Exposure Assessment: Dusts, fibers and metals

O-23 ASBESTOS EXPOSURE IN WASTEWATER COLLECTION AND TREATMENT WORKERS: A LITERATURE REVIEW AND ANALYSIS OF FRENCH EXPOSURE DATABASES

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Introduction Releases from asbestos abatement activities, asbestos-cement pipes and natural sources may contaminate wastewater with asbestos fibres. However, asbestos exposures in wastewater collection and treatment (WCT) workers are insufficiently characterized.
Objective To identify workers at risk of asbestos exposure in the WCT sector in France.
Methods We conducted a search of the international literature to identify sources of asbestos exposure and risks of asbestos-related diseases in WCT workers. We also extracted measurements from occupations related to WCT activities contained in two large French administrative databases of workplace measurements (Colchic and Scola) collected since 1987.
Results Studies conducted in the United States in the 1990s showed detectable concentrations of asbestos fibres in sewage sludge from several cities, with residual concentrations varying between disposal methods (e.g., incineration, composting). We identified six cohort studies of sewer workers and/or treatment plant operators. Five studies reported non-significant increases of respiratory cancer incidence or mortality, and one study of French sewer workers showed increased mortality from mesothelioma. Analyses of the two databases provided 2886 measurements from 13 occupations and collected from 2003 to 2020, with 58% below the limit of detection. Ninety-fifth percentiles of asbestos concentrations by occupation were 22 f/L for sewer workers (n=135), 148 f/L for sanitary systems control technicians (n=36), and ranged between 185 to 520 f/L for pipe laying, installing, or removal occupations. Sewer cleaners (n=12) and sewer workers supervisors (n=24) had no detectable concentrations of asbestos fibres.
Conclusion The available literature and the reported presence of fibres in sewage sludge suggest that WCT workers are potentially exposed to asbestos at various endpoints of the wastewater collection and treatment process. While asbestos exposure levels for most workers are likely to be low, a detailed risk assessment was not possible because of a lack of quantitative measurement data.

O-27 SILICA EXPOSURE ESTIMATES IN ARTIFICIAL STONE BENCHTOP FABRICATION AND ADVERSE RESPIRATORY OUTCOMES

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Introduction Silicosis is being increasingly reported among young stonemasons in the artificial stone (AS) benchtop fabrication and installation industry.
Objectives To identify metrics of exposure that predict risk of work-related respiratory ill-health among these stonemasons.
Methods Respiratory health screening which included a job and exposure history, a chest x-ray (CXR), a respiratory health questionnaire and gas transfer testing, were offered to stonemasons in Victoria Australia.
Results Workers typically reported a variety of tasks, including cleaning and labouring, which made exposure assessment complex. We estimated the relative respirable crystalline silica exposure intensity of each job from the proportion of time using AS and doing dry work (work without water suppression). The average intensity of exposure for up to five jobs was calculated. Cumulative exposure was calculated as the sum of the work duration multiplied by intensity for each job. Stone bench installers and factory machinists (other than CNC operators) were the most likely to report dry work with AS, and so had a greater average intensity of exposure. Exposure intensity and cumulative exposure were associated with increased odds of an ILO CXR category of $\geq$1 and with dyspnoea. Exposure duration was also associated with increasing ILO CXR profusion category. In multivariate analyses of health outcomes, only job type was associated with the ILO category. For both most recent and longest duration job type, factory machinists were more likely to have a CXR ILO category $\geq$1 than the lowest-exposed job group.

Conclusions This suggests that intensity of exposure estimated from the proportion of time dry cutting and proportion of time working on AS can predict risk of adverse respiratory outcomes for workers in this industry.

O-64 ASSOCIATIONS OF CUMULATIVE, ALVEOLAR AND PLASMA INDIUM WITH RESPIRATORY HEALTH OUTCOMES AT AN INDIUM-TIN OXIDE MANUFACTURING FACILITY

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Introduction Previous epidemiologic studies have reported associations between respiratory symptoms, lung function, and biomarkers of lung disease and indices of cumulative exposure and plasma indium in indium-exposed workers. Indices of exposure at a location more proximal to the dose at target tissue might provide more precise and accurate estimates of dose-response relationships. The objective of this study was to compare exposure-response relationships for respiratory health outcomes with indices of cumulative exposure, alveolar indium, and plasma indium.
Methods In a study of 110 indium-tin oxide manufacturing workers, indium exposures, plasma indium, respiratory symptoms, lung function, and serum biomarkers of lung disease were measured during two surveys. Cumulative exposure was calculated by multiplying current exposures with time spent in jobs and summed across all jobs. The International Commission on Radiological Protection's Human

Respiratory Tract Model was used to calculate the mass of indium remaining in the alveolar compartment after accounting for initial deposition, particle characteristics, and mechanical and dissolution clearances. Relationships between exposure indices and health outcomes were evaluated using generalized linear mixed models with subject as a random factor and adjusted for smoking status and age. Models were compared using a ratio of the regression coefficient to its standard error, a measure of precision, and the Akaike Information Criterion (AIC), a relative measure of model fit.

Results The alveolar dose metric correlated well with cumulative exposure (rsp = 0.876) and plasma indium (rsp = 0.726). All three exposure indices were associated with respiratory symptoms, lung function, and serum biomarkers, but alveolar dose identified additional significant or borderline significant associations not present for cumulative or plasma indium. Alveolar dose often had the highest precision for the effect estimate and lowest AIC.

Conclusion The alveolar dose metric performed better than cumulative exposure and plasma indium despite the high correlation, demonstrating that dose-based metrics can improve exposure-response modeling.

O-317 CURRENT RESPIRABLE CONCENTRATIONS OF QUARTZ ACROSS OCCUPATIONS IN DENMARK

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Introduction High airborne concentrations of respirable quartz have been reported from workers in construction, foundries, and quarries. Current exposure levels in prevalent but presumably lower exposed jobs have been less examined.

Objectives To quantify the current exposure concentrations of respirable dust and quartz across prevalent occupations with expected moderate to high levels of exposure in Denmark. A second aim was to identify determinants of respirable quartz exposure across occupations.

Methods 189 full-shift personal samples of respirable dust within 11 occupations were sampled and analysed for quartz content with infrared spectrometry. Determinants for respirable quartz like use of tool and location of worksite were analysed in mixed linear effect models.

Results The overall geometric means (geometric standard deviation) for respirable dust and quartz were 220 µg/m3 (4.19) and 16 µg/m3 (4.07), respectively. The highest quartz concentrations were observed among stone cutters and carvers (93 µg/m3 (3.47)), and metal melters and casters (61 µg/m3 (1.71)). Use of power tools increased exposure concentrations by a factor of 3.5. Of the total variance, variability between jobs explained 27%, variability between companies within jobs explained 29%, and variability between workers within a job within a company explained 14%. 30% of the total variance was explained by day-to-day variability.

Conclusion A number of jobs in this study had average exposure levels to respirable quartz above 50 µg/m3. Use of power tools were the main determinant. Preventive measures to lower excess risk of lung cancer among these workers are still needed.

O-462 ASSESSMENT OF OVEREXPOSURE TO MULTIPLE METALS IN ELECTRONIC RECYCLING FACILITIES: USING AIR SAMPLES AND BIOMARKERS TO HIGHLIGHT POTENTIAL TOXICITY

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Objective To estimate potential toxicity risks associated with exposure to several metals in electronic waste recycling (e-recycling) facilities in Quebec.

Methods In a cross-sectional study, personal air samples were collected on cellulose ester filters from six e-recycling facilities, during an 8-hour work day for 85 workers (66 men, 19 women). Twelve metals were analyzed by inductively coupled plasma mass spectrometry (ICP-MS). End-of-shift blood and urine spot samples were taken; blood cadmium and urinary arsenic were also analyzed by ICP-MS, and blood lead and urinary mercury by atomic absorption spectrometry. Additive hazard indices (HIs) were calculated for organ-specific toxic effects, by adding the ratios of measured concentrations of metals in air or biological fluids, on the threshold limit value (TLV®) or on the biological exposure indices (BEI®).

Results All facilities provided workers with some personal protective equipment, with inconsistent wearing of respiratory equipment. They all conducted manual dismantling, and three performed shredding of electronic/plastic residues. Cadmium, copper and lead were found in the highest concentrations in the air, albeit all below the TLVs. Air concentrations of lead showed a strong association with biological levels, indicating an occupational exposure origin. HIs calculated with the biological measures revealed an exceedance of the mixture's threshold limit for lung toxicity (arsenic, cadmium, cobalt, nickel and chrome) in 95% of the workers, as well as an exceedance for skin irritation (arsenic, mercury, cobalt, nickel) in 19% of them. HIs exceeded the unity as well in some workers for gastrointestinal, peripheral nervous system, and reproductive function toxicity.

Conclusions

Multi-exposures complicate risk assessment Although individual metals all respected the TLVs, the calculation of hazard indices from both air samples and biomarkers highlighted potentially increased risks of toxicity for several organs or systems in e-recycling workers.

Heat and Climate Change

O-127 HEAT-RELATED ACUTE KIDNEY INJURY IN INDOOR AND OUTDOOR WORKERS IN THE U.S.

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Introduction Heat-related acute kidney injury (HR-AKI) may increase workers' risk of chronic kidney disease. Occupational HR-AKI has been reported in agriculture and a few other sectors, but there has been no comprehensive study of HR-AKI across indoor and outdoor industries.