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Comparative Potency Method for Cancer Risk Assessment: Application to Diesel Particulate Emissions[1]

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An estimation of the human lung cancer "unit risk" from diesel engine particulate emissions has been made using a comparative potency approach. This approach involves evaluating the tumorigenic and mutagenic potencies of the particulates from four diesel and one gasoline engine in relation to other combustion and pyrolysis products (coke oven, roofing tar, and cigarette smoke) that cause lung cancer in humans. The unit cancer risk is predicated on the linear nonthreshold extrapolation model and is the individual lifetime excess lung cancer risk from continuous exposure to 1 μg carcinogen per m^3 inhaled air. The human lung cancer unit risks obtained from the epidemiologic data for coke oven workers, roofing tar applicators, and cigarette smokers were, respectively, 9.3×10^{-4}, 3.6×10^{-4}, and 2.2×10^{-6} per μg particulate organics per m^3 air. The comparative potencies of these three materials and the diesel and gasoline engine exhaust particulates (as organic extracts) were evaluated by in vivo tumorigenicity bioassays involving skin initiation and skin carcinogenicity in SENCAR mice and by the in vitro bioassays that proved suitable for this analysis: Ames Salmonella microsome bioassay, L5178Y mouse lymphoma cell mutagenesis bioassay, and sister chromatid exchange bioassay in Chinese hamster ovary cells. The relative potencies of the coke oven, roofing tar, and cigarette smoke emissions, as determined by the mouse skin initiation assay, were within a factor of 2 of those determined using the epidemiologic data. The relative potencies, from the in vitro bioassays as compared to the human data, were similar for coke oven and roofing tar, but for the cigarette smoke condensate the in vitro tests predicted a higher relative potency. The mouse skin initiation bioassay was used to determine the unit lung cancer risk for the most potent of the diesel emissions. Based on comparisons with coke oven, roofing tar, and cigarette smoke, the unit cancer risk averaged 4.4×10^{-4}. The unit lung cancer risks for the other, less potent motor-vehicle emissions were determined from their comparative potencies relative to the most potent diesel using three in vitro bioassays. There was a high correlation between the in vitro and in vivo bioassays in their responses to the engine exhaust particulate extracts. The unit lung cancer risk per μg particulates per m^3 for the automotive diesel and gasoline exhaust particulates ranged from 0.20×10^{-4} to $0.60\times$

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