mean urinary levels (mean = 0.52 ug/l; range 0.352 ug/1 to 1.4 ug/l). These data suggest that exposure to PAH can be relatively well-controlled in the rubber industry. However, it is plain that certain individuals may have significantly higher exposure that can be traced back to specific exposure conditions in some production functions in particular companies.

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BENZENE UPTAKE AMONG AUTOMOBILE MECHANICS: CONCENTRATIONS IN EXHALED BREATH USING A SELF-ADMINISTERED SAMPLING TECHNIQUE. P. Egeghy, L. Nylander-French, I. Hertz-Picciotto, S. M. Rappaport, University of North Carolina at Chapel Hill, Chapel Hill, NC; K. Gwin, NIOSH, Cincinnati, OH.

Automobile mechanics constitute a large population of workers exposed to benzene, a known human carcinogen, through their contact with gasoline vapor and automobile exhaust. However, little has been reported on the benzene uptake associated with these exposures. We used self-administered monitoring, a technique which has been gaining popularity in exposure assessment, to repeatedly measure uptake (via benzene in exhaled breath) among 83 workers from 12 automobile repair garages in North Carolina. Post-exposure benzene concentrations in breath averaged 57 $\mu g/m^3$ (SD = 157 $\mu g/m^3$) with a range of <3.2 - 2,030 $\mu g/m^3$. Preliminary analysis using mixed-effects statistical models yielded three significant predictors of benzene concentration in breath, namely, benzene exposure concentration ($p <$ 0.0001), pre-exposure benzene concentration in breath ($p = 0.0003$), and smoking status ($p =$ 0.0014). The within-person component comprised 97% of the total variance, indicating that environmental rather than interindividual differences were primarily responsible for the large variability in uptake. We validated the self breath measurements with expert measurements performed nearly concurrently on a subset of workers. The intraclass correlation coefficient for 63 pairs of breath samples was 0.70, indicating good agreement between the "self" and "expert" methods. This study demonstrates that self-administered monitoring can be efficiently used to measure biomarkers in exhaled breath.

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BIOLOGICAL MONITORING OF OCCUPATIONAL EXPOSURE TO SEVOFLURANE IN OPERATING ROOM PERSONNEL. S. Ghittori, Fondazione Salvatore Maugeri, Pavia, Italy.

Sevoflurane, alone or in combination with nitrous oxide, is a relatively new volatile inhalational anaesthetic. Two urinary metabolites of sevoflurane have been identified. These are inorganic fluoride and a non-volatile compound that yields hexafluoroisopropanol (HIFP) when digested with the enzyme b-glucoronidase. In order to investigate the role of HIFP in urine (HU,µg/l) as an indicator of occupational exposure to sevoflurane (CI, ppm), CI was measured in 99 members of operating room staffs. The measurements of the time-weighted average of the sevoflurane environmental concentration in the breathing zone were made by means of the diffusive personal sampler "TK200 " (Zambelli). Urine samples were collected near the end of the shift and were analyzed for HIFP by head-space gas chromatography after glucuronide hydrolysis. To 21.8-ml head-space vial were added 0,5 ml urine, 1,5 ml 10 M sulfuric acid. Samples were maintained at 100 degree for 30 min, after which glucuronide hydrolysis was 99 per-cent complete. Analyses were performed on a gas chromatograph GC plus a mass selective detector MSD. With our analytical procedure, the limit of detection of HIFP in urine was 20 µg/l. The median value for exposure to sevoflurane was 0,77 ppm (Geometric Standard Deviation = 3,10; range 0.07- 10,48 ppm). The correlation between airborne concentration of sevoflurane and its urinary metabolite HIFP was: Log HU(µg/l) = 0.880XCI ppm + 2.502 (r = 0.807, n = 99 , P< 0.0001). On the basis of the equation it was possible to establish tentative biological limit values corresponding to the respective occupational exposure limit values. Based on our experimental result HIFP value of 584 µg/l and 172 µg/l correspond to airborne concentrations of 2 and 0.5 ppm respectively .

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BIOLOGICAL MONITORING TO ASSESS EXPOSURE TO HEXAMETHYLENE DIISOCYANATE IN AUTO BODY REPAIR SHOPS. Y. Liu, M. Stowe, F. Walsh, M. Cullen, J. Sparer, C. Holm, C. Redlich, Yale University School of Medicine, New Haven, CT; M. Berode, University of Lausanne, Lausanne, Switzerland; M. Boeniger, NIOSH, Cincinnati, OH.

Urinary hexane diamine (HDA) has been reported as a good biomarker of occupational exposure to hexamethylene diisocyanate (HDI). However, most previous studies in auto body shops have limited their measurements to small numbers of workers and job groups. This study was designed to evaluate the temporal, inter- and intra-worker variability of urinary HDA, its relation to tasks performed and the respiratory and dermal exposures, and its usefulness as an exposure index for assessing respiratory and dermal health effects in a large epidemiological study of isocyanate asthma. All workers from 10 participating shops were requested to provide a minimum of 15 ml of morning and afternoon (end-of-shift) urine samples Monday through Thursday during the survey week with an additional sample obtained the following Monday morning. Samples were processed with the addition of an internal standard followed by acid hydrolysis at 100°C for 16 hours. The HDA was extracted in toluene at pH 14 and determined as heptafluorobutyric derivative by capillary gas chromatography-mass spectrometry. Results of the first 120 samples analyzed from 21 workers in 5 shops showed an average level (µg/g creatinine: mean±sd) of 1.44±0.98 for spray painters, 1.30±0.71 for technical repairers and 0.88±0.28 for administrative workers. End-of-shift levels were not significantly different from morning levels. Average levels the following Monday morning were lower than previous Thursday afternoon levels. The highest level measured was 6.50. In comparison, some of the shop workers exposed to 25 ppb HDI in our chamber tests showed a maximal HDA level of 27 µg/g. These results suggest HDA levels in this population were generally lower than those previously reported from other studies. More samples are being analyzed to provide complete evaluation. Implications of specific painting tasks and use of personal protective equipment, correlation with respiratory and dermal exposures, and related health effects are also being assessed.

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URINARY ARSENIC LEVELS OF MAINTENANCE ENGINEERS IN WAFER FABRICATION FACILITIES. Y. Wang, National Taiwan University, Taipei, Taiwan Republic of China.

Exposure to inorganic arsenic is a potential risk for the engineers in charge of the maintenance of arsenic-related equipment in the semiconductor fabrication facility. The purpose of this study was to evaluate the arsenic exposure levels of these maintenance engineers. Fifty-five equipment engineers responsible for maintenance work were recruited as study subjects and ten office personnel were included as the control group. Urine samples were collected from all subjects in a week, which were first morning void, and some additional samples obtained after work shift. These collected samples were analyzed with hydride generation AAS for arsenic. Besides, a questionnaire was used to facilitate the clarification of maintenance activities. Results showed that metabolites of inorganic arsenic, i.e., As3+, As5+, MMA and DMA, in urine samples of the maintenance engineers ranged from 5.9 to 159 mg/L with a mean of 33.4 mg/L. The mean urinary arsenic concentration of the control group was 38.6mg/L, varying from 0.88 to 180.7 mg/L. Besides, urinary arsenic metabolites in urine after work shifts were higher than the level before work shifts for the maintenance engineer group. The results of the present study could be used to identify the source and distribution of arsenic exposure in the working environment, and, therefore, to help the industrial hygiene practice to promote the status of occupational health in the field.

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APPLICATION OF A PHYSIOLOGICALLY BASED PHARMACOKINETIC MODEL TO ESTIMATE THE BIOAVAILABILITY OF INHALED STYRENE-7,8-OXIDE IN REINFORCED PLASTICS WORKERS. R. Tornero-Velez, S. Rappaport, University of North Carolina, Chapel Hill, NC; D. Echeverria, University of Washington, Seattle, WA.

Styrene is a major industrial chemical used in a variety of polymer applications. The most severe exposures occur in the reinforced-plastics industry where styrene-containing resins are used in the manufacture of products such as boats, truck parts, and bath and shower parts. During the lamination process, where resins are applied manually or by spraying into open molds, workers are exposed to styrene levels that can exceed the current ACGIH threshold limit value of 20 ppm. Workers in this industry are also exposed to small amounts of airborne styrene-7,8-oxide (SO). Since SO is also the primary in vivo metabolite of styrene and is thought to be responsible for the genotoxicity of styrene, the primary goal of this project was to assess the relative contribution of inhaled SO to systemic levels of SO. Despite its relatively low concentration, airborne SO may present a hazard that is comparable to the hazard of styrene. We employed a physiologically-based pharmacokinetic (PBPK) model to describe the distribution of styrene and SO in humans following inhalation. The model's structure includes metabolism of styrene to SO and a first-pass hydrolysis of SO, catalyzed by epoxide hydrolase. The model was validated with data for styrene and SO exposure from 328 workers employed in 17 plants in the Pacific Northwest. We concluded that the highly efficient first-pass hydrolysis of SO greatly reduces the systemic availability of metabolic SO. In contrast, low-level airborne SO, absorbed via inhalation, is immediately available to systemic circulation. This work suggests that future studies should assess the risk of exposure to airborne SO as well as styrene.

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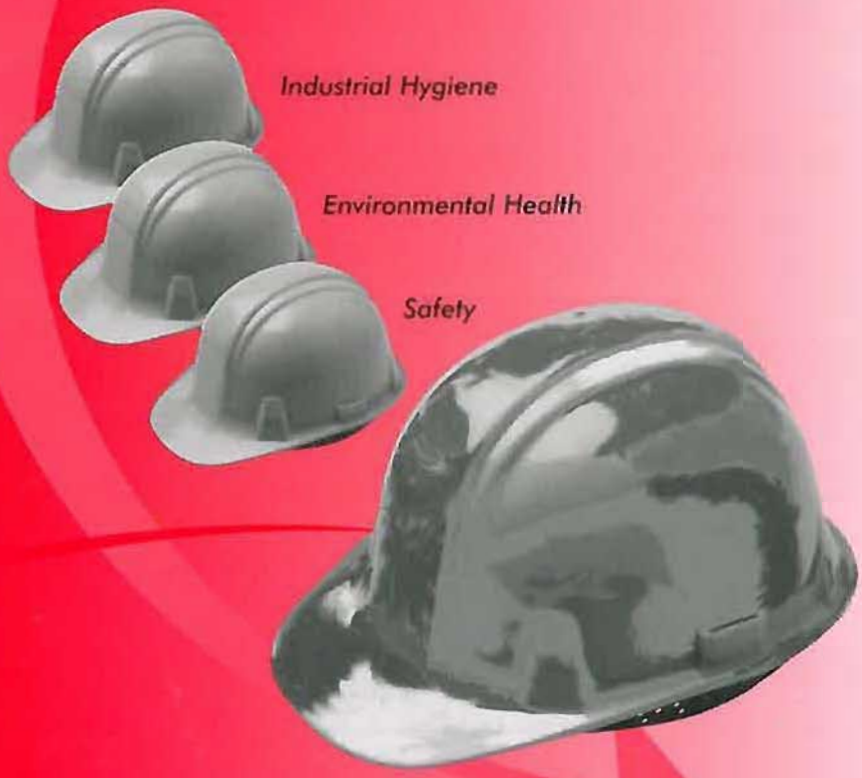

ABSTRACTS