



Esophageal Cancer and Exposure to Ionizing Radiation

Summary: Strong evidence has been recorded of a possible connection between esophageal cancer and exposure to ionizing radiation. This evidence is based upon studies of nuclear workers and others exposed to ionizing radiation. These findings are consistent with the National Research Council's determination that cancer of the esophagus increased in populations exposed to ionizing radiation. Esophageal cancer is designated as a "specified" cancer under the Energy Employees Occupational Illness Compensation Program Act. Historically, esophageal cancer incidence and mortality have both been moderate in Los Alamos County and in Rio Arriba County among New Mexico counties. Incidence means new cases of cancer, while mortality means deaths due to cancer.

What is Esophageal Cancer?

The esophagus is a hollow tube that carries food and liquids from the throat to the stomach. When a person swallows, the muscular walls of the esophagus contract to push food down into the stomach. Cancer that begins in the esophagus is called esophageal cancer. Esophageal cancer may be named for the type of cell that is cancerous. For example, squamous cell carcinoma or adenocarcinoma. (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 esophageal cancer among people exposed to ionizing radiation.

All of these studies found increases and possible in esophageal 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. The research included an incidence study, which looked at new cases of cancer. These can track health more quickly and accurately than mortality studies of deaths due to cancer. Adding to the strength of the findings is that increasing rates of esophageal cancer were observed with higher doses in some studies.

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.

- **LANL Mortality Study up to 1991:** Rates of death due to esophageal cancer were observed to increase with increasing doses of external radiation.^{21 *+}

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 esophageal cancer and workplace exposures among nuclear workers in other parts of the United States.

- **Fernald, Ohio:** A possible increase in deaths due to esophageal cancer was found in a study of 4,014 uranium processing workers employed between 1951 and 1989, and then followed through 1989.¹



- **Mallinckrodt, St. Louis, Missouri:** A possible increase in deaths due to esophageal cancer was found in a study of 2,514 uranium processing workers who were employed between 1942 and 1966, and followed through 1993.²
- **Rocky Flats, Colorado:** A possible increase in deaths due to esophageal cancer was found in workers with plutonium body burdens greater than 2 nanocuries (a measure of radiation exposure). However, this was based on only two cases.²⁸
- **Combined Hanford, Washington, Oak Ridge, Tennessee and Rocky Flats, Colorado:** Increasing rates of death due to esophageal cancer was found with increasing doses of external radiation in a study of 45,000 workers employed for at least six months.^{1 *+}

Studies of Other Nuclear Workers Worldwide

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

- **Sellafield, England:** A possible increase in deaths was found due to esophageal cancer in a study of 5,203 plutonium workers employed between 1947 and 1975, who were followed through 1992, when workers were compared to non-radiation workers.³ A possible increase in deaths due to esophageal cancer was also found in a study of 10,157 radiation workers, who were followed through 1983.⁴
- **Canadian Radiation Workers:** A possible increased incidence of esophageal cancer from 1969 to 1988 was observed in a study of 191,300 workers who were employed between 1951 and 1988.⁴⁷

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 esophageal 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:** Increasing deaths due to cancer of the esophagus with increasing doses of radiation in a study of 86,572 A-bomb survivors.^{8 **}

Other Research and Policy Findings

Is the Esophagus Sensitive to Radiation?

- **Yes.** According to the National Research Council's BEIR V Committee, "[c]arcinoma of the esophagus has been observed to occur with increased frequency in several irradiated human populations."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 Esophageal Cancer a “Specified” Cancer Under the Energy Employees Occupational Illness Compensation Program Act (EEOICPA)?

- **Yes.** Esophageal 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 Esophageal Cancer?

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 esophageal cancer.

- **Smoking.** Smoking is considered to be related to esophageal cancer.^{10, 11, 12}
- **Alcohol Use.** Chronic and/or heavy use of alcohol is another major risk factor for esophageal cancer.
- **Causes of significant irritation.** Long-term irritation or damage to the lining of the esophagus can increase the risk of esophageal cancer. This may be due to factors such as if stomach acid frequently “backs up” into the esophagus or by swallowing lye or other caustic substances.

These factors may add to any risk due to workplace exposure to ionizing radiation. Esophageal cancer is more likely to occur as people get older. It is more common in men than women.

Rates of Esophageal Cancer In Exposed Counties

Los Alamos County

There have been moderate rates of esophageal cancer incidence reported in Los Alamos County for esophageal cancer and low rates of esophageal cancer mortality.

- Los Alamos County ranked 21st in esophageal cancer incidence from 1970 to 1996 of the 33 counties in New Mexico.³³
- Los Alamos County ranked 28th in esophageal cancer mortality from 1970 to 1996 of the 33 counties in New Mexico.³³
- In recent years, there has been less than one diagnosed each year in Los Alamos County.^{13, 14}

Rio Arriba County

Rates of esophageal cancer reported in Rio Arriba County have been moderate for cancer incidence and mortality.

- Rio Arriba County ranked 15th in esophageal cancer incidence from 1970 to 1996 of the 33 counties in New Mexico.³³
- Rio Arriba County ranked 15th in esophageal cancer mortality from 1970 to 1996 of the 33 counties in New Mexico.³³

¹ Gilbert ES, Cragle DL, Wiggs LD. Updated analysis of combined mortality data for workers at the Hanford Site, Oak Ridge National Laboratory, and Rocky Flats Weapons Plant. Radiation Research 1993;136:408-421.



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- 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.
- ⁴ Smith PG, Douglas AJ. Mortality of workers at the Sellafield plant of British Nuclear Fuels. *British Medical Journal* 1986;293:845-854.
- 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.
- ¹⁰ Wald NJ, Hackshaw AK. Cigarette smoking: an epidemiological overview. *British Medical Bulletin* 1996;52(1):3-11.
- ¹¹ Shopland DR. Tobacco use and its contribution to early cancer mortality with a special emphasis on cigarette smoking. *Environmental Health Perspectives* 1995;103(S8):131-141.
- ¹² Anon. Cigarette smoking-attributable mortality and years of potential life lost - United States, 1990. *Morbidity and Mortality Weekly Report* 1993;42(33):645-649.
- ¹³ New Mexico Department of Health. Steering Committee Data; Appendix E, Table N. Cancer Cases; Los Alamos Residents 1970-1990; Site by Year of Diagnosis. Los Alamos Cancer Rate Study. Santa Fe, NM, 1992;1.
- ¹⁴ Athas WF, Key CR, Sewell M, Voorhees R. Cancer Trends in Los Alamos County, 1973-1997. In: Fuller Lodge; July 14, 1999; Los Alamos, NM; 1999. p. 27.
- 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.
- ³³ Athas WF. Cancer in New Mexico 1970-1996: Changing Patterns and Emerging Trends. Santa Fe, NM: New Mexico Department of Health, 1998.
- ⁴⁷ Sont WN, Zielinski JM, Ashmore JP, Jiang H, Krewski D, Fair ME, et al. First analysis of cancer incidence and occupational radiation exposure based on the National Dose Registry of Canada. *American Journal of Epidemiology* 2001;153(4):309-318.