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Dermal absorption of benzene in occupational settings: Estimating flux and applications for risk assessment.

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Abstract
There is growing emphasis in the United States and Europe regarding the quantification of dermal exposures to chemical mixtures and other substances. In this paper, we determine the dermal flux of benzene in neat form, in organic solvents, and in aqueous solutions based on a critical review and analysis of the published literature, and discuss appropriate applications for using benzene dermal absorption data in occupational risk assessment. As part of this effort, we synthesize and analyze data for 77 experimental results taken from 16 studies of benzene skin absorption. We also assess the chemical activity of benzene in simple hydrocarbon solvent mixtures using a thermodynamic modeling software tool. Based on the collective human in vivo, human in vitro, and animal in vitro data sets, we find that the steady-state dermal flux for neat benzene (and benzene-saturated aqueous solutions) ranges from 0.2 to 0.4 mg/(cm2•h). Observed outlier values for some of the animal in vivo data sets are possibly due to the use of test species that have more permeable skin than humans or study conditions that resulted in damage to the skin barrier. Because relatively few dermal absorption studies have been conducted on benzene-containing organic solvents, and available test results may be influenced by study design or vehicle effects, it is not possible to use these data to quantify the dermal flux of benzene for other types of solvent mixtures. However, depending on the application, we describe several potential approaches that can be used to derive a rough approximation of the steady-state benzene dermal flux for these mixtures. Important limitations with respect to quantifying and evaluating the significance of dermal exposures to benzene in occupational settings include a lack of data on (1) factors that affect the dermal uptake of benzene, (2) the dermal flux of benzene for different organic solvent mixtures, (3) meaningful metrics for evaluating the dermal uptake of benzene, (4) steady-state versus non-steady-state dermal flux values for benzene, (5) the effect of skin damage on the dermal flux of benzene, (6) standardized test methods for estimating the dermal flux of benzene, and (7) robust estimates of the evaporation rate of benzene from different liquid vehicles.

Keywords: Benzene, dermal absorption, dermal flux, OSHA PEL, risk assessment