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Uranium Dust Exposure and Lung Cancer Risk in Four Uranium Processing Operations

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We examined the relation between uranium dust exposure and lung cancer mortality among workers employed in four uranium processing or fabrication operations located in Missouri, Ohio, and Tennessee. Among workers who had at least 30 years of potential follow-up, we identified 787 lung cancer cases from death certificates and matched one control to each case. Health physicists estimated individual annual lung doses from occupational exposure primarily to insoluble uranium compounds, using contemporary monitoring data. With a 10-year lag, cumulative lung doses ranged from 0 to 137 centigrays (cGy) for cases and from 0 to 80 cGy for controls. Health physicists assigned annual external radiation doses to workers having personal monitoring records. Archivists collected

smoking information from occupational medical records. Odds ratios for lung cancer mortality for seven cumulative internal dose groups did not demonstrate increasing risk with increasing dose. We found an odds ratio of 2.0 for those exposed to 25 cGy and higher, but the 95% confidence interval of 0.20 to 20 showed great uncertainty in this estimate. There was a suggestion of an exposure effect for workers hired at age 45 years or older. Further analyses for cumulative external doses and exposures to thorium, radium, and radon did not reveal any clear association between exposure and increased risk, nor did dichotomizing workers by facility. (Epidemiology 1995;6:370-375)

Keywords: ionizing radiation, lung neoplasms, radium, radon, smoking, thorium, uranium, occupation.

Four studies of workers in the Department of Energy (DOE) nuclear complex investigated the health effects of exposure to uranium dust in uranium processing and fabrication operations.¹⁻⁴ All but one of these studies¹ reported an excess of lung cancer deaths among selected subgroups of workers. A study of 18,869 white males employed at a uranium processing plant between 1943 and 1947¹ found that lung cancer standardized mortality ratios (SMRs) for workers with the greatest potential uranium dust exposure were not higher than SMRs for unexposed workers. Risk was increased, however, among potentially exposed workers hired at age 45 years or older. A nested case-control study of 330 lung cancer cases among this cohort² confirmed the increased risk in this age group among workers with a cumulative lung

dose of 20 centigrays (cGy) or more. A study of 6,781 white males employed at a nuclear weapons fabrication plant between 1947 and 1979³ reported an elevated risk for lung cancer. A dose-response trend with increasing cumulative external dose was reported among those workers with a cumulative lung dose of 5.0 centisieverts (cSv) or more, but small numbers and the diminishing of this trend with a 10-year lag made this result equivocal.

Subjects and Methods

STUDY FACILITIES

To investigate the relation between lung cancer and uranium dust exposure, we identified eligible workers from four uranium processing or fabrication operations. Two of the operations were located at the Y-12 facility in Oak Ridge, TN, during two nonoverlapping time periods. The first was the uranium enrichment operations run by Tennessee Eastman Corporation (TEC) between 1943 and mid-1947. The second, which operated from mid-1947 through the end of the study, was a materials processing and fabrication operation. The operations from 1943 to 1947 will be referred to as TEC and those from 1947 onward as Y-12. Both operations have been described elsewhere.^{1,4} The third operation was Mallinckrodt Chemical Works' Uranium Division (MCW), located at two different sites in Missouri from 1942 to shutdown in 1966. The Feed Materials Production Center (FMPC) in Fernald, OH, the fourth operation, came on-line in 1951 and concluded production in

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Abstract

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those exposed to 25 cGy and higher, but the 95% confidence interval of 0.20 to 20 showed great uncertainty in this estimate. There was a suggestion of an exposure effect for workers hired at age 45 years or older. Further analyses for cumulative external doses and exposures to thorium, radium, and radon did not reveal any clear association between exposure and increased risk, nor did dichotomizing workers by facility.

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