Findings from the International Nuclear Workers Study (INWORKS): Ionizing Radiation and Solid Cancer

Previous studies suggest exposure to high doses of ionizing radiation may cause solid cancer. However, it is still unclear if prolonged low doses of ionizing radiation, which are common in some workplaces, also cause solid cancer. An international team of researchers recently completed a study of cancer-related deaths in French, British, and American nuclear workers who were exposed to ionizing radiation at work.

What We Found

The results of this study suggest a positive association between ionizing radiation exposure and death from solid cancer, all cancer, and all cancer excluding leukemia among more than 300,000 nuclear workers.

- The rate of death from cancer increased with radiation dose.
    - We found that the risk of solid cancer increased by about 5% per 100 millisieverts (mSv) (10 rem).
    - The average dose of the group of workers in our study was 21 mSv (2.1 rem).
- We estimated that, within the group of workers we studied, about 2 in every 200 deaths from cancer (other than leukemia) were due to their workplace radiation exposure.
- Among the cohort members who received at least 5 mSv of radiation dose in the workplace, we estimated that out of every 200 deaths from cancer other than leukemia, about 5 were due to their workplace radiation exposure.

What does this mean?

Exposure to ionizing radiation cannot be avoided completely. According to the National Council on Radiation Protection & Measurements, on average persons in the U.S. receive an effective dose of about 6.0 mSv, or 0.006 Sieverts (Sv) each year from natural and man-made radiation sources.

The link between ionizing radiation exposure and some cancers is well known. However, much of this knowledge comes from studies of acutely exposed people, such as Japanese atomic bomb survivors and radiation therapy patients. Questions remain about using information from these studies to describe risks under much different (usually much lower) exposure conditions, such as those experienced by nuclear workers.

This study supports previous findings and strengthens the evidence of a relationship between cancer and ionizing radiation. This relationship is observed not only at high doses following acute exposure, but also from prolonged, low exposures found in the workplace.

This information emphasizes the need for continued efforts to reduce ionizing radiation exposure to levels that are as low as reasonably achievable, and, in the case of patient exposures, to justify that the radiation exposure does more good than harm.

What should you do?

- If you currently work with radioactive materials contact your health and safety representative or employer if you have questions on how to best protect yourself from exposure.
- Share this information with your doctor if you are concerned about your health or have questions about these illnesses.

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How the Study Was Done

Our approach is sometimes referred to as a cohort study. We followed a group of nuclear workers over time to find out how long workers lived and what their causes of death were. Using the radiation dosimetry information that had been collected by personal badge dosimeters in the workplace, we estimated a worker's excess relative rate, or ERR (that is, the relative rate minus 1) of death from cancer. The relative rate compares the mortality rate in an exposed group to the mortality rate (for the same cause) in an unexposed group. For example, an ERR of 0.5 means that the cancer rate among exposed people was 50% higher than the rate among people without exposure. To do this, our study had four general steps:

Step 1. We assembled the study cohort.
Employment records were used to identify 308,297 workers from France, the United Kingdom and the United States of America who worked in the nuclear industry for at least one year and were monitored for radiation exposure. The period of risk observation (sometimes referred to as follow-up) varied by country. The French, British, and American worker subgroups were followed between 1968-2004, 1946-2001, and 1944-2005, respectively.

Step 2. We evaluated each worker's potential job-related exposures.
Ionizing radiation received in the workplace was our exposure of interest. Historical records maintained by dose registries, governments, and employers were thoroughly searched for information on the radiation dose for each worker. Recorded doses were adjusted to account for measurement practices that differed by exposure location and time period. Colon dose was preferred for comparison of findings to other studies.

Step 3. We obtained death information.
We used national death databases and other record sources in each country to determine if a worker was alive or deceased and, if deceased, his or her underlying cause of death. For this study, we studied deaths from all cancer, as well as deaths from cancer excluding leukemia, and solid cancer (cancer excluding leukemia and lymphoma).

Step 4. We examined the relationship between radiation dose and these cancers.
Using standard methods of statistical modeling, we assessed the dose-response relation between ionizing radiation exposure and each cancer outcome of interest. For consistency with other studies, the estimated risk was reported as an ERR per gray (Gy) of radiation exposure. However, typical occupational exposures are far less than that amount.

Study limitations

This study has a number of limitations including incomplete or imperfect information on radiation doses and other risk factors such as asbestos exposure and tobacco use. The impact from these limitations is believed to be small and unlikely to change study conclusions.

For more information

Study Publication
Richardson DB, Cardis E, Daniels RD, Gillies M, O'Hagan JA, Hamra GA, Haylock R, Laurier D, Leuraud K, Moissonnier M, Schubauer-Berigan MK, Thierry-Chef I, Kesminiene A. Risk of cancer from exposure to ionizing radiation: a retrospective cohort study of workers in France, the United Kingdom, and the United States (INWORKS). BMJ (2015).

Other related papers
Leuraud K , Richardson DB, Cardis E, Daniels RD, Gillies M, O'Hagan JA, Hamra GA, Haylock R, Laurier D, Moissonnier M, Schubauer-Berigan MK, Thierry-Chef I, Kesminiene A [2015]. *Ionising radiation and risk of death from leukaemia and lymphoma in radiation-monitored workers (INWORKS): An international cohort study.* Lancet Haematol DOI: http://dx.doi.org/10.1016/S2352-3026(15)00094-0

Hamra GB, Richardson DB, Cardis E, Daniels RD, Gillies M, O'Hagan J, Haylock R, Laurier D, Leuraud K, Moissonnier M, Schubauer-Berigan MK, Thierry-Chef I, Kesminiene A [2015]. *The International Nuclear Workers Study (INWORKS).* Int J Epidemiol 2015, 1–7 doi: 10.1093/ije/dyv122

Thierry-Chef I, Richardson DB, Daniels RD, Gillies M, Hamra GB, Haylock R., Kesminiene A, Laurier D, Leuraud K, Moissonnier M, O'Hagan J, Schubauer-Berigan MK, Cardis, E. Dose estimation for a study of nuclear workers in France, the United Kingdom and the United States of America: methods for the International Nuclear Workers Study (INWORKS), Radiat Res 183:632-642. doi: 10.1667/RR14006.1