

Liver Cancer and (including intra-hepatic bile duct) Exposure to Ionizing Radiation

Summary: Moderately strong evidence has been recorded of a possible connection between liver cancer deaths and exposure to ionizing radiation. This evidence is based upon studies conducted at Los Alamos National Laboratory, studies of nuclear workers at other sites, and others exposed to ionizing radiation. These findings are consistent with the National Research Council's determination that the liver is sensitive to ionizing radiation. Liver cancer is designated as a "specified" cancer under the Energy Employees Occupational Illness Compensation Program Act. Historically, incidence of liver cancer has been among the lowest in the state for Los Alamos County. Incidence of liver cancer in Rio Arriba County has been higher than average New Mexico county rates. Mortality in Rio Arriba County has been among the highest reported in the state. Incidence means new cases of cancer, while mortality means deaths due to cancer.

What is Liver Cancer?

The liver is the largest organ in the body. The liver removes harmful material from the blood and has other important functions that keep a person healthy. It makes enzymes and bile (a fluid) that help digest food. The bile duct is a tube that connects the liver and the gallbladder to the small intestine. The part of the bile duct that is inside the liver is called the intrahepatic bile duct. Cancer of this part of the bile duct is often reported together with liver cancer. (National Cancer Institute)

Cancer that begins in the liver is called *primary* liver cancer. In the United States, this type of cancer is uncommon. However, it is common for cancer that began in other parts of the body to spread to the liver (metastasize). When this happens, the disease is not liver cancer. Instead it is a secondary cancer that would be named for the organ or the tissue in which it began (such as breast cancer if the cancer first began in the breast).

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 liver cancer among people exposed to ionizing radiation.

All of these studies found increases and possible increases in liver cancer 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. An asterisk (*) was placed by statistically significant findings. Several of these studies directly measured personal exposure to radiation.

* Findings were statistically significant (strong evidence)

+ Evidence of a dose-response relationship (strongest evidence)



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):** A possible increase in deaths due to cancer of the liver and the gall bladder was observed in 4,942 men who were employed by Zia between 1946 and 1978, and then followed through 1984.¹⁵

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

- **Fernald:** A possible increase in liver cancer deaths was observed in uranium processing workers employed from 1951 to 1989, followed to 1990.¹
- **Hanford:** A possible dose-response trend was observed between external radiation exposure and the risk of death due to liver cancer in workers employed from 1944-1978 and followed to 1987.^{49 +}

Studies of Other Nuclear Workers World-Wide

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

- **Canadian Radiation Workers:** There was a possible increase in the rate of liver cancer in female workers who were monitored for external radiation.⁴⁷
- **Mayak, Russia:** An increased rate of liver cancer was seen in plutonium oxide workers. This was most strongly observed among those with large body burdens (average = 230 nanocuries ? a measure of radiation exposure), who also had lifetime exposures to external radiation over 100 rem (a measure of radiation dose).⁶²

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 liver 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 liver cancer deaths were observed with increasing doses of radiation in a study of 86,572 A-bomb survivors.^{*+} Possible increasing deaths were observed due to cancer of the gall bladder with increasing doses of radiation.^{8 +}

* Findings were statistically significant (strong evidence)

+ Evidence of a dose-response relationship (strongest evidence)

Other Research and Policy Findings

Is the Liver Sensitive to Radiation?

- **Yes.** According to the National Research Council's BEIR V Committee, there is "conclusive" evidence that chronic exposure to alpha emitters can cause liver cancer in humans. Beta emitters have caused liver cancer in animals. (Alpha and beta emitters are different categories of radioactive substances).¹²

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 Liver Cancer a "Specified" Cancer Under the Energy Employees Occupational Illness Compensation Program Act (EEOICPA)?

- **Yes.** Liver cancer is a "specified" cancer under the EEOICPA consideration of Special Exposure Cohorts (except if cirrhosis or hepatitis B is indicated). Cancer of the bile ducts is also a specified cancer as well.

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 Liver Cancer?

In considering the risks of occupational exposure to ionizing radiation leading to liver cancer, it is important to understand other risk factors. Below is a list of other possible risk factors for liver cancer.

- Liver diseases including hepatitis B, cirrhosis, and hepatitis C.
- Hazardous chemicals, including vinyl chloride and thorium oxide.
- Aflatoxins, a hazardous substance made from mold that is sometimes a contaminant of poorly stored grain and nuts.

* Findings were statistically significant (strong evidence)

+ Evidence of a dose-response relationship (strongest evidence)



These factors may add to any risk due to workplace exposure to ionizing radiation. Hispanics are known to have a higher rate of cancer of the gallbladder; however the reasons are not yet known. Note that the risk of liver cancer is not higher in Hispanics.¹

What Makes Liver Cancer and Radiation Exposure Difficult to Study?

There are difficulties in all human studies because one cannot precisely determine all exposures and track all individual outcomes. In cancer this is especially the case as the cancer may take many years to develop to the point of diagnosis and possible death (disease latency). Liver cancer research is made particularly difficult due to errors in diagnosing liver cancer. Primary cancers of many other sites in the body can spread (metastasize) to the liver. This may lead to some other cancers to be improperly diagnosed as liver cancer. It is important to make sure that primary liver cancer is the accurate diagnoses.

Rates of Liver Cancer In Exposed Counties

Los Alamos County

There have been very low rates of liver cancer reported in Los Alamos County for liver cancer incidence.

- Los Alamos County had the lowest rate of liver cancer incidence from 1970 to 1996 of the 33 counties in New Mexico.³³
- In recent years, there have been fewer than one case diagnosed each year in Los Alamos County.¹⁴

Rio Arriba County

Rates of liver cancer incidence reported in Rio Arriba County have been somewhat higher than average county rates and quite high for liver cancer mortality. These higher rates may be due to chance differences in area rates.

- Rio Arriba County ranked 11th highest in liver cancer incidence from 1970 to 1996 and
- 4th highest in liver cancer mortality from 1970 to 1996 of the 33 counties in New Mexico.³³

Rio Arriba County's ranking for liver cancer mortality is worse than its ranking for liver cancer incidence. This means that the rates of diagnosis and treatment may be low relative to the number who actually have the disease. More work needs to be done to detect and treat liver cancer early.

¹ New Mexico Department of Health. Steering Committee Meeting Minutes, Third Meeting. Los Alamos Cancer Rate Study: Phase I. Santa Fe, NM, 1992;21.

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+ Evidence of a dose-response relationship (strongest evidence)