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## The Relationship Between Urinary Trans, Trans-Muconic Acid and Airborne Benzene in the Petrochemical Plants

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Benzene is a common toxic volatile substance in many industries. Particularly, occupational exposure to benzene has been causally associated with leukemia. Urinary trans, trans-muconic acid (ttMA) determination was a helpful test for monitoring of benzene in working environment. To investigate the relationship between external dose marker and internal dose marker in benzene-exposed workers, we measured airborne benzene in working environments and urinary ttMA in the workers. The study population contained 159 workers (88 exposed group, 71 controls in a same plant) in the petrochemical plants. The airborne benzene was sampled during survey day, and urine samples were obtained at the prior to shift (PS) and end of shift (EOS) on the survey day. Personal information on age, body weight, height, employment duration, smoking habit, and alcohol consumption was obtained by a structured questionnaire. Airborne benzene and urinary ttMA levels were analyzed by the gas chromatograph and the high performance liquid chromatograph, respectively. For statistical estimation, Mann-whitney test, t-test, paired t-test, analysis of variance, correlation analysis, and regression analysis were executed by SPSS/PC (Windows version 10). The median of environmental benzene (0.014 ppm) of exposed groups was higher than that (<0.007 ppm) of controls ( $p < 0.05$ ). The ttMA (EOS) mean concentration (191  $\mu\text{g/g}$  creatinine) of exposed group was higher than that (150  $\mu\text{g/g}$  creatinine) of controls ( $p < 0.05$ ). The EOS ttMA mean concentrations of exposed group and controls were higher than those in the PS ( $p < 0.001$ ). The urinary concentration of EOS ttMA was correlated with the environmental concentration of benzene ( $r = 0.717$ ,  $p < 0.001$ ), PS ttMA ( $r = 0.556$ ,  $p < 0.001$ ), and smoking amount in the smokers ( $r = 0.312$ ,  $p < 0.01$ ). The regression equation between the urinary concentration of EOS ttMA in  $\mu\text{g/g}$  creatinine (CttMA) and airborne concentration of benzene in ppm (Cbz) was:  $\text{Log (CttMA)} = 2.88 + 0.35 \times \text{Log (Cbz)}$ , where  $R^2 = 0.51$  and  $n = 159$  for  $p < 0.001$ . From the results of step-

wise multiple regression analysis about EOS ttMA, significant independents were airborne benzene and PS ttMA in total study population. In smokers, significant independents were airborne benzene, PS ttMA, and smoking amount. There was significant correlation between the urinary concentration of ttMA and the airborne concentration of benzene. The urinary ttMA was an effective biomarker for airborne benzene exposure in the petrochemical plants. But it was influenced by non-occupational benzene source, smoking.

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