Occupational and Environmental Exposures of Skin to Chemicals - 2005

Abstract for Poster 63

Development and Evaluation of a New Identification and Decontamination System for Removing Toxic Elements, Especially Lead

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Background

NIOSH Health Hazard Evaluations and other reports from the literature document that risks for ingestion of toxic elements via hand-to-mouth and hand-to-food transfer can be a significant occupational health problem that is unfortunately under recognized. A colorimetric wipe method has been developed that can be used both qualitatively and quantitatively to assess lead contamination of skin (hands) and work surfaces. The method results in an immediate colorimetric response that has proven exceptionally useful for rapid screening and decision making for lead contamination on skin and surfaces. In developing the new method, it was discovered that common soap and water is not an effective means of removing lead and other metals from the skin. In response, a novel toxic metals decontamination system was developed. "Hands Off!" was invented to maximize toxic metals removal from the skin without the use of harsh or abrasive cleansers and designed to be an environmentally benign product.

Methods

Critical components of a skin decontamination system were researched, identified and a product was formulated. Performance tests were initially conducted with non-blinded evaluations using known amounts of lead oxide dust (PbO) applied to the hands. Timed, standardized multi-step approaches for each test were followed for hand contamination and decontamination. Lead oxide was applied at 2970 ug, an amount identified as a mid- to upper range of contamination found in some studies. Following trial decontamination, the palms of both hands were wiped with a certified metals sampling wipe with three separate media and the samples combined for quantitative analysis. The new decontamination system was evaluated in several scenarios including single use with rinse/no rinse, and duplicate use with/ without rinse. To investigate the effect of the systems approach, individual components were removed to assess impact on overall performance. The system was evaluated to determine removal efficiency of other elements besides lead including arsenic, cadmium, nickel and tin. For comparisons,

several commercial skin cleansers were tested including liquid soaps and heavy duty industrial cleansers including abrasive cleansers containing sand, chelating agents and hand cleaning towellettes.

As a final evaluation a panel of 15 blinded participants were recruited as subjects who contaminated their hands with lead using the standardized approach. Two of the best performing commercial products that had been identified through non-blinded tests, the new skin cleanser system, and a common household cleanser (Ivory Liquid Soap) were used by each participant three times. Subjects were also asked to serially rate each cleanser on the basis of perceived power of cleansing, aspects of fragrance, and cleanser feel both during and after use.

As part of a separate evaluation in vitro human skin penetration testing was conducted (see Francesca Larese Filon, et al "Lead Skin Absorption and the Effects of Cleaning Procedure with Detergents" for details) to investigate the new cleansing system's influence on skin penetration of metals compared to Ivory Liquid Soap and no skin cleansing/decontamination.

Results

The new cleansing system was highly effective in non-blinded and in blinded tests. Non-blinded evaluations revealed that skin concentrations of lead at approximately 3000 ug was reduced to less than 25 ug compared to one industrial-use product where over 400 ug of lead was recoverable from the hands. In blinded studies, the new cleanser system surpassed all other cleansers in the removal of lead ($P<0.05$). Only 14 ug Pb was residual with the new cleanser compared to Ivory liquid soap where 62 ug was recovered. Subject preferences were essentially similar across all four of the skin cleansers. No detectable adverse effect was noted on the skin from using the new cleanser system up to six times per day for up to a week.

Conclusion

Two novel and effective methods for identification of lead contamination and skin decontamination have been recently developed. The lead detection method is patented, fully commercialized and has been awarded two technology transfer awards. The skin decontamination method has been fully developed and evaluated using an objective test protocol designed to compare various aspects of cleanser performance against several existing skin decontamination products and was found to be superior. The newly developed skin cleansing system, combined with the colorimetric wipe method for detecting the presence of lead on surfaces and the hands, have the potential to effectively identify and reduce previously unrecognized exposures to toxic elements, especially lead.

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