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Hexavalent Chromium and Lung Cancer in the Chromate Industry: A Quantitative Risk Assessment

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Objectives: The purpose of this investigation was to estimate excess lifetime risk of lung cancer death resulting from occupational exposure to hexavalent chromium-containing mists and dusts.

Methods: The mortality experience in a previously studied cohort of 2357 chromate chemical production workers with 122 lung cancer deaths was analyzed with Poisson regression methods. Extensive records of air samples evaluated for water-soluble hexavalent chromium were available for the entire employment history of this cohort. Diverse models of exposure-response for hexavalent chromium were evaluated by comparing deviances and inspection of cubic splines. Smoking cumulative exposure imputed from cigarette use at hire was included as a predictor. Lifetime risks of lung cancer death from exposure to hexavalent chromium were estimated using an actuarial calculation that accounts for competing causes of death.

Results: A linear relative rate model gave a good and readily interpretable fit to the data. Combining races, the estimated rate ratio for 1 mg/m3-yr in cumulative exposure to hexavalent chromium (as CrO3), with a lag of 5 years, was RR = 2.44 (95% CI=1.54-3.83). The observed chromium effect depended strongly on race in the better fitting models, with nonwhite workers showing a strong trend of increasing risk with (lagged) cumulative exposure to chromium (RR=5.31, 95% CI=2.78-10.1 for 1 mg/m3-yr). White workers showed an overall excess weakly related to measured cumulative exposure. Based on all men, the excess lifetime risk for exposure to respirable hexavalent chromium at the current OSHA Permissible Exposure Limit (0.10 milligram/m3) was 255 per 1000 (95% CI: 109-416). This estimate is comparable to earlier estimates by U.S. EPA and OSHA using different occupational data.

Conclusions: Current occupational standards for hexavalent chromium permit lifetime risks of lung cancer far in excess of that usually considered acceptable by OSHA (less than one in a thousand).

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