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BIOSOLUBILITY OF ENGINEERED STONE IN SIMULATED LUNG FLUIDS

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Objective

Engineered stone (ES) workers have increased rates of silicosis and scleroderma. Notably accelerated silicosis has been observed and thought to be related to ES constituents such as crystalline silica and binding resin. The aetiology of ES-related silicosis initially involves interaction of stone dust with interstitial and intracellular lung fluids. There appears to be no reported biosolubility study of ES dusts. The aim of this study was to investigate the biosolubility of engineered stone dusts, of variable composition, including both high and low resin content.

Method

A range of engineered stone dust samples, obtained by low temperature comminution of commercial ES, were reacted with simulated lung fluids (SLF), namely artificial lysosomal fluid (ALF) and Gambles solution, for periods of 24 hours, 1 week, 2 weeks and 4 weeks at 37C with agitation. Changes in the composition of SLF were assessed. ES dust mineralogy, elemental content and organic content were assessed using XRD, XRF and pyrolysis GC-FID/GC-MS respectively. Elemental analysis of SLF was performed using ICP-OES.

Results

Fifteen different ES from 4 suppliers were analysed. The products had more than 60% crystalline silica, with two samples having more than 40% cristobalite. On pyrolysis, ES dust released volatile organic compounds such as phthalic anhydride, benzaldehyde, and styrene.

Reaction with SLF released different metal ions which varied according to ES and type of SLF. In general, greater changes were observed with ALF, likely due to lower pH and a greater potential for metal chelation. Major elements released in solution included iron, manganese and cobalt.

Early results indicate that the element release rate varied with ES and the highest concentration was typically at 1 week.

Conclusion

Although crystalline silica is the major constituent of the ES dusts, there are other inorganic and organic compounds that might play a role in accelerated silicosis and immune diseases. Metal ions such as cobalt are catalysts for polyester resin polymerisation and their release suggests resin breakdown in SLF. Inhalation of cobalt is associated with lung disease, thought to be via immunologic and oxidative stress mechanisms. A systematic investigation of the engineered stone dust is required to understand the pathogenesis of accelerated silicosis.

Keywords: engineered stone, resin, biosolubility, accelerated silicosis