1.312

Calcite as a Preventive Agent for Coal Workers' Pneumoconiosis

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Abstract

Background: Coal remains a major energy resource worldwide. While energy costs from a new coal power plant are low, both health and environmental costs, including occupational lung disease compensation, can render coal a more expensive energy option. Underground coal miners are at risk of developing coal workers' pneumoconiosis (CWP). We have previously shown that bioavailable iron (BAI) in the coal is one of the factors responsible for coal dust toxicity, and that differences in levels of BAI probably contribute to the regional differences in the prevalence of CWP. BAI originated from oxidation of pyrite (FeS_2), a typical component of coal dusts. The stability of BAI is pH-dependent. Coals containing high levels of calcite ($CaCO_3$) have high pH but low BAI. Calcite is present in most of the Western coals, such as Utah and Colorado and workers in these mines also experience low CWP.

Objectives: In the present study, we tested a hypothesis that, when dust reduction has been maximized at the work setting by the current dust control technologies, using calcite to decrease the BAI and toxicity of coal dust effectively prevents CWP.

Methods: We determined the minimal effective doses of calcite needed to eliminate BAI in the Eastern coal dusts that also inhibited BAI-induced inflammation and fibrosis in mice.

Results: Adding calcite into water takes 5-20 min to neutralize BAI in the coal compared to calcite in buffered solution that mimics the phagolysosomes of the cells, which takes up to 4 weeks. Calcite also reduces epithelial mesenchymal transition markers such as alpha-smooth muscle actin and fibroblast specific protein-1 in mice. Although minimal doses of calcite depend upon the levels of BAI in the coals, 10% calcite (w/w) in the respirable fraction appears sufficient to reduce all BAI.

Conclusions: Based on these data, we expect that introduction of calcite to high BAI-containing coals, such as those in the Eastern coalmine region will have a long lasting protective effect on underground coalminers susceptible to CWP. Calcite is the main constituent of rock dust and widely used in underground mines for prevention of explosions and in the treatment of acid mine drainage. Hence, introduction of calcite to coal during mining causes no environmental concerns to the coal industry. Most importantly, calcite treatment could provide a cost-effective solution to prevent CWP and significantly enhance the health of underground coal workers. As a result, this could reduce coal-produced energy costs and benefit the coal industry financially. Supported by NIOSH R01 OH009771

1.313

Complex Profile of Mechanical Responses of Guinea-Pig Isolated Airways to the Popcorn Butter Flavorings, Diacetyl and 2,3-Pentanedione

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Abstract

Objectives: Inhalation of microwave popcorn butter flavorings in the workplace induces a bronchiolitis obliterans-like obstructive disease in workers, termed "popcorn workers' lung." In animal models inhalation of popcorn butter flavoring, its constituent flavoring, diacetyl (D), or diacetyl substitute, 2,3-pentanedione (2,3-P), evoke marked damage to the epithelium of upper airways and large lower airways. While the toxicity of these flavorings on airway epithelium is now acknowledged, nothing is known about the effects of D and 2,3-P on airway smooth muscle. Therefore, we investigated the pharmacological activity of D and 2,3-P on isolated airways.

Methods: The isolated, perfused trachea preparation was used; this method allows separate addition of agents to the mucosal surface [intraluminal (IL) bath] or serosal surface [extraluminal (EL) bath] of the airway. Tracheas removed from anesthetized guinea pigs were mounted on holders to allow perfusion of the lumen with modified Krebs-Henseleit solution while measuring mechanical responses, i.e., change in diameter, from inlet minus outlet pressure difference (ΔP; cm H_2O). RESULTS. In unstimulated tracheas, or in tracheas first contracted with EL methacholine (3×10^{-7} M; EL EC_{50}), D applied to the IL bath elicited contraction (1 - 3 mM); higher concentrations (10 - 30 mM) elicited contraction followed by relaxation. The relaxation component of the response could have been mediated by the release of epithelium-derived relaxing factor (EpDRF), which is triggered by elevations in IL osmolarity greater than 3 mosM. This possibility was investigated by adding D intraluminally to tracheas from which the epithelium had been removed, and by adding D to the EL bath. In both instances responses to D were obtained that did not differ from epithelium-containing tracheas following the addition of D to the IL bath. Responses to IL and EL 2,3-P mimicked those to D over the same concentration range, and were not affected by epithelium removal.

Conclusions: The concentrations of D that elicit contractile responses of the trachea have been calculated through modeling to exist in the airway wall of exposed rats, and are associated with epithelial damage. D and 2,3-P are nearly identical in their activities as bronchoconstricting and bronchodilating agents in this in vitro model. The relaxant responses to the two flavorings in higher concentrations are not attributable to the elevation in osmolarity and the release of EpDRF. The results suggest that the direct effects of the two flavorings on airway smooth muscle of workers may be comparable.

NORA

Symposium 2011

Achieving Impact through Research and Partnerships

July 12-13, 2011
Hyatt Regency Cincinnati
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Table of Contents

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Public Health Service

Centers for Disease Control
and Prevention (CDC)
National Institute for Occupational
Safety and Health (NIOSH)
395 E Street, SW
Washington, DC 20201

July 12, 2011

NORA Symposium Attendees

It is my pleasure to welcome you to the 2011 National Occupational Research Agenda (NORA) Symposium: Achieving Impact through Research and Partnerships. This is the seventh NORA Symposium. Like its predecessors, the 7th NORA Symposium will showcase excellence in occupational safety and health research, and the application of that research to prevent work-related injury and illness. This year we are focusing on research and partnerships. The sector-based structure of the second decade of NORA has fostered the creation of many exciting partnership opportunities among many diverse organizations.

New partnerships with practitioners have significantly enhanced the NIOSH Research-to-Practice (r2p) initiative, which helps us assure that the products of our research ultimately benefit the health and well-being of workers. These benefits extend as well to workers' families, their communities, businesses, and society as a whole.

In addition to recognizing 15 years of NORA, 2011 also marks the 40th anniversary of NIOSH and the Occupational Safety and Health Administration (OSHA) under the Occupational Safety and Health Act of 1970. Please join us Tuesday evening for a reception in commemoration of this important date in history.

Finally, I would like to thank our co-sponsor, the University of Cincinnati, for their efforts in organizing this year's symposium as well as each of our participants and attendees for joining us here in Cincinnati for the 2011 NORA Symposium. I wish each of you a successful Symposium.

John Howard, M.D.
Director

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July 11, 2011

Welcome!

The University of Cincinnati Department of Environmental Health, College of Medicine, and the NIOSH-supported Education and Research Center that brings together faculty and students in the Colleges of Engineering, Medicine and Nursing, welcome you to Cincinnati, the Queen of the West and a wonderful city on a river.

Cincinnati is a center for industry, labor, government and education: an ideal location for a meeting of stakeholders representing the broadest aspects of worker health and safety to discuss achieving impact through research and partnership. Few achievements in workplace improvement result from singular effort; this team science requires partnerships at all levels: concept, research, translation to practice, feedback from practice for improvement in concept. Ultimately, we hope that prevention through design will reduce the number of exposures causing injury and illness in the workplace.

The University of Cincinnati has a long history of research and education in core disciplines of workplace improvement. The College of Engineering initiated the highly regarded concept of co-op education in 1906. The Department of Environmental Health was formed about 80 years ago as an interdisciplinary team of physicians, analytical chemists, toxicologists, industrial hygienists, engineers and librarians to study occupational and environmental health problems in the auto industry. For many years, the UC occupational medicine mini-residency was a recognized mechanism for practicing physicians to enhance skills in this important field during summer and off-campus experience. The Nursing program was started in 1889, and joined UC as its eighth college in 1938. The College of Nursing was one of the first to offer BSN (1916) and MSN (1956) degrees.

Enjoy the world-class art museums while you are here. Visit Music Hall. just to see the hall even if the orchestra is away. Sit in Fountain Square to discuss new ideas with colleagues and watch the locals. Eat some Graeter's ice cream on a hot summer night. (Unfortunately, this is All Star game week, and the Reds participants are in Phoenix.) Cincinnati offers a bridge some of you may have seen in Brooklyn and architecture with a European flavor. Findlay Market is a special place for coffee and browsing.

Wishing you a productive meeting, and a great stay in our city,

Shuk-Mei Ho, PhD
Professor and Chair

Carol Rice, PhD, CIH
Professor and ERC Director

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