Developing a Framework for the Quantitative Risk Characterization of Dermal Sensitizers in the Workplace

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ABSTRACT
Situation/Problem: The control or elimination of workplace exposure to dermal sensitizers is critical. Dermal exposure control strategies often incorporate a qualitative risk assessment process that links qualitative hazard and exposure assessments which is then used to determine appropriate control strategies. Because of the increased availability of quantitative hazard data for dermal sensitizers, a logical step to build on the qualitative risk assessment processes is seen as combining quantitative hazard and exposure data to give a quantitative risk characterization. However, since the qualitative approach will still be widely used to initially identify workplace control measures, a logical step to build on the qualitative risk characterization will be developed to more effectively control workplace exposure to dermal sensitizers.

QUALITATIVE RISK ASSESSMENT FOR DERMAL SENSITIZERS

Qualitative dermal risk assessment processes, in general, characterize the potential for dermal risk based on the dermal toxicity (e.g. characterized as low, moderate or high toxicity) of a chemical and estimated level of exposure to the chemical (also as low, moderate or high). As an example, the GHS classification of a chemical as a skin sensitizer (hazard category 1A, 1B, hazard statement H317 – may cause an allergic skin reaction) can be used as the qualitative industrial hygienist place to place the potential of chemicals to produce dermal sensitization based on the qualitative hazard estimates. A qualitative estimate of dermal exposure to this chemical can then be made based on an assessment of a combination of various quantitative exposure parameters that may include the: 1) degree of dermal exposure (low, moderate, high); 2) frequency of dermal contact (low, moderate, high); 3) likelihood of dermal retention (low, moderate, high); and 4) concentration of the chemical (low, moderate, high).

Since health risk is a function of both hazard (toxicity) and exposure, a qualitative estimate of dermal risk for known dermal sensitizers can be obtained by combining the qualitative toxicity estimate with the qualitative exposure estimate. Again, the final qualitative risk assessment would be in terms of high, moderate, or low risk.

In this exercise, the qualitative dermal risk assessment for a known dermal sensitizer (an intermediate-high potential for occupational dermal exposure during a specific task, and thus, a potential moderate-high qualitative health risk during that task.

QUALITATIVE RISK ASSESSMENT FOR DERMAL SENSITIZERS

Resolution: Quantitative health hazard data for dermal sensitizers (i.e. potency data in the form of EC3 values) are obtained from the literature and ECHA’s REACH registration database. ECHA methodology is used to transform EC3 values into dermal “benchmark” exposure concentrations that would not be expected to induce dermal sensitization in susceptible individuals. Obtaining quantitative, task-based dermal exposure estimates is more complex, as well as more time and resource-consuming. Many methods exist for obtaining dermal exposure estimates such as dermal wipe sampling, dermal exposure models, worker biomonitoring, use of standard exposure equations, or a combination thereof.

Results: Benchmark exposure concentrations for known dermal sensitizers have been developed. However, calculation of quantitative dermal exposure estimates is still an on-going process and needs to be done on a task-based basis. The following is one such example: An initial qualitative assessment showed a potential for dermal risk from acrylic use in the workplace setting. A sensitization “benchmark” of 140 µg/cm2 of skin surface area was derived for the chemical. Dermal exposure estimates (using conservative, Tier 1 modeling) for the task were 100 µg/cm2 (with glove use) and 1000 µg/cm2 (with no glove use). Because appropriate gloves were already being used in the task, and exposure was less than the benchmark, no workplace control measures were deemed necessary.

Lessons Learned: Qualitative exposure tools/processes will continue to be invaluable for reducing risk to dermal sensitizers in the workplace. A quantitative risk assessment approach has been shown to be feasible and able to be employed to validate results of the qualitative approach. However, quantitative risk assessment approaches still require further development, especially in terms of exposure assessment.

QUANTITATIVE RISK CHARACTERIZATION FOR DERMAL SENSITIZERS

For this exercise, conservative, Tier 1 modeling was used to provide an estimate of worker exposure to the acrylate during a specific task. In brief, this Tier 1 exposure assessment assumed: 1) maximal dermal exposure to the acrylate during the task (i.e. large dermal surface area of contact); and 2) appropriate gloves were not being used. This modeling gave a maximal dermal exposure = 1000 µg/cm2. Because appropriate gloves were already being worn by the workers this reduced maximal exposure estimate to 100 µg/cm2 (note: with gloves). Thus, no further gloves, occupational dermal exposure is reduced by 90% [6]. Lastly, worker training also included advice to “avoid contact with skin” and to “wash hands after use”.

The modelled, maximal occupational dermal exposure (100 µg/cm2), with glove use, was less than the calculated occupational benchmark (140 µg/cm2) for induction of dermal sensitization. Therefore, it can be concluded that workers would not be expected to induce dermal sensitization in susceptible individuals (workers) under this exposure scenario. Therefore, no further control measures determined to be needed for worker protection. This conclusion is further strengthened because a maximally-exposed worker was used for comparison to the benchmark (i.e. actual dermal exposure is probably less than 100 µg/cm2).

CONCLUSIONS
Qualitative risk assessment will continue to be an invaluable tool for identifying potential occupational tasks, etc. where exposure to dermal sensitizers could give rise to a significant health issue for workers.

The use of a quantitative dermal exposure assessment framework/process for dermal sensitizers has been shown to be feasible in this preliminary exercise. Published EC3 values are available for a number of dermal sensitizers. While methodologies currently exist for deriving conservative estimates of dermal occupational exposure, more work is needed to further develop/implement dermal exposure modeling capabilities to get more “realistic” estimates of occupational-level exposure. The next type of framework for the quantitative risk assessment of dermal sensitizers can be used in certain cases for risk assessment purposes, as well as assist with selection of additional exposure control measures (e.g. gloves, workwear, etc.). Lastly, this framework may also find application in the future for the quantitative risk assessment of dermal sensitizers in consumer-use scenarios.

REFERENCES