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THE INFLUENCE OF HAND MOVEMENT ON THE PERMEATION AND PENETRATION OF CAPTAN THROUGH DISPOSABLE NITRILE RUBBER GLOVES

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Despite ongoing chemical protective clothing testing efforts, about 2.9 million workers still suffer from dermatitis each year in the United States. One critical gap in knowledge is the level of protection afforded by protective clothing under worker-use conditions. The aim of this study was to test the influence of hand movement on the permeation and penetration of captan through disposable nitrile gloves, and to test whether movement caused a change in glove properties. Testing was conducted using a previously described robotic hand test system exposed to an aqueous emulsion (217 mg/mL) of captan at 35 ± 0.7°C. The method blank was exposure to water alone. Tensile strength and elongation tests were also performed on the glove materials in accordance with ASTM methods D3187-00 and D412-98a. With hand movement, the permeated mass of captan collected after 8 hr ranged from 1.6 to 970 µg (brand A) and 8.6 ± 1.2 µg (brand B). Without hand movement, the corresponding masses were 1.4 to 8.4 µg (brand A) and 11 ± 3 µg (brand B). These results were not significantly different at $p \leq 0.05$ using parametric and nonparametric statistical tests, but they indicated that hand movement could influence the precision of permeation (F-test $p \leq 0.05$). One glove (brand C) exhibited catastrophic failure after 2 hr with movement (including the method blank), in comparison with 0.5 to 9.9 µg captan with no movement. No significant differences, at $p \leq 0.05$, in tensile strength or elongation existed between the glove materials. Thus, the ASTM standard test methods were not good indicators of glove performance under worker-use conditions. Hand movement did not appear to significantly affect the permeation of captan through nitrile gloves. However, hand movement did influence degradation, resulting in catastrophic glove failures and signs of penetration.

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DEFINING A DEXTERITY TEST BATTERY FOR THE EVALUATION OF PROTECTIVE GLOVES

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Gloves protect the wearer from various hazards, but they impair manual dexterity. These effects have been largely investigated through dexterity testing. However, few studies have attempted to define a standardized test battery for the efficient comparative evaluation of gloves and the classification of products, which in turn would allow users in a workplace environment to select gloves meeting their specific needs. The objective of this study was to evaluate the efficiency of 12 existing dexterity tests to discriminate different types of gloves, in order to identify the most sensitive and reliable tests to serve in a standardized test battery. An experiment was conducted with 30 voluntary subjects who performed 12 dexterity tests, including those proposed by ASTM standards F2010 and EN420, under four conditions: barehanded and wearing three types of gloves. Nine types of gloves were selected for the experiment, covering a wide spectrum of thickness, adherence, flexibility, and type of protection. Each subject tested a different set of three types of gloves among the nine preselected gloves. The results show that an efficient test battery is generally composed of tests that discriminate within a specific range of manual dexterity, from fine to gross. The most efficient test batteries combine either the Minnesota rate of manipulation test or the ASTM F2010 method, with one or two of the following tests: O'Conner finger dexterity, Purdue pegboard, and Crawford screws dexterity. The Crawford pins and collars test, the O'Conner tweezer dexterity test, and the dexterity test of the EN420 standard are the least discriminative ones. The grooved pegboard test, even though it is good at discriminating gloves, does not add any discriminative power to a combination of tests.

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SIMULTANEOUS TESTING OF PROTECTION AND COMFORT OF PROTECTIVE SUITS

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When developing a protective suit, the first phase is to ensure the protective properties of the material. However, this is not the protection the final suit is going to offer. Therefore, whole-system testing with animated mannequins is used to gain insight into the protective properties of the suit (as a part of the protective ensemble). Comfort, heat stress, and moisture balance testing, performed with volunteers, is as important as measuring the protection level, because there is always a trade-off between comfort and protection level. Especially with a high protection level, heat stress might become the limiting endurance factor for operations with protective clothing. For users of protective clothing, it is highly important to receive adequate information before choosing a suit that provides a balance between protection level and endurance time in accordance to the user's needs. Currently, tests concerning protection and comfort are performed separately. To get a fair comparison, however, it is advisable to measure comfort and protection simultaneously. Tests were performed to investigate the validity of this method.

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STATISTICAL ANALYSES OF THE DECONTAMINATION EFFICACY OF CHEMICAL PROTECTIVE CLOTHING

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Effective decontamination of chemical protective clothing (CPC) is an important issue for reducing occupational skin diseases and disorders. To adequately protect the work force against dermal exposure to chemical hazards, the efficacy of decontamination techniques (and thus the reusability of CPC) needs to be carefully evaluated. The changes in permeation resistance and physical properties of CPC material after exposure/decontamination should be used to define the limits of reusability. Recently, NIOSH conducted a study to evaluate the reusability of 7 commonly used CPC materials against 12 ASTM selected liquid chemicals, comprising 26 material-chemical combinations. Two sets of replicate swatches were prepared, one for thermal decontamination and the other for decontamination using water and detergent. Exposure/decontamination was repeated up to 10 cycles. Permeation parameters, including ASTM normalized breakthrough time and cumulative permeation mass, were calculated for new material and exposed material (after each exposure/decontamination cycle) using the Permeation Calculator computer software. Normality was checked via q-q plots (and verified via the Shapiro-Wilks test), and appropriate transformations were implemented as necessary. A mixed model, with the repeated cycles represented by random effects, was performed using the SAS data analysis package to assess significance, estimated effect of each cycle, and differences between decontamination methods. The study found that thermal decontamination removed residual chemicals more effectively than water/detergent decontamination for most combinations. However, less material degradation was observed for the decontamination using water/detergent. Changes in physical properties, the other important criterion, were not considered in this study.

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A VALIDATION STUDY OF A MATHEMATICAL MODEL FOR ESTIMATING SOLVENT EXPOSURES IN THE WORKPLACE

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Abstract Book

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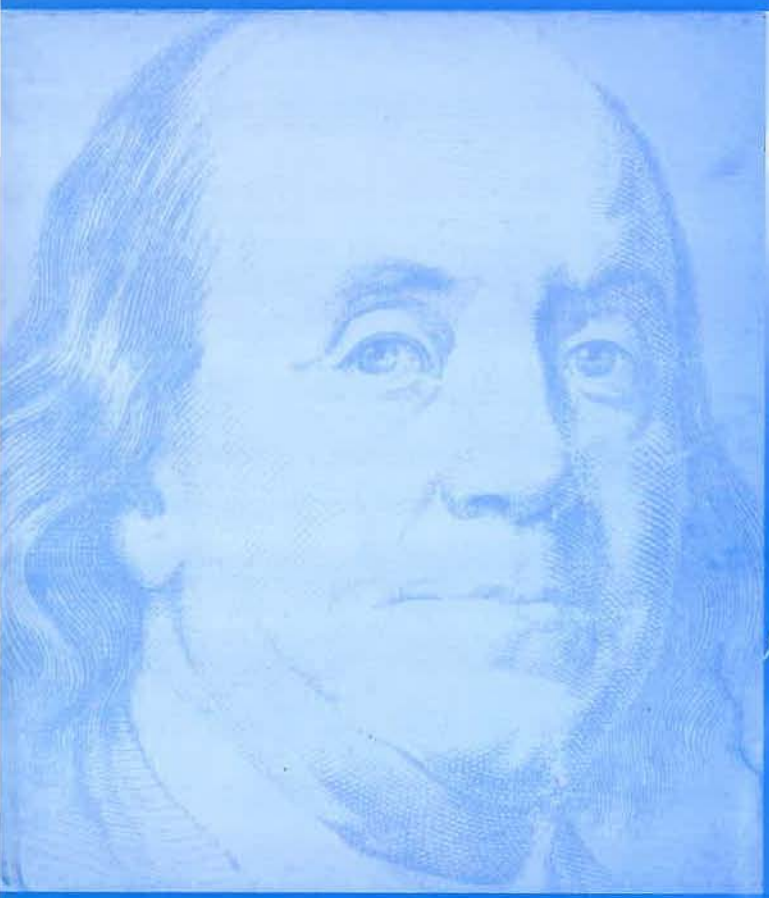

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