Welding Fumes: An Interdisciplinary Annotated Bibliography

Boelter, F. W., et al. (2009). "Two-zone model application to breathing zone and area welding fume concentration data." J Occup Environ Hyg 6(5): 298-306.

This study assessed a professional pipefitter/welder performing shielded metal arc welding on carbon steel under field conditions. The resulting breathing zone (near field) and area (far field) welding fume concentration data were applied to the two-zone model for the purpose of determining field-derived personal exposure emission (generation) rates during actual welding work. The study is unique in that one welder was evaluated under high production conditions for 2 days at two different welding locations: a boiler room and a breezeway. Samples were collected and analyzed for total particulate following NIOSH Method 0500 and for select metals following NIOSH Method 7300. Breezeway average personal breathing zone sample total particulate concentrations ranged from 2.89 mg/m(3) to 4.38 mg/m(3), Fe concentrations ranged from 0.53 to 0.63 mg/m(3), and Mn concentrations ranged from 0.10 to 0.12 mg/m(3). The boiler room average personal breathing zone sample total particulate concentrations ranged from 4.73 mg/m(3) to 5.90 mg/m(3), Fe concentrations ranged from 0.48 to 0.85 mg/m(3), and Mn concentrations ranged from 0.06 to 0.16 mg/m(3). Average arc times ranged from 20 to 25% of the total sampling time. Both tracer gas and anemometer techniques were used to estimate ventilation of the boiler room. The steady-state form of the two-zone model was applied to long-term and short-term sample total particulate, Fe, and Mn concentrations obtained during welding in the boiler room and breezeway. The average generation rate in the boiler room was 39.2 mg/min for TP, 6.4 mg/min for Fe, and 1.3 mg/min for Mn. The average generation rate in the breezeway was 40.0 mg/min for TP, 6.6 mg/min for Fe, and 1.2 mg/min for Mn. The field-based generation rates were considerably lower than laboratory-derived published emission rates of between 280 and 650 mg/min for TP. This study emphasizes the need for field-derived welding fume generation rates and showed the personal breathing zone and area sample concentrations can be described by the two-zone model in a way that may help the industrial hygienist estimate exposures. [Supplementary

welded. RESULTS: At follow-up, mean blood Mn concentration had decreased from 10.0 to 8.4 mug/L (p=0.002). Those still welding had higher blood Mn than those no longer welding (9.9 mug/L vs. 6.8 mug/L, p=0.002). Several domains of co

multidisciplinary method to identify the dose-effect relationship between adverse health effects and Mn in air or whole blood. Bridge welders (n = 43) with little or no personal protection equipment and exposed to a welding fume containing Mn, were administered neurological, neuropsychological, neurophysiological and pulmonary tests. Outcome variables were analysed

between PM2.5 and metal content, we used a two-step approach that treated the residuals from linear regression models of each metal on PM2.5 as surrogates for the differential effects of metal exposures in models for night rMSSD. RESULTS: The median PM2.5 exposure was 650 microg/m3; median metal exposures for iron, manganese, aluminum, copper, zinc, chromium, lead, and nickel ranged from 226 microg/m3 to non-detectable. We found inverse linear associations in exposure

decrease in the afternoon. SDNN(i) was lower on workdays as compared with non-workdays with the largest, statistically significant differences observed between 10:00 and 16:00, during active working. Lower SDNN(i), albeit smaller yet statistically significant differences, was also observed in the evening hours following work (17:00-21:00) and early morning (4:00). In regression models using all time periods, an average workday SDNN(i) was 8.1 ms (95% CI -9.8 to -6.3) lower than non-workday SDNN(i). The circadian pattern of HRV exhibited two peaks which differed on work and non-workdays. CONCLUSION: While workday and non-workday HRV followed a circadian pattern, decreased HRV and variation of the circadian pattern were observed on workdays. Declines and changes in the circadian pattern of HRV is a concern among this exposed population.

Chen, J. C., et al. (2006). "Personal coronary risk profiles modify autonomic nervous system responses to air pollution." J Ow Oirbg5-2 (s)-2 ((e)6 (d)2 gtu)]TJ(-t22 (e48-2 (00)]4(e1(kda)4 ((. ()3 (2xpo)-n

solvents, and removal of paints. CONCLUSIONS: Our study of construction workers employed at DOE sites demonstrated increased COPD risk due to occupational exposures and was able to identify specific exposures increasing risk. This study provides additional support for prevention of both smoking and occupational exposures to reduce the burden of COPD among construction workers.

Fethke, N. B., et al. (2016). "Reduction of Biomechanical and Welding Fume Exposures in Stud Welding." Ann Occup Hyg 60(3): 387-401.

The welding of shear stud connectors to structural steel in construction requires a prolonged stooped posture that exposes ironworkers to biomechanical and welding fume hazards. In this study, biomechanical and welding fume exposures during stud welding using conventional methods were compared to exposures associated with use of a prototype system that allowed participants to weld from an upright position. The effect of base material (i.e. bare structural beam versus galvanized decking) on welding fume concentration (particle number and mass), particle size distribution, and particle composition was also explored. Thirty participants completed a series of stud welding simulations in a local apprenticeship training facility. Use of the upright system was associated with substantial reductions in trunk inclination and the activity levels of several muscle groups. Inhalable mass concentrations of welding fume (averaged over ~18 min) when using conventional methods were high (18.2 mg m(-3) for bare beam; 65.7 mg m(-3) for through deck), with estimated mass concentrations of iron (7.8 mg m(-3) for bare beam; 15.8 mg m(-3) for through deck), zinc (0.2 mg m(-3) for bare beam; 15.8 mg m(-3) for through deck), and manganese (0.9 mg m(-3) for bare beam; 1.5 mg m(-3) for through deck) often exceeding the American Conference of Governmental Industrial

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adopted respirable Mn TLV (20 mug/m(3)). This study shows that a welding fume exposure control and management program is warranted, especially for welding jobs in confined spaces.

Harezlak, J., et al. (2007). "Penalized solutions to functional regression problems." Comput Stat Data Anal 51(10): 4911-4925.

Recent technological advances in continuous biological monitoring and personal exposure assessment have led to the collection of subject-specific functional data. A primary goal in such studies is to assess the relationship between the functional predictors and the functional responses. The historical functional linear model (HFLM) can be used to model such dependencies of the response on the history of the predictor values. An estimation procedure for the regression coefficients that uses a variety of regularization techniques is proposed. An approximation of the regression surface relating the predictor to the outcome by a finite-dimensional basis expansion is used, followed by penalization of the coefficients of the neighboring basis functions by restricting the size of the coefficient differences to be small. Penalties based on the absolute values of the basis function coefficient differences (corresponding to the LASSO) and the squares of these differences (corresponding to the penalized spline methodology) are studied. The fits are compared using an extension of the Akaike Information Criterion that combines the error variance estimate, degrees of freedom of the fit and the norm of the bases function coefficients. The performance of the proposed methods is evaluated via simulations. The LASSO penalty applied to the linearly transformed coefficients yields sparser representations of the estimated regression surface, while the quadratic penalty provides solutions with the smallest L(2)-norm of the basis functions coefficients. Finally, the new estimation procedure is applied to the analysis of the effects of occupational particulate matter (PM) exposure on the heart rate variability (HRV) in a cohort of boilermaker workers. Results suggest that the strongest association between PM exposure and HRV in these workers occurs as a result of point exposures to the increased levels of particulate matter corresponding to smoking breaks.

Hong, O., et al. (2014). "The association between occupational exposures and cigarette smoking among operating engineers." Archives of Environmental and Occupational Health 69(3): 172-179.

The purpose of this study was to determine the relationship between occupational exposures and cigarette smoking among operating engineers. A cross-sectional survey was conducted with operating engineers (N =412) from a midwestern state in the United States. The survey included validated questions on cigarette smoking, occupational exposures, demographics, comorbidities, and health behaviors. About 35% were current smokers. Those exposed to asphalt fumes, heat stress, concrete dust, and welding fumes were less likely to smoke (odds ratio [OR] = .79, 95% confidence interval [CI]: .64-.98). Other factors associated with smoking included younger age (OR = .97, 95% CI: .94-.99), problem drinking (OR = 1.07, 95% CI: 1.03-1.12), lower Body Mass Index (OR = .95, 95% CI: .90-.99), and being separated/widowed/divorced (OR = 2.24, 95% CI: 1.19-4.20). Further investigation is needed for better understanding about job-specific exposure patterns and their impact on cigarette smoking among operating engineers.

Background: Exposure to pollutants including metals and particulate air pollution can alter DNA methylation. Yet little is known about intra-individual changes in DNA methylation over time in relationship to environmental exposures. Therefore, we evaluated the effects of acute- and chronic metal-rich PM 2.5 exposures on DNA methylation. Methods. Thirty-eight male boilermaker welders participated in a panel study for a total of 54 person days. Whole blood was collected prior to any welding activities (pre-shift) and immediately after the exposure period (post-shift). The percentage of methylated cytosines (%mC) in LINE-1, Alu, and inducible nitric oxide synthase gene (iNOS) were quantified using pyrosequencing. Personal PM2.5 (particulate matter with an aerodynamic diameter ≤ 2.5 μm) was measured over the work-shift. A questionnaire assessed job history and years worked as a boilermaker. Linear mixed models with repeated measures evaluated associations between DNA methylation, PM2.5 concentration (acute exposure), and years worked as a boilermaker (chronic exposure). Results: PM2.5 exposure was associated with increased methylation in the promoter region of the iNOS gene (β = 0.25, SE: 0.11, p-value = 0.04). Additionally, the number of years worked as a boilermaker was associated with increased iNOS methylation (β = 0.03, SE: 0.01, p-value = 0.03). No associations were observed for Alu or LINE-1. Conclusions: Acute and chronic exposure to PM2.5 generated from welding activities was associated with a modest change in DNA methylation of the iNOS gene. Future studies are needed to confirm this association and determine if the observed small increase in iNOS methylation are associated with changes in NO production or any adverse health effect. © 2013 Kile et al.; licensee BioMed Central Ltd.

Kim, J. Y., et al. (2004). "Comparison of fine particle measurements from a direct-reading instrument and a gravimetric sampling method." J Occup Environ Hyg 1(11): 707-715.

Particulate air pollution, specifically the fine particle fraction (PM2.5), has been associated with increased cardiopulmonary morbidity and mortality in general population studies. Occupational exposure to fine particulate matter can exceed ambient levels by a large factor. Due to increased interest in the health effects of particulate matter, many particle sampling methods have been developed In this study, two such measurement methods were used simultaneously and compared. PM2.5 was sampled using a filter-based gravimetric sampling method and a direct-reading instrument, the TSI Inc. model 8520 DUSTTRAK aerosol monitor. Both sampling methods were used to determine the PM2.5 exposure in a group of boilermakers exposed to welding fumes and residual fuel oil ash. The geometric mean PM2.5 concentration was 0.30 mg/m3 (GSD 3.25) and 0.31 mg/m3 (GSD 2.90)from the DUSTTRAK and gravimetric method, respectively. The Spearman rank correlation coefficient for the gravimetric and DUSTTRAK PM2.5 concentrations was 0.68. Linear regression models indicated that log, DUSTTRAK PM2.5 concentrations significantly predicted loge gravimetric PM2.5 concentrations ($p < 0.01$). The association between log(e) DUSTTRAK and log, gravimetric PM2.5 concentrations was found to be modified by surrogate measures for seasonal variation and type of aerosol. PM2.5 measurements from the DUSTTRAK are well correlated and highly predictive of measurements from the grl (nd hi)-2 (ghl3 (r)3 1s)-12 (o be)-6 (i)-244 (t)-2 wd xpose (

Kim, J. Y., et al. (2004). "Urinary 8-hydroxy-2'-deoxyguanosine as a biomarker of oxidative DNA damage in workers exposed to fine particulates." Environ Health Perspect 112(6): 666-671.

Residual oil fly ash (ROFA) is a chemically complex mixture of compounds, including metals that are potentially carcinogenic because of their ability to cause oxidative injury. In this study, we investigated the association between exposure to particulate matter with an

samples. These five metals were moderately to strongly correlated with the total fine particle fraction on filters (Spearman rho = 0.41 for zinc to 0.97 for iron). Such strong correlations and comparable results suggested that the portable XRF could be used as an effective and reliable tool for exposure assessment in many studies.

Liu, Y., et al. (2005). "Estimation of

Topics in Construction Safety and Health:

reduce worker exposure to CrVI, data on the effectiveness of LEV to reduce CrVI exposures from welding are lacking. The goal of the present study was to characterize breathing zone air concentrations of CrVI during welding tasks and primary contributing factors in four datasets: (1) OSHA compliance data; (2) a publicly available database from The Welding Institute (TWI); (3) field survey data of construction welders collected by the Center for Construction Research and Training (CPWR); and (4) controlled welding trials conducted by CPWR to assess the effectiveness of a portable LEV unit to reduce CrVI exposure. In the OSHA (n = 181) and TWI (n = 124) datasets, which included very few samples from the construction industry, the OSHA permissible exposure level (PEL) for CrVI (5 mug/m(3)) was exceeded in 9% and 13% of samples, respectively. CrVI concentrations measured in the CPWR field surveys (n = 43) were considerably higher, and 25% of samples exceeded the PEL. In the TWI and CPWR datasets, base metal, welding process, and LEV use were important predictors of CrVI concentrations. Only weak-to-moderate correlations were found between total particulate matter and CrVI, suggesting that total particulate matter concentrations are not a good surrogate for CrVI exposure in retrospective studies. Finally, in the controlled welding trials, LEV reduced median CrVI concentrations by 68% (p = 0.02). In conclusion, overexposure to CrVI in stainless steel welding is likely widespread, especially in certain operations such as shielded metal arc welding, which is commonly used in construction. However, exposure could be substantially reduced with proper use of LEV.

Mills, J. B., et al. (2013). "Comparison of the DiSCmini aerosol monitor to a handheld condensation particle counter and a scanning mobility particle sizer for submicrometer sodium chloride and metal aerosols." J Occup Environ Hyg 10(5): 250-258.

We evaluated the robust, lightweight DiSCmini (DM) aerosol monitor for its ability to measure the concentration and mean diameter of submicrometer aerosols. Tests were conducted with monodispersed and polydispersed aerosols composed of two particle types (sodium chloride [NaCl] and spark-generated metal particles, which simulate particles found in welding fume) at three different steady-state concentration ranges (Low, <10(3); Medium, 10(3)-10(4); and High, >10(4) particles/cm(3)). Particle number concentration, lung deposited surface area (LDSA) concentration, and mean size measured with the DM were compared with those measured with reference instruments, a scanning mobility particle sizer (SMPS), and a handheld condensation particle counter (CPC). Particle number concentrations measured with the DM were within 16% of those measured by the CPC for polydispersed aerosols. Poorer agreement was observed for monodispersed aerosols (+/-35% for most tests and +101% for 300-nm NaCl). LDSA concentrations measured by the DM were 96% to 155% of those estimated with the SMPS. The geometric mean diameters measured with the DM were within 30% of those measured with the SMPS for monodispersed aerosols and within 25% for polydispersed aerosols (except for the case when the aerosol contained a substantial number of particl

Mukherjee, S., et al. (2004). "Smoking status and occupational exposure affects oxidative DNA injury in boilermakers exposed to metal fume and residual oil fly ash." Cancer Epidemiol Biomarkers Prev 13(3): 454-460.

Epidemiologic studies demonstrate increased cancer incidence among workers exposed to polycyclic aromatic hydrocarbons (PAH) and metals, probably through cumulative oxidative DNA damage in response to carcinogens. Boilermakers are exposed to particulates of residual oil fly ash (ROFA) and metal fume that contain carcinogenic PAH and metals. We conducted a repeated-measures cohort study in boilermakers during the overhaul of an oil-fired boiler to determine a possible association between the level of 8-hydroxy-2'-deoxyguanosine (8-OH-dG; an oxidative injury biomarker) and biomarkers of PAH (1-hydroxypyrene; 1-OHP) and metal exposure. Preshift and postshift urine samples were analyzed for 8-OH-dG, cotinine, 1-OHP, and metals. Generalized estimating equations were used to model the multivariate relationship of 8-OH-dG to the explanatory variables of interest. Biomarker levels were determined for 181 urine samples from 20 male subjects (mean age 45 years, 50% smokers). Metal and 1-OHP levels increased cross-week and were affected by smoking status. Levels of 8-OH-dG were higher in nonsmokers at the start of the workweek yet declined after occupational exposure to similar levels as in smokers. Multivariate analysis indicated that metal x cotinine interaction terms for nickel, vanadium, chromium, and copper were significantly associated with the 8-OH-dG level, but there were differential effects depending on the metal. This study suggests that oxidative DNA damage in boilermakers is influenced by the interaction between occupational exposures and smoking status. In addition, boilermakers may have reduced ability to repair damaged 6 (ls)1 (a)6 (s)1 (in)2(oki oc)-6Ackersng snd copp6itc[3.0(ng a)-73oracre ex (r)3p (r)3[(w)2 (e)-6 -2 (

bedtime, and next morning measurements were collected. Twenty-two workers participated as controls. RESULTS: Linear regression was used to model pairwise change in u-8-isoprostane and u-8-OHdG: pre- to postshift, preshift to bedtime, postshift to bedtime, and postshift to next morning. In the models, pre- to postshift change in 8-OHdG was statistically significant, whereas postshift to bedtime change in 8-isoprostane showed an unexpected inverse

intracellular signal transduction, cell cycle, and programmed cell death. In particular, the preinflammatory cytokine interleukin 8 and one of its receptors, chemokine receptor 4, seemed to play important roles in early-stage response to heavy metal exposure and were down-regulated. Furthermore, most observed expression variations were from nonsmoking exposed individuals, suggesting that smoking profoundly affects whole-blood expression profiles. Our study is the first to demonstrate that with a paired sampling study design of pre- and postexposed individuals, small changes in gene expression profiling can be measured in whole-blood total RNA from a population-based study. This technique can be applied to evaluate the host response to other forms of environmental exposures.

Weisskopf, M. G., et al. (2005). "Prospective study of occupation and amyotrophic lateral sclerosis mortality." Am J Epidemiol 162(12): 1146-1152.

Occupational exposures are suspected of contributing to the risk of amyotrophic lateral sclerosis (ALS), but results of epidemiologic studies have been inconsistent. The authors prospectively assessed the relation between occupation and ALS mortality among more than 1 million participants in the Cancer Prevention Study II of the American Cancer Society. 14 (c (pi)-2 (v7-11 (]) (i

10-1, P < 0.01) unit increase in relative telomere length, controlling for age at baseline, current and past smoking status, work history, BMI (log kg/m2) and leukocyte differentials.

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