RESPIRATORY DISEASE

EVALUATION OF SUBSTITUTE MATERIALS USED IN CONSTRUCTION

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PURPOSE: Evaluate the cytotoxicity of abrasive substitutes for silica, determine the importance of fiber length in the cytotoxicity of fibers, and elucidate mechanisms for initiation and progression of fibrosis.

RESEARCH SUMMARY: Silica and asbestos are known to cause lung damage and fibrosis. Therefore, there is a great deal of interest in limiting the use of silica as an abrasive material in sandblasting and to create fibers that would replace asbestos as a construction material. However, toxicological information on silica and asbestos substitutes is incomplete or absent, and data are lacking concerning the possible adverse effects of inhalation of abrasive substitutes for silica. Researchers on this project will develop a database on in vitro and in vivo pulmonary toxicity of several abrasive substitutes and characterize the role of physical and chemical properties of fibers in the development of lung disease.

- The toxicity of silica substitutes will be evaluated using assays of lung cell function and viability after both in vitro and in vivo exposure to these materials. To date, the in vivo effects of silica and 10 abrasive substitutes (garnet, iron oxide, starolite, coal slag, treated sand, olivine, copper slag, nickel slag, crushed glass. and steel grit) have been investigated.
- A dielectrophoresis apparatus has been developed that separates fibers according to length. Such a system allows the evaluation of the role of physical dimensions versus chemistry in the development of pulmonary disease and should assist in predicting the potential fibrogenicity of created asbestos substitutes. To date, a strong relationship between fiber length and in vitro toxicity has been shown with fiberglass. Additional experiments evaluated the role of fiber length on the production of inflammatory and fibrogenic cytokines and on transcription events.
- Mechanistic studies (oxidant generation, activation of transcription factors, induction of mRNA for cytokine production) will be used to explain the initiation and progression of pulmonary inflammation, damage, and fibrosis. Such information could be used to evaluate the potential occupational health hazard posed by substitute materials and result in the development of early diagnostic tests for pulmonary disease.

KEYWORDS: Asbestos, silicosis, silica substitutes, sandblasting

RECENT CITATIONS:

Blake, T., V. Castranova, D. Schwegler-Berry, P. Baron, G.J. Deye, C. Li, and W. Jones. 1998. Effect of fiber length on glass microfiber cytotoxicity. *Journal of Toxicology and Environmental Health,* v. 54, Part A, pp. 243-259.

Hubbs, A.F., N.S. Minhas, W. Jones, M. Greskevitch, L.A. Battelli, D.W. Porter, W.T. Goldsmith, D. Frazer, D.P. Landsittel, J.Y.C. Ma, M. Barger, K. Hill, D. Schwegler-Berry, V.A. Robinson, and V. Castranova. 2001. Comparative pulmonary toxicity of 6 abrasive blasting agents. *Toxicological Science*, v. 61, pp. 135-143.

Porter, D.W., D. Ramsey, A.F. Hubbs L. Battelli, J. Ma, M.A. Barger, D. Landsettel, V.A. Robinson, J. Mc-Laurin, A. Khan, W. Jones, A. Teass, and V. Castranova. 2001. Time course of pulmonary response of rats to inhalation of crystalline silica: Histological results and biochemical indices of damage, lipidosis and fibrosis. *Journal of Environmental Pathology, Toxicology and Oncology*, v. 20, Supplement 2, pp. 1-14.

MOLECULAR MECHANISMS OF DISEASE DEVELOPMENT WITH MIXED DUSTS

KEYWORDS: Cancer, crystalline silica, pulmonary disease

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PURPOSE: Investigate the effects of different metal ions deposited on crystalline silica during sandblasting of metal plates and the independent and synergistic interaction of trace metals associated with exposures to mixed dusts.

RESEARCH SUMMARY: It is estimated that there are approximately 536,000 cancer deaths in the United States each year and that 23% of these deaths are related to workplace exposures either to a single toxic agent or in synergy with mixtures of agents. Workers are commonly exposed to dust mixtures containing minerals or crystalline silica containing trace amounts of metals during the use of cutting tools, drills, pulverizers, etc. While acute and chronic inhalation of mixed dusts has been shown to affect the pulmonary system adversely and even lead to death, epidemiological studies have also shown that cancer occurrences vary considerably within populations exposed to different sources of crystalline silica.

The relationship between exposures to crystalline silica and lung cancer has been debated since laboratory tests showed that inhaled silica can cause lung cancer in rats at relatively low doses (1 mg/m^3). In 1997, the International Agency for Research in Cancer (IARC) published a report concluding that evidence was sufficient to state that crystalline silica is a carcinogen. However, the report also noted that carcinogeneity was not observed in all industries in which workers were exposed to silica, and that some inherent, unknown characteristics of crystalline silica were involved in its biological effects, thus confounding clear understanding as to the mechanisms involved.

Laboratory studies will investigate the early biological and molecular events involved in pulmonary molecular reactions that may lead to carcinogenesis after exposure to pure crystalline silica containing trace amounts of pure metals. Studies on biomarkers may provide some positive identification of groups at high risk when exposed to mixed dusts.

METHOD DEVELOPMENT FOR FUNGI IN OCCUPATIONAL DISEASES

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PURPOSE: Develop a fast, inexpensive, specific, fungal sampling and analytical method to detect fungi in soil and bird and bat droppings.

RESEARCH SUMMARY: Workers in various construction trades have become seriously ill and some have died from occupationally acquired histoplasmosis. Outbreaks of this and other fungal diseases among construction workers continue to be reported following the demolition of contaminated buildings. Inhalation of spore-containing dust often contaminated with bird or bat droppings is the primary cause of these diseases.

NIOSH has received numerous inquiries and has actively engaged in the preparation of Health Hazard Evaluations pertaining to worker concerns about *Histoplasma capsulatum*, *Cryptococcus neoformans, Blastomyces dermatitidis*, and *Coccidioides immitis* associated with bat and bird droppings or contaminated soil in various occupational settings.

The efficacy of various technologies and methods for preventing these infections has not been adequately evaluated because no reliable, direct, soil isolation method exists for detecting these fungal agents. Small quantities of *H. capsulatum* are difficult to detect in soil samples. Fast, inexpensive analytical methods for specific fungi would permit their detection in soil and bird and bat droppings. The efficacy of various disinfectants could then be evaluated, as well as environmental control measures such as dust suppression. A method with sufficient sensitivity to detect small numbers of fungi is being developed using state-of-the-art molecular bioanalytical techniques to identify pathogenic fungi from construction and agricultural workplaces. A DNA analytical method, the polymerase chain reaction (PCR), has been developed specifically to detect *H. capsulatum*.

PATENT: Application number U.S.S.N. 60/082,477

KEYWORDS: *H. capsulatum*, PCR, pathogenic fungus

RECENT CITATIONS:

Reid, T.M., and M.P. Schafer. 1999. Direct detection of *Histoplasma capsulatum* in soil suspensions by two-stage PCR. *Molecular and Cellular Probes*, v. 13, pp. 269-273.

INITIAL RESPIRATORY RESPONSES IN WELDING APPRENTICES

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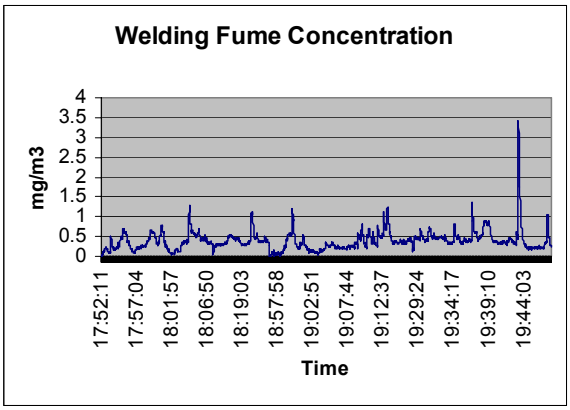

PURPOSE: Investigate the nature of the association between exposures to welding fumes and acute respiratory responses through a study of welding apprentices.

RESEARCH SUMMARY: Despite some inconsistencies in study results, evidence of an association between exposure to welding fumes and occupational asthma has been growing over the past 15 years. Most earlier epidemiological studies concerning exposures to welding fumes and their respiratory effects have been limited by the cross-sectional study design, the selection of study populations with extensive welding experience, and limited information on the timing and nature of exposures to welding fumes.

We propose a study of 200 welding apprentices in which airway reactivity and acute respiratory responses will be measured early in the apprentices' careers, that is, within 6 months of their first exposure to welding fumes. Since welders who experience respiratory problems related to welding are less likely to stay in the welding field over the long term, a study of welding apprentices who are just entering the field has the advantage of including workers who experience respiratory problems early on.

The study design focuses on short-term changes in pulmonary function parameters with simultaneous real-time assessment of exposures to particulates and nitrous oxide (NOx). Average levels of exposure to these variables and to fluoride will be provided during the training session. Recent evidence suggests that there is an acute respiratory response 15 minutes after the first daily exposure to welding fumes, so pulmonary function and respiratory symptoms will be measured before the start of a welding training session, 15 minutes after the first weld, and at hourly intervals throughout the welding session.

The real-time personal exposure measurements will be used to identify peak levels. These exposure variables will be examined in relation to respiratory responses, and airway reactivity will be measured by response to cold-air challenge testing before and after apprentices have learned to weld. In addition, determinants of welding fume exposures will be identified by considering factors such as ventilation, type of welding work, and worker habits.

This study will provide insights into the nature of the association between welding fume exposures and acute respiratory responses. Recommendations will be made for the most effective respiratory and exposure variables to use in epidemiological assessments. Assessment of determinants of exposure will also be useful for consideration of exposure control options.

KEYWORDS: Welding, asthma

ROLE OF O_3 IN MODULATING Cr TOXICITY IN THE LUNGS

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PURPOSE: Investigate mechanisms underlying the elevated lung cancer incidence in welders exposed to fumes containing both chromium and O_3 (ozone).

RESEARCH SUMMARY: Most studies of occupationally relevant chemical hazards have focused on single contaminants, and so the biological and safety implications of inhaling mixtures have been ignored in evaluations of the effects of contaminants on worker health and safety. A major health hazard from inhalation exposure to chromium- (Cr) containing materials is lung cancer. However, the contribution from other co-inhalants in modulating Cr-initiated responses is not clear. Co-contaminants may change the pulmonary environment, producing conditions that could enhance the formation and survival of Cr-initiated tumors. During welding, Cr is released with ozone (O_3). It has been demonstrated that inhaling O_3 simultaneously with Cr increases the retention of insoluble Cr particles in the lungs. This situation could ultimately give rise to conditions within the lungs conducive to the formation and survival of Cr-initiated neoplasia.

This research will address the hypothesis that the carcinogenic potential of insoluble Cr in the lungs of welders and other workers inhaling a Cr/O_3 mixture is greater than carcinogenic potential in hosts inhaling Cr alone. The cause is thought to stem from O_3-mediated increases in the lung tissue burdens of Cr and/or augmentation of one or more documented genetic/epigenetic mechanisms (increased level of DNA damage, chromosomal aberrations, and/or increases in the activity of cell kinases) associated with Cr-induced conversion of normal to abnormal cells. More specifically, the effects of O_3 on mechanisms utilized for the intracellular processing of insoluble calcium chromate [Cr(VI)] particles will be studied.

This project involves exposing rats to atmospheres containing carcinogenic Cr(VI) alone and in combination with O_3. The results of this study should improve our understanding of the mechanisms underlying the interaction between Cr and O_3 in the lungs and the role that mixtures of air contaminants may play in pulmonary disease pathogenesis following exposure.

KEYWORDS: Airborne contaminants, cancer, mixed exposures

RECENT CITATIONS:

Cohen, M.D., M. Sisco, K. Baker, D. Bowser, L.C. Chen, and R.B. Schlesinger. (In press.) Impact of co-exposure to ozone on the carcinogenic potential of inhaled chromium. I: Effects on retention and on extra- and intracellular distribution. *Journal of Toxicology and Environmental Health.*

PREVENTION OF INHALATION HAZARDS IN CONSTRUCTION

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CONSORTIUM: **Center to Protect Workers' Rights**

PURPOSE: Reduce respiratory exposures in concrete work and other stages of construction through the development and evaluation of appropriate organizational and technological interventions.

RESEARCH SUMMARY: Highway construction workers and operators of heavy construction equipment are exposed to a variety of inhalation hazards, including dust, diesel exhaust, quartz, welding fumes, and lead. Personal samples for exposure to dust, diesel exhaust, quartz, and welding fumes were collected from these workers. The respirable, thoracic, and inhalable fractions of dust and quartz exposures were estimated from 260 personal samples. Respirable quartz exposures exceeded the NIOSH Recommended Exposure Limit (REL) in 7% to 31% of the cases in the trades sampled. Over 50% of the samples from workers finishing concrete and installing drop ceilings and wall tiles exceeded the NIOSH REL for quartz. Thoracic exposures to quartz and dust exceeded respirable exposures by factors of 4.5 and 2.8, respectively. Inhalable exposures to quartz and dust exceeded respirable exposures by factors of 25.6 and 9.3, respectively. These findings are important because quartz was identified as a carcinogen by the National Toxicology Program and the International Agency for Research on Cancer.

Fourteen percent of the 261 personal samples for elemental carbon collected as a marker for diesel exhaust exceeded the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) for diesel exhaust. Seventeen of the twenty-two (77%) samples taken during a partially enclosed welding operation reached or exceeded the ACGIH TLV of 5 mg/m^3 for welding fumes.

Given the potential for high exposures to inhalation hazards in construction, efforts to develop and implement exposure controls are needed. Exposure monitoring using videos and quantification of crystalline silica in the respirable, thoracic, and inhalable particle-size fractions will be used to evaluate the efficacy of several engineering control interventions, including the use of local exhaust ventilation and wetting, during the use of power tools on concrete. Worker and management barriers to organizational interventions and engineering controls to reduce exposures will be evaluated.

The New England Laborers Training Center is collaborating on this project.

KEYWORDS: Silica, quartz, highway construction, respiratory hazards, silicosis, interventions

RECENT CITATIONS:

Bello, D., M.A. Virji, A. Kalil, and S.R. Woskie. (In press.) Quantification of respirable, thoracic and inhalable quartz by FT-IR in impactor samples from construction sites. *American Industrial Hygiene Association Journal*.

Kalil, A. 2002. Use of a work sampling method (TVEA) to characterize particulate exposure determinants in heavy and highway construction. Doctoral dissertation, University of Massachusetts-Lowell.

Virji, M.A., D. Bello, S.R. Woskie, M.X. Liu, and A. Kalil. 2002. Analysis of quartz by FT-IR in air samples of construction dust. *Applied Occupational and Environmental Hygiene*, v. 17, no. 3, pp. 165-175.

Woskie, S.R., A.J. Kalil, D. Bello, and M.A. Virji. (In press.) Exposures to quartz, diesel, dust and welding fumes in heavy and highway construction. *American Industrial Hygiene Association Journal*.

REVISED NIOSH GUIDE FOR RESPIRATORY PROTECTION

KEYWORDS: Recommendations, respirators

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PURPOSE: Revise the NIOSH Guide to Industrial Respiratory Protection to incorporate important advances in respirator technology, updated OSHA standards, current respirator research, NIOSH recommendations, and information on emerging nuclear, biologic, and chemical threats where the use of respirators may be required.

RESEARCH SUMMARY: In partnership with other federal agencies, NIOSH has a long history of direct involvement in preventing respiratory injury and illness by certifying respirators and disseminating information to workers and health and safety professionals about proper respirator use. Respirators are critical personal protective equipment for workers in many industries—construction, agriculture, mining, firefighting, and health care. For example, it has been estimated that 20% of U.S. farmers suffer from some form of respiratory aliment. Among construction workers, silicosis is a major concern; among miners, black lung and related respiratory illnesses have not been eliminated. Recently, the rise in drug-resistant tuberculosis has resulted in the need for respirator training and use among many health care workers. Finally, there is new nationwide emphasis on respirator training for police, firefighters, and emergency medical teams in response to the threat of terrorism.

In this project, the NIOSH Guide to Industrial Respiratory Protection, first published in 1987, will be updated. Following a format similar to that in the 1987 publication, the revised edition will incorporate new NIOSH recommendations and policies, describe current advances in respiratory protection, update the OSHA Respiratory Protection Standard, examine trends in respirator research, and address timely issues related to nuclear, biologic, and chemical threats where the use of respiratory protection may be necessary.

A team of respirator experts was convened to outline the document, establish a production timeline, and write the document. When complete, the document will be widely disseminated, both in print and on the NIOSH website, and will be a valuable reference for health and safety professionals working to prevent respiratory illnesses in construction, agriculture, mining, firefighting, health care, and other work sectors requiring protection from respirable hazards.

RESPIRATORY PROTECTION FOR CONSTRUCTION WORKERS

KEYWORD: Respirators

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PURPOSE: Develop a series of informational and educational products on respiratory protection for construction workers.

RESEARCH SUMMARY: More than 20 million workers are potentially exposed to occupational-disease-causing agents. Currently, 6-12 million workers wear respirators on a routine basis as the final method of protection and in a wide range of emergency situations. Workers engaged in the construction trades (e.g., laborers, painters, sand blasters, demolition) are exposed to a wide variety of airborne contaminants such as silica, asbestos, lead, and solvent fumes. However, respiratory protection is only as good as the training the user receives and how well the respirator program is designed, administered, and used. Many of these construction workers receive little or no training on the proper selection and use of respiratory protection.

Respirators serve as the major source of protection for many of these individuals, yet effective respirator use requires considerable training in selecting, fitting, maintaining, and operating them. A series of documents have been produced to provide small business owners, safety professionals, and workers in the construction trades with guidance in setting up an adequate respiratory protection program. Checklists, sample forms, and the information needed for proper selection, use, and maintenance of respirators are a part of the package. In consultation with the Center to Protect Workers' Rights, specific trades at risk from respiratory hazards were identified. Drywallers were chosen as the first construction group for which an instruction package would be prepared on the maintenance and fitting of respirators and the training needed for an effective respirator protection program.