of Cancer* 1999; 79(7/8):1288-1301.
- ⁶ Fraser P, Carpenter L, Maconochie N, Higgins C, Booth M, Beral V. Cancer mortality and morbidity in employees of the United Kingdom Atomic Energy Authority, 1946-1986. *British Journal of Cancer* 1993;67:615-624.
- ¹⁵ 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.
- ¹⁶ 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.
- 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.
- ²¹ Wiggs LD, Johnson ER, Cox-DeVore CA, Voelz GL. Mortality through 1990 among white male workers at the Los Alamos National Laboratory: considering exposures to plutonium and external ionizing radiation. *Health Physics* 1994;67(6):557-586.
- ²⁸ Wilkinson GS, Tietjen GL, Wiggs LD, Galke WA, Acquavella JF, Reyes M, Voelz GL, Waxweiler RJ. Mortality among plutonium and other radiation workers at a plutonium weapons facility. *American Journal of Epidemiology* 1987;125(2):231-250.
- ³² New Mexico Department of Health. Steering Committee Meeting Minutes, Third Meeting. In: Los Alamos Cancer Rate Study: Phase I. Santa Fe, NM; 1992. p. 21.
- ³⁵ Athas WF, Key CR. Los Alamos Cancer Rate Study: Phase I; Cancer Incidence in Los Alamos County, 1970-1990; Final Report. Santa Fe, NM: New Mexico Department of Health, Division of Epidemiology, Evaluation and Planning University of New Mexico Cancer Center, New Mexico tumor Registry, 1993; March 1993.
- ⁴⁴ Cragle DL, McLain RW, Qualters JR, Hickey JLS, Wilkinson GS, Tankersley WG, et al. Mortality among workers at a nuclear fuels production facility. *American Journal of Industrial Medicine* 1988;14:379-401.
- ⁵¹ Mancuso TF, Stewart A, Kneale GW. Radiation exposures of Hanford workers dying from cancer and other causes. *Health Physics* 1977;33:369-385.
- ⁷¹ Wing S, Richardson D, Wolf S, Mihlan G, Crawford-Brown DJ, Wood J. A case control study of multiple myeloma at four nuclear facilities. *Annals of Epidemiology* 2000;10(3):144-153.



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* *Findings were statistically significant (strong evidence)*
+ *Evidence of a dose-response relationship (strongest evidence)*