

Estimating Historical Occupational Exposure to Airborne Hexavalent Chromium in a Chromate Production Plant: 1940–1972

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This article presents a retrospective exposure assessment for 493 workers who were occupationally exposed to airborne hexavalent chromium, Cr(VI), at a Painesville, Ohio, chromate production plant from 1940–1972. Exposure estimates were reconstructed using a job-exposure matrix approach that related job titles with area monitoring data from 21 industrial hygiene surveys conducted from 1943 to 1971. No personal monitoring data were collected. Specifically, airborne Cr(VI) concentration profiles for 22 areas of the plant, termed job-exposure group (JEG) areas, were constructed for three distinct time periods (1940–1949, 1950–1964, and 1965–1972), with cut points based on known major plant and process changes. Average airborne Cr(VI) concentrations were the highest for the bridge crane operators (5.5 mg/m³) prior to 1965, although only four cohort members held this job title. Airborne concentrations for the rest of the production areas of the plant ranged from 1.9 mg/m³ for packers in the 1940s to 0.012 mg/m³ for ore mill operators after 1964. For nearly all JEG areas, exposures decreased over time, particularly after 1964. For example, average airborne concentrations in production areas of the plant decreased from 0.72 mg/m³ in the 1940s to 0.27 mg/m³ from 1950 to 1964, and the average was 0.039 mg/m³ after 1964. Former workers were interviewed to determine activity patterns in the plant by job title. This information was combined with Cr(VI) monitoring data to calculate cumulative occupational exposure for each worker. Cumulative exposures ranged from 0.003 to 23 (mg/m³) × years. The highest monthly 8-hour average exposure concentration for each worker ranged from 0.003 to 4.1 mg/m³. These exposure estimates have been combined with mortality data for this cohort to assess the lung cancer risk associated with inhaled Cr(VI), and a positive dose-response relationship was observed for increases in lung cancer mortality with measures of cumulative exposure and highest monthly exposure.

Keywords exposure reconstruction, hexavalent chromium, job-exposure matrix, occupational exposure limit, risk assessment