Exposure Assessment-1

01D.1 DERMAL PAH EXPOSURE IN SWEDISH FIREFIGHTERS AND POLICE FORENSIC INVESTIGATORS – PRELIMINARY RESULTS FROM TAPE STRIPPING ON WRIST AND COLLARBONE

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Objectives Firefighters (FFs) and police forensic investigators (PFI) may be exposed to a wide range of particles and combustion products, such as the carcinogenic benzo(a)pyrene and other polycyclic aromatic hydrocarbons (PAHs). The aim of this study was to evaluate the dermal exposure to 32 different PAHs for FFs and PFIs.

Methods The skin was sampled by tape stripping (three consecutive tapes) on lower wrist and collarbone area after end of work shift of 7 FFs (fire starters; team leaders inside the burning house; team leaders outside the burning house) during training fires (14 samples), 9 PFIs investigating the aftermath of fire events (10 samples) and 7 office workers/control persons (7 samples). We used semipermeable membrane dialysis for clean-up of the tape strip extracts and analysed the PAHs by gas chromatography mass spectrometry.

Results The median sum 32 PAH dermal exposure of the measured groups was in the range of 2 to 16 ng/cm² on the wrist and 2 to 4.6 ng/cm² on the collarbone area. Both gaseous and particle-associated PAHs were present on skin with large variability in levels between specific PAHs. The most abundant PAHs were phenanthrene, fluoranthene, and chrysene. For sum 32 PAHs the exposure of the wrist was statistically significantly higher for FF fire starters and PFIs than for controls. FF fire starters had the highest exposure for benzo(a)pyrene. For the collarbone area, the FFs and PFIs had lower exposures than on the wrist and similar to the levels for control persons.

Conclusions The dermal occupational PAH exposure for FFs and PFIs was generally higher on the wrist than on the collarbone area. Thus, the wrists seem to be less well protected by personal protective equipment than the collarbone area. On the collarbone area, the dermal PAH exposure levels were similar between FFs, PFIs and control persons.

01D.2 OBJECTIVE MEASUREMENT OF WORK-ENVIRONMENT CARCINOGENIC EXPOSURES IN FLORIDA FIREFIGHTERS USING SILICONE-BASED PASSIVE SAMPLING WRISTBANDS

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Firefighters are likely to be exposed to many toxic chemicals in the performance of their work duties such as polycyclic

aromatic hydrocarbons (PAHs). Chemical exposures may occur through dermal, oral, or inhalation pathways. Passive sampling devices are used to sequester organic molecules through passive diffusion and provide time-weighted averages of chemical concentrations. This pilot study uses silicone-based wristbands as a personal passive sampler to detect known carcinogens during a 24 hour work shift. Twenty-four wristbands were deployed across various fire services throughout South Florida. Prior to deployment, bands were cleaned using a standardized cleaning protocol to remove contamination and optimize the surface for absorption. Wristbands were then packaged in airtight bags to prevent contamination. Wristbands were worn on fire service personnel and collected at the end of a 24 hour work shift. Chemical contaminants were then extracted from the wristband and analyzed for PAHs—identified using the EPA IRIS, California Proposition 65, and IRAC datasets—using gas chromatography-mass spectrometry. The average number of chemicals found across all wristbands (n=24) was 23 with 4 categorized as carcinogenic to humans (i.e., Benzo [b]fluoranthene, Benzo[j]fluoranthene, Chrysene, and Naphthalene). All bands had at least one PAH present, specifically, 87.5% contained Benzo[b]fluoranthene (mean=5.23 ng/band), 50% contained Benzo[j]fluoranthene (mean=2.05 ng/band), 79.2% contained Chrysene (mean=9.55 ng/band), and 100% contained Naphthalene (mean=176.53 ng/band). Actual types of exposure compounds is likely to be larger than the observed data as the group of PAHs detected was limited to three existing datasets. Silicone-based wristbands are feasible to use within the fire service to detect and characterize ambient hazardous chemical compounds. These personal self-samplers used during a 24 hour collection period identified various PAHs in the firefighter work environment. Objective measures of harmful chemical exposures in the fire service should be monitored with a comprehensive surveillance system that includes personal sampler devices.

01D.3 FUMIGANT AND CHEMICAL RESIDUE 8-HOUR EXPOSURES IN WORKERS HANDLING CARGO FROM SHIPPING CONTAINERS AND EXPORT LOGS IN NEW ZEALAND

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Background Previous studies found elevated concentrations of fumigants and other chemicals in the air of unopened shipping containers, which led to the assumption that workers were likely to be highly exposed. This study assessed personal 8 hour exposures in workers handling cargo from shipping containers or export logs, which were fumigated prior to loading.

Methods 193 personal 8 hour air samples were collected and analysed for 1,2-dibromoethane, chloropicrin, ethylene oxide, hydrogen cyanide, hydrogen phosphide and methyl bromide, 1,2-dichloroethane, C2-alkylbenzenes, acetaldehyde, ammonia, benzene, formaldehyde, methanol, styrene and toluene. Additive Mixture Values were calculated using the Work Exposure (WES) standard set by Worksafe NZ and the Threshold Limit Values (TLV) set by the ACGIH. Linear regression was conducted to assess associations between time spent inside shipping containers and exposure (n=98).

Results Chemical exposures as indicated by median and geometric mean values were low (e.g. 2.5 and 4.4 ppb respectively for methyl bromide) and none exceeded the NZ WES, although formaldehyde exceeded the TLV in 48 (26.2%) samples. The AMV-TLV threshold of 1 was exceeded in 54 (29.5%) samples. Major differences between the occupational groups (container, log and retail workers and fumigators) were not found. Time spent inside the container was significantly and positively associated with ethylene oxide, C2-alkylbenzenes and acetaldehyde, but this was based on a small number of detectable observations (non-detects 52.0%–95.9%) and for one chemical (methyl bromide, n=94) we found inverse associations.

Conclusion This study has shown that personal exposures measured over an 8 hour working day were low, with the exception of formaldehyde, and do not confirm earlier suggestions (based on measurements inside closed containers) that they regularly exceed exposure limits. Association with time spent unloading containers was weak suggesting that exposures may result from short peak exposures rather than continuous low level exposure.

01D.4 OCCUPATIONAL EXPOSURE TO FORMALDEHYDE IN FRANCE IN 2015

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Context Formaldehyde has been used in a large range of activities for decades. It was classified as human carcinogenic in 2004 by the International Agency for Research on Cancer and in France, formaldehyde has been regulated as a carcinogen since 2007.

The aim of this work is to describe the occupational exposure to formaldehyde in France in 2015 and to identify the most exposed activities.

Method A formaldehyde job-exposure matrix, developed under the MATGENÉ programme, provides an exhaustive and retrospective exposure assessment for all jobs in France. These data were linked with the 2015 French census, annually elaborated from 2013 to 2017, to estimate the occupational exposure prevalence by gender, occupation, industries and worker status.

Results In 2015, 90 000 workers were occupationally exposed to formaldehyde (3.5% of the French population at work), 60 600 (4.6%) among men and 29 400 (2.4%) among women.

The industries with the highest prevalence exposure rate were for men veterinary area (8.8%), wood industries (7.7%) and agriculture (4.8%); for women, veterinary area (7.3%), fishing and aquaculture (5.3%) and agriculture (5.1%).

The exposed workers are retrieved in agriculture (26%), healthcare sectors (13.5%) and specialized construction work (12%) for employees and agriculture (69.6%), specialized construction work (13.5%) and other personal services (8.1%) for people with worker status different (mostly self-employed).

Conclusion These results, the first describing the occupational exposure to formaldehyde in France, according to gender for the entire working population, show the importance of regulation in the variation of occupational exposure prevalence rates. This information will help in the surveillance of this occupational risk and to prioritize prevention actions.

01D.5 NON-DETECTS IN OSHA'S IMIS DATABANK: ARE THEY SHORT-TERM OR SHIFT-LONG SAMPLES?

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Objectives The Integrated Management Information System (IMIS) is the largest multi-industry source of exposure measurements available in North America. However, the lack of information on the censoring value (that depends on duration of sampling) of non-detected (ND) measurements considerably limits the usefulness of this databank. Released in 2010, the Chemical Exposure Health Database (CEHD) contains analytical results and measurement details, including duration of sampling for some of the records in IMIS. We assessed which ND results stored in IMIS are short-term (ST), and which are shift-long (LT) samples, based on information available in CEHD.

Methods We analyzed exposure measurements for 54 agents from 1984–2009 (n=238,826). First, we calculated kappa coefficients (κ) for each agent to investigate the agreement between the exposure type of IMIS detected records (already indicated as ST or LT, i.e. selected by OSHA officers) and the exposure type suggested by sampling duration found in CEHD. If κ exceeded 0.3 for an agent, we employed classification and regression trees (CART) models to predict whether the ND results from IMIS should be classified as ST or LT samples. CART was developed using CEHD and applied to IMIS, relying on predictors common to both databanks: industry, reason for inspection, scope of inspection, region, union status, and year of sampling.

Results The median proportion of ND results per agent was 37% (interquartile range (IQR)=22%–62%). The median κ was 0.45 (IQR=0.37–0.64) and 0.03 (IQR=0.01–0.16) for solvents/gases and metals/isocyanates, respectively. Solvents (n=22) and gases (n=7) were selected for CART modeling. Industry was the most important predictor variable in classifying ND results into either ST or LT.

Conclusions This novel approach can be used to assign a censoring value to ND results, thus allowing more accurate inference about distribution of exposure levels in IMIS.

Work Organisation

01E.2 INFLUENCE OF WORK ORGANIZATION AND ENVIRONMENT ON HEALTH AND PRODUCTIVITY OUTCOMES AMONG CONSTRUCTION APPRENTICES: A TOTAL WORKER HEALTH® APPROACH

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Introduction Construction is a hazardous industry, with well-recognized risks of traumatic injury and high physical demands. Other threats to construction workers' health and well-being occur from work organization and work environment factors, including precarious employment, long