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Occupational and Environmental Exposures of Skin to Chemicals - 2005

Abstract for Poster 56

Lead skin absorption and the effects of cleaning procedure with detergents

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Background

Skin contamination by dusts containing lead and other toxic metals is not generally regarded by many as posing significant risks for absorption and toxic effects. Limited experimental studies suggest that under physiologically relevant conditions metal dusts may ionize, which can increase risks of percutaneous absorption of toxic metals (Stauber 1994, Hostynek 2003, Larese 2004). It is known that polar organic compounds and some metals can appreciably be absorbed through damaged skin but this has not been studied in regards to lead particulate compounds (e.g., PbO, PbO₂, etc). Previous in-vivo experiments with inorganic lead compounds indicate absorption through the skin (Stauber 1994) but there was previously no information on the effect on absorption of decontamination agents.

The aim of our study was to investigate the skin absorption of PbO, the effect of a rapid skin decontamination with two different detergents and the comparative absorption in normal or abraded skin.

Methods

The study protocol entailed using discarded excised human abdominal skin obtained from medical procedures that was mounted in a two chamber testing device commonly used for such testing (Franz TJ 1975). The skin was mounted so that the surface faced the donor chamber and the dermis faced the receptor chamber. In the donor side 5 mg/cm² lead oxide dust (<10 um particles) was applied to which synthetic sweat adjusted to a pH of 5 was added. Eight replicate tests were run for each set of experiment. In one set of tests, nothing more was done to the skin until 24 hours when the test was stopped. In a second set of tests, Ivory Liquid Soap, containing sodium lauryl sulfate and sodium laureth sulfate, was used with cotton balls to decontaminate the skin after 30 minutes and the skin

remounted in the penetration cell for the remaining 24 hours with only synthetic sweat solution added to the donor side. In a third set of tests, the NIOSH soap solution was used with cotton balls to decontaminate the skin after 30 minutes and the skin remounted as in the second set of experiments. At 24 hours the skin was removed from all test cells, carefully cleaned with running water and the remaining content of lead determined in the skin. The receptor chamber fluid was also analyzed for lead. All samples were analyzed for lead using electro-thermal atomic absorption spectrometry with Zeeman background correction, according to NIOSH Method 7105 (NIOSH/CDC, Cincinnati, Ohio). The above three sets of experiments were also repeated using skin that had been damaged by lightly drawing a hypodermic needle across the skin surface (Bronaugh 1985). For each experiment 4 cells were added as blanks.

Results

Our results confirm that Pb oxide can pass through the skin with an absorption amount in 24 hours of 3.9 ng/cm² median (25-75 percentiles 1.2-8.5). This absorption increased significantly ($P < 0.05$) when we use an abraded skin protocol (median value 26.8 ng/cm², 25-75 percentiles 15.8-36.5).

Removing PbO after 30 minutes didn't decrease the Pb content in donor solution: the cleaning procedure using the Ivory Liquid cleanser did increase significantly skin penetration with a median value of 31.1 ng/cm², 25-75 percentiles 12.9-62.1 (Mann-Whitney U-test, $p = 0.0002$). The cleaning procedure done with NIOSH soap did not increase significantly absorption (median value 8.5 ng/cm², 25-75 percentiles 3.9-11.6). The difference in penetration between the NIOSH cleanser and Ivory Liquid cleanser was also significant when analyzed separately. Penetration of lead through damaged skin was 5.6 times greater than through intact skin when no cleansers were used. When the cleansers were tested on damaged skin, penetration of lead in NIOSH cleanser group was 1.6-fold greater than for the no treatment group, but the difference is not statistically significant. Skin penetration for the test cells in which Ivory Liquid soap had been used contained 4.4 times more lead than those skins that had not been treated with a cleanser ($p = 0.0003$).

Conclusions

Results of experiments done when washing the skin after 30 minutes with different soaps were surprising. First of all, removing Pb after 30 minutes did not cause a reduction of Pb penetration in 24 hours, but only caused a reduction in skin Pb content. This suggests that removing Pb powder after 30 minute is not sufficient to reduce the apparently rapid initial absorption that can occur during the first few minutes. It means that in 30 minutes a sufficient amount of Pb has already passed into the stratum corneum and created a concentration gradient. The quick rapid Pb skin absorption is in accord to previous reports (Chee-Ching Sun 2002) and we know that sodium lauryl sulphate (Ivory) increased nickel penetration (Lindberg 1989, Emilson 1993, Frankild 1995) because it reduces barrier integrity of the skin and increased percutaneous penetration by direct action on the skin (Ashton 1986).

These results indicate that it is necessary to prevent at all skin contamination from occurring, because a short contact can increase skin content and permeation even if followed by washing. These results also suggest that it is necessary to carefully choose the decontamination measures that are provided to workers.

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This conference follows the success of the first [International Conference on Occupational and Environmental Exposures of Skin to Chemicals: Science and Policy](#), which was held near Washinton, DC, in September, 2002.

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