



National Institute for Occupational Safety and Health Announcement of Findings

October 2004

Glossary of Terms

Cohort: A group of persons identified by common characteristics who are studied over a period of time.

Confidence Interval (CI): Confidence intervals reflect uncertainty in the risk estimates, e.g., SMRs. Larger intervals indicate greater uncertainty.

Excess Relative Risk (ERR): Proportional change in the risk for disease relative to exposure. If $ERR > 0$, risk increased with higher exposures.

Lagged Analysis: A dose-response analysis that ignores more recent exposures since chronic diseases such as cancer take a long time to develop and cause death, in which case earlier exposures may be more relevant.

Sievert (Sv): A measure of radiation dose that is adjusted for tissue interaction. Equivalent to 100 rem.

Standardized Mortality Ratio (SMR): Ratio of the number of deaths observed in the study group to the number of deaths expected based on rates in an external comparison population, indirectly standardized by age, race, sex, and time period.

Standardized Rate Ratio (SRR): Ratio of the mortality rate for a more highly exposed group to a mortality rate for a less-exposed internal referent group, after direct standardization of rates by age, race, sex, and time period.

An Epidemiologic Study of Mortality and Radiation-Related Risk of Cancer among Workers at the Idaho National Engineering and Environmental Laboratory (INEEL), a U.S. Department of Energy Facility

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Study Purpose: To evaluate causes and numbers of deaths among workers at the INEEL facility, and to determine if and how past radiation exposures are associated with cancers among INEEL workers.

Study Population: This cohort mortality study included 63,561 civilian workers employed by the DOE, its contractors and subcontractors, or the Naval Reactors Facility (NRF) at the INEEL at any time between 1949 and the end of 1991. Members of the military, university staff on temporary assignment at the INEEL and workers whose records did not have enough information to be followed up were excluded. Excluded workers generally worked for shorter periods of time and received no doses or low average doses of radiation.

How the Study Was Done: Causes of death prior to 12/31/1999 were obtained for deceased workers using the National Death Index and death certificates. Gamma and neutron radiation doses were estimated for each worker from individual dosimetry records at the INEEL and the NRF. Workers were also classified for possible internal occupational radiation exposure using site information. About 57% of the cohort had been monitored for external occupational radiation exposure at INEEL. Also, subcohorts of workers potentially exposed to other workplace hazards were identified, including construction and maintenance service workers, asbestos workers, painters, reactor workers, chemical workers, security workers, and drivers.

Standardized mortality ratios (SMRs) for all causes of death were calculated based on comparisons of the cohort to the regional population. Standardized rate ratios (SRRs) compared workers with higher exposures to those with lower exposures and the subcohorts to other workers within the cohort. Cancer risks in workers receiving higher radiation doses were compared with those receiving lower doses, while accounting for other factors related to cancer, such as age, gender, time period, duration of employment, and socio-economic status.

Study Findings: About 83% of the cohort was still alive at the end of 1999. The overall mortality rate among INEEL workers was slightly lower than in the regional population [SMR: 0.96, 95% confidence interval (CI): 0.94-0.97, 10,788 deaths], but the overall cancer mortality rate was slightly elevated (SMR: 1.07, 95% CI: 1.03-1.11, 2873 deaths). Radiation-monitored workers experienced lower mortality rates than non-monitored workers for most causes of death. The non-Hodgkin lymphoma mortality rate was elevated among the cohort (SMR: 1.26, 95% CI: 1.05-1.50), particularly among male painters (SRR: 2.46, 95% CI: 0.89-6.80) and female construction workers (SRR: 4.07, 95% CI: 1.08-15.3). Construction and maintenance service workers showed elevated mortality rates from asbestosis (SMR: 4.92, 95% CI: 2.35-9.26) and cancers likely to be mesotheliomas (SRR: 4.54, 95% CI: 1.01-20.4). Mortality rates for these causes were particularly high among those identified as asbestos workers (asbestosis SRR=25.6, 95% CI: 6.25-105; likely-mesothelioma SRR=4.28, 95% CI=1.19-15.5). The brain cancer mortality rate was slightly elevated within the overall cohort (SMR: 1.12, 95% CI: 0.91-1.36) and showed evidence of a dose-response relation with a 20-year dose lag ($p=0.002$ for SRR trend).

Negative dose-response relations were observed for emphysema, heart disease, and smoking-related cancers, suggesting that radiation workers were perhaps less likely to smoke. Radiogenic non-smoking-related cancers showed a very weak negative association with radiation exposure due to lower relative risk in workers receiving more than 100 mSv.

Positive, but not statistically significant, associations were detected for brain tumors, for leukemia, and for lymphatic cancers. The excess relative risk per 10 mSv (1 rem) external dose for all brain tumors combined was 0.087; (95% CI: -0.0037 to 0.338), for multiple myeloma was 0.0638; (95% CI: -0.0150 to 0.345), and for non-CLL leukemia was 0.0543 (95% CI: -0.0114 to 0.238).

Discussion: This study assembled one of the largest nuclear worker cohorts to date. The cohort is relatively young and less than 20% are deceased. More than thirty years have passed since the highest exposures occurred at the site in the 1960's. In comparison with other nuclear worker studies, the average external radiation doses are somewhat lower yet the risks of non-CLL leukemia are similar. This study also reports a possible association of radiation exposure with non-Hodgkin lymphoma and multiple myeloma, although uncertainty is high.

Conclusions: Mortality risks for most causes of death are lower among INEEL workers compared to the regional population. However, cancer rates are slightly elevated, and differ by the type of work conducted at the INEEL. While the results of the study suggest that there may be a relationship between workplace radiation exposures and the risk of brain tumors, leukemia, and lymphatic cancers, the numbers were not statistically significant. The findings provide guidance for further research needed to determine conclusively if past radiation exposures were associated with a risk of cancer.

Further NIOSH Information

For a copy of the final report, call:
1-800-356-4674

For a summary of NIOSH research involving Department of Energy workers, visit on-line at:

<http://www.cdc.gov/niosh/2001-133.html>

NIOSH/HERB Contact Points for Further Information...

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