Podium Session 146

Occupational Epidemiology

Thursday, May 23, 2013, 12:30 PM – 4:30 PM

SR-146-01
Neurologic and Reproductive Effects of Solvents on Automotive Repair Workers: Assessment of Exposure for the Bay Area Solvent Study (BASS)
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Objective: Automotive parts cleaners have often contained n-hexane, known to cause peripheral neuropathy. Although measurements indicated exposures below the TLV®, some automotive mechanics developed peripheral neuropathy. Furthermore, animal studies suggest that n-hexane may also cause testicular toxicity. These findings prompted an epidemiologic study of automotive repair workers to investigate neurologic and reproductive effects of solvents on automotive repair workers. This presentation focuses on developing methods to assess exposure to n-hexane and other solvents.

Methods: Industrial hygienists evaluated work practices of automechanics through site- visits and interviews to prepare detailed questions about the frequency solvent-related tasks were performed in each job, work practices, and products used. These questions were incorporated into an occupational history which gathered information on each job. Participants were recruited using records from the history which gathered information on each job.

Results: 835 participants visited the BASS clinic for a two hour interview, peripheral neuropathy, vision and neuropsychological exams, and collection of urine for reproductive hormonal assays. They had worked over 3,000 jobs at 1,952 shops. Algorithms were developed to estimate solvent exposures in each year (average intake of solvents each day) by integrating self reported frequency of performing tasks (e.g., use of aerosol spray cans and solvent tanks) with MSDSs, airborne concentrations and estimates of dermal absorption. Major changes in source of exposures were found, e.g., cleaning with solvent tanks accounted for 71% of the exposures in the 1960s, 30% in 2000–2004, but only 7% in 2005–2012; concomitantly, exposures from aerosol cans rose from 23% to 64% and then 84%. Work practices also contributed to significant reductions in dermal exposures.

Conclusions: Work histories were more complex than indicated in the pilot of 39 mechanics. Exposures were significantly affected by temporal trends in cleaning methods, composition of materials, and work practices. Epidemiologic studies must account for these changes.

SR-146-02
Exposures to Organic Aerosols and Effects on Pulmonary Function among Western U.S. Dairy Workers
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Objective: Organic dust inhalation has been associated with adverse respiratory responses among dairy workers. Worker susceptibility may be associated with dust constituents; intrinsic (genetic traits; immune system regulation) and extrinsic (smoking; work-related behaviors) factors.

Methods: This study quantified breathing-zone personal work shift exposures and pulmonary function among 116 dairy workers during various tasks. Inhalable dust was analyzed for endotoxin, 3-hydroxy fatty acid (3-OHFA), muramic acid, and ergosterol. Pre- and post-work-shift pulmonary function tests included: forced vital capacity (FVC), forced expiratory volume in 1 second (FEV1), and FEV1/FVC ratio. The maximum of 3 valid maneuvers was used in analyses.

Results: Participants were 91% Hispanic and 88% male. Geometric mean inhalable dust levels were low (0.68 mg/m³), but highly variable (range 0.02–6.81 mg/m³). Geometric mean endotoxin levels, 3-OHFA,
and muramic acid were 469 EU/m³, 359 ng/m³, and 11 ng/m³, respectively. Ergosterol concentrations were primarily non-detectable. Mean baseline FVC and FEV1 were 96.5% and 97.0% of predicted, respectively, and varied widely (FVC 75%–121%, FEV1 68%–125%). Cross-shift fluctuations FVC and FEV1 were significantly reduced for all workers. Mean cross-shift changes were -1.3% (95% confidence interval [CI]: -2.2, -0.4) and -1.6% (95% CI: -2.5, -0.7) for FVC and FEV1, respectively. The greatest mean reductions in cross-shift PFTs occurred during cleaning (-4.0% for FVC and -3.3% for FEV1) and repairs (-3.3% for FEV1). No clear patterns in cross-shift pulmonary function changes by exposure tertiles were observed.

Conclusions: Bioaerosol exposure and pulmonary function reductions were variable. On average, all workers experienced cross-shift reductions in pulmonary function; however, an association between increasing exposures and cross-shift reductions in pulmonary function was not observed. The relatively high endotoxin exposures for all workers may contribute to this absence of a dose-response relationship and may indicate that workers were above the threshold of effect for endotoxin.

SR-146-03
Pulmonary Restriction among Workers at a Food Flavoring Manufacturing Facility: A Follow Up Study

Objective: High rates of pulmonary restriction were reported at a flavorings manufacturing facility in Indiana by NIOSH in 2009. A reanalysis of those data failed to associate their observation with work-related factors, such as work with diacetyl. To further study the potential association between the occupational exposure to pulmonary health of this cohort, we conducted a follow-up study of these workers which included an additional four years of pulmonary health data.

Methods: Pulmonary function tests that met American Thoracic Society recommendations for acceptable quality were available for 131 workers for up to 13 years. Work-related medical records, industrial hygiene records, and employment records were also evaluated to identify data on occupational exposures. Cumulative exposure to diacetyl was considered a proxy estimate of relative exposure to other food flavorings. A job-exposure-matrix for each worker was created based on median 8-hour time weighted averages of diacetyl concentrations and tenure; which was applied to all work areas. The association between the prevalence of restriction in the worker population and exposure to food flavorings was examined through multiple logistic regression models adjusted for age, gender, race/ethnicity, obesity status (body mass index ≥ 30 kg/m²), hypertension status, and smoking status at time of most recent pulmonary function test. Tenure at the facility was also examined.

Results: Workers involved in the processes of mixing and blending flavorings had the highest exposures to diacetyl. Of the 131 workers in the study cohort, 45 (34%) were determined to have restriction. The association between cumulative exposure to diacetyl and pulmonary restriction was not statistically significant (p=0.53). Tenure at the facility was not significantly associated with restriction (p=0.42).

Conclusions: Although the prevalence of restriction is relatively high in this worker population, exposure to diacetyl and other food flavorings there is no indication that it is linked to this health outcome.

SR-146-04
The Diesel Exhaust in Mines Study: Exposure Monitoring Surveys

Objective: Develop quantitative exposure estimates for an epidemiology study of miners exposed to diesel exhaust.

Methods: Air monitoring surveys were conducted at seven non-metal mining facilities to measure exposure to respirable elemental carbon (REC), a surrogate for diesel exhaust. Personal exposure measurements were taken on workers in a cross-section of jobs located underground and on the surface. Air samples taken to measure REC were also analyzed for respirable organic carbon (ROC). Concurrent measurements to assess exposure to nitric oxide (NO) and nitrogen dioxide (NO₂), two gaseous components of DE, were also taken.

Results: The average REC exposure levels for underground jobs with five or more measurements ranged from 31 to 58 mg/m³ at the facility with the lowest average exposure levels and from 313 to 488 mg/m³ at the facility with the highest average exposure levels. The average REC exposure levels for jobs located on the surface ranged from 2 to 6 mg/m³ across the seven facilities. The average ROC levels underground ranged from 64 to 195 mg/m³, while on the surface, the average ROC levels ranged from 38 to 71 mg/m³. The average NO and NO₂ levels underground ranged from 0.20 to 1.49 ppm and from 0.10 to 0.60 ppm, respectively; and on the surface from 0.02 to 0.11 ppm and from 0.01 to 0.06 ppm, respectively.

Conclusions: The average REC exposure levels by facility were from 15 to 64 times higher underground.
than on the surface. The large contrast in exposure levels measured underground versus on the surface, along with the differences between the mining facilities and between underground jobs within the facilities resulted in a wide distribution in the exposure estimates for evaluation of exposure-response relationships in the epidemiologic analyses.

CS-146-05
A New Hybrid Approach for Assigning Workplace Chemical Exposures in the Context of Population-based Case-control Epidemiological Studies
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Situation/Problem: Evaluating lifetime chemical exposures in the context of population-based epidemiological studies has always been problematic because of the wide range of occupations and industries in which the subjects may have worked. Traditional approaches have included self-reports of exposure, using occupational titles, use of a job-exposure matrix (JEM), or coding of the occupational histories by experts. Self-reports are limited by the subjects’ awareness of their true exposures, occupational titles do not capture well variations in chemical exposures, JEMs do not reflect true exposures which vary within a given occupational group, and expert coding requires details about workplace circumstances, is lengthy and expensive and it is difficult to find experienced coders. Our team needed to develop a cost-effective approach to code over 16,000 jobs for hundreds of chemicals in a population-based case-control study of prostate cancer in the Montreal area.

Resolution: The method we have developed is a hybrid approach through which a JEM was developed specifically to assist expert coders. Using data from the expert coding of previous large population-based studies carried out in the same geographic area, we developed a database of exposure profiles. After reading the occupational history, the coder quickly pulls up a list of exposures coded in our previous studies for subjects with the same or similar job codes as well as the exposure indices (prevalence, reliability, concentration and frequency). About 100 job profiles annotated by experts were developed to provide guidance to the coders in assigning exposure to some 300 chemicals.

Results: Using this approach, we have coded nearly 4000 jobs in 300 coder-days, which represents a significant reduction in coding time.

Lessons Learned: Not only does this approach allow the coders to evaluate each job more quickly but this tool reduces inter-coders variability, and it is an invaluable training tool for new coders.

SR-146-06
Comparison between Three Publically Available Sources of Occupational Cadmium Measurements
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Objective: Publically available occupational exposure data have been used to aid occupational health surveillance and exposure reconstruction for population-based epidemiology studies. Because these data were originally collected for widely varying reasons, they may not represent average exposures for the sampled populations. We compared industry-specific average cadmium exposure levels reported in three sources of publically available occupational exposure data.

Methods: We extracted cadmium exposure information from three sources: 1) NIOSH’s Health Hazard Evaluation (HHE) reports, 2) published literature (PL), and 3) electronic compliance data from OSHA’s Integrated Management Information System (IMIS) database. We restricted comparisons to personal air measurements collected between 1980 and 2011. We calculated source-specific arithmetic mean (AM) cadmium exposure levels for each 3-digit 1987 Standardized Industrial Classification (SIC) code. For each pair of sources, we calculated the Spearman correlation coefficients (\(\rho\)) between the industry-specific AMs.

Results: The IMIS data set contained the most industries (IMIS=185; HHE=49%; PL=13%), personal measurements (IMIS=10,361; HHE=634; PL=3,077) and non-detectable measurements (IMIS=65%; HHE=49%; PL<10%); however, PL and HHE data sets included more detailed exposure information (e.g., tasks, work practices and control measures). We found moderately-high correlations in industry-specific AM exposure levels between HHE and PL (\(\rho=0.58; n=9\)) and between IMIS and PL (\(\rho=0.74; n=13\)), but only poor correlation between IMIS and HHE (\(\rho =0.17; n=22\)).

Conclusions: The similar rank order of industries in three very different sources suggests that these sources may provide a reasonable estimate of average exposure patterns in these industries. HHE data were less correlated with the other sources, reflecting the sometimes unusual circumstances captured in HHE evaluations and the heterogeneity of industries within the same 3-digit industry code. Our preliminary analyses did not account for time period and occupation differences, which may further improve observed associations.
Validation of a Practical Measurement Tool for Injury Prevention at Workplaces: The Prevention Index (PI)
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Objective: Prevention Index (PI) is a practical measurement tool which is currently used in Germany to monitor injury prevention activities at workplaces. The 12-item scoring system has 3 subscales rating technical, organizational and personnel-related internal safety conditions of a company. Each item of the score has a rating value ranging from 1–9, with higher values indicating higher level of safety conditions. The reliability and validity of this instrument were evaluated in a cross-sectional survey in 128 companies in the German metal industry during the time between December 2011 and May 2012.

Methods: The Inter-rater-reliability of this instrument was examined by 2 trained safety engineers of the German Social Accident Insurance. One engineer is responsible for safety consulting of the rating company while the other one is responsible for other firms and less informed about the conditions in the rating company. The agreement of the double ratings was quantified by interclass correlation coefficient (ICC) and absolute agreement of the rating values. Validity of this instrument was evaluated by quantifying the association between PI-values and 5-years injury rates of the corresponding companies. Poisson regression analysis was performed to assess the strength of the association adjusted for company size and related industrial sectors.

Results: Our analysis indicate a moderate to good inter-rater-reliability (ICC=0.46–0.75) of PI-values with an absolute agreement between 72% and 81%. The Poisson regression analysis demonstrate that higher technical and personnel safety conditions (PI-value ≥7) are associated with a decrease of injury rates, while less association was found between organisational conditions and injury rates.

Conclusions: This analysis indicates that PI is a valid and reliable instrument which can be effectively used to monitor safety conditions at workplaces.