RISKOFDERM: Risk Assessment of Occupational Dermal Exposure to Chemicals. An Introduction to a Series of Papers on the Development of a Toolkit

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Dermal exposure to industrial chemicals during work is of major concern in the risk assessment of chemicals. Current approaches in procedures for European legislation are not based on experimental data on dermal exposures in workplaces because these are lacking. A large project, with four interrelated work parts, was funded by the European Commission (DG Research) in order to overcome large parts of this problem. The 4 year project is now in its final year and an overview is given of an important part of the project: the development of a risk assessment and risk management toolkit for dermal exposure. Five other papers in this issue deal with various aspects of this development.

Keywords: toolkit; dermal exposure; chemicals

INTRODUCTION

In a project funded by the European Commission (RISKOFDERM, QLKA4-CT-1999-01107), scientists from 15 Institutes in 10 European countries are working together with the following major aims:

- Qualitative survey in European workplaces to obtain an overview of tasks, processes and determinants relevant for dermal exposure (work part 1).
- Quantitative survey to obtain detailed data on dermal exposure and determinants in the most relevant tasks and processes (work part 2).
- Development of a predictive dermal exposure model (set) using all relevant variables (work part 3).
- Development of a risk assessment and management toolkit from data on hazard, dermal absorption, dermal exposure and effectiveness of control measures for use in workplaces (work part 4).

This introductory paper will reflect the outline of the project to better understand and introduce the development of the toolkit, which is more fully described in other papers in this issue (Goede et al., 2003; Marquart et al., 2003; Oppl et al., 2003; Schuhmacher-Wolz et al., 2003; Warren et al., 2003).
RESULTS AND DISCUSSION

For work part 1, it is assumed that dermal exposure, in the right format dimensions, can be extrapolated from one compound to another when it is task based. This may not hold for every task, so expert knowledge is required to check the assumption for the task under consideration. To obtain these ‘tasks’, Dermal Exposure Operation (DEO) units were defined, with various scenarios for each DEO unit (RISKOFDERM, 2001, 2002). The scenarios that must be defined should, under practical conditions and in real work situations, be: (i) measurable with respect to dermal exposure; (ii) have an observable beginning and end; (iii) relevant for exposure modelling; (iv) universal: they have to occur in various branches and industries. These DEO units have been defined on the basis of similar routes of exposure and form the basis of the toolkit. The main purpose of the DEO units is to cluster dermal exposure situations with similar (expected) relations between exposure determinants and exposure levels (RISKOFDERM, 2001).

Since hygienists from 10 different institutes in nine different European countries would have to make observations with respect to dermal exposure and exposure determinants, it was essential to develop an extensive ‘Questionnaire for on-site surveys’, as well as a detailed ‘Instruction manual’. Furthermore, the observers needed to be trained in order to obtain comparable results. Observations have been made for 10 different scenarios taken in such a way that all DEO units are covered. Pilot studies have been carried out and were reported and discussed/evaluated in order to make appropriate changes for the main studies. On the basis of the evaluation, the questionnaire has been adapted to some extent for work part 1, but extensively for use to collect data for work part 2. Table 1 shows the major items which were asked for in appreciable detail. The questionnaire contains many questions which cover possible determinants of exposure as relevant for work parts 3 and 4. The main studies have now been carried out and reported (RISKOFDERM, 2003).

In work part 2, the state-of-the-art methodology for measuring external dermal exposure has been discussed and choices have been made for the selected scenarios (Table 2). Each of seven institutes selected three scenarios in such a way that all DEO units were covered. The methodology varied with the studied scenario because the suitability of measurement methods depends on the exposure route, type of substance and determinants of the exposure situation. Also in this work part, pilot studies have been carried out, reported and discussed/evaluated with respect to required changes for the main studies. Currently, the main studies have been reported. An overall report is in preparation. These studies will lead to a series of publications on quantitative dermal exposure assess-

Table 1. Main items in questionnaire

| Enterprise (sector and size) |
| Worker (e.g. experience) |
| Workplace and organization |
| Scenario (15 questions) |
| Control measures and protective equipment |
| Skin care |

Table 2. DEO units (numbered) and scenarios that have been studied in work part 2

1 Handling of objects
   - Filling
   - Collecting
   - Maintenance and servicing
   - Loading
   - Mixing/diluting
2 Manual dispersion of substance
   - Wiping
3 Dispersion of substance with hand-held tool
   - Pouring
   - Spreading with comb
   - Rolling
   - Brushing
4 Spray dispersion of substance
   - Spraying
5 Immersion
   - Immersing of objects (electroplating)
6 Mechanical treatment (of solid objects)
   - Machining
   - Grinding
   - Sawing

- In work part 3, the exposure is considered to occur through three different routes: direct contact, surface contamination and deposition and impaction (Schneider et al., 1999). On the basis of a thorough
evaluation of the literature on dermal exposure (assessment), some dermal exposure levels were obtained, as well as determinants of exposure and available approaches for modelling. Based on this, a framework of theoretical approaches was developed, including: (1) processes and tasks; (2) substance and product characteristics; (3) situations and conditions (RISKOFDERM, 2002). This information (a list of possibly relevant variables) was essential for the experimental work to be done in the other three work parts as it was a major input to the measurement strategies and the questions asked on determinants. In Table 3, the major variables are indicated. The development of this overview is presented elsewhere in this issue (Marquart et al., 2003).

Models have been developed based on the results of work parts 1 and 2, and will be validated/benchmarked with experiments in which model compounds will be measured for the various DEO units.

In work part 4, the available literature has been analysed for approaches to risk assessment that could be of use for the toolkit development. For this toolkit (Table 4), approaches are developed for hazard, exposure and risk assessment of dermal exposure based on label information and MSDSs for the hazard assessment (Schuhmacher-Wolz et al., 2003) and based on the approach taken in work part 3 for exposure assessment (Goede et al., 2003), both described elsewhere in this issue. The risk assessment is carried out for systemically and locally acting chemicals. The risk management (control) section is based on literature information (Oppl et al., 2003).

For the exposure assessment method an approach is taken that uses all available published dermal exposure studies (Warren et al., 2003). From this information typical default values for defined scenarios are derived that can be used to assess dermal exposures, which are then corrected using a graded system for the effect of most of the variables indicated in Table 3.

The draft toolkit will be considered by an international selection of occupational hygienists (work in progress) and adapted on the basis of the results obtained from an evaluation in practice using the observations and data from the work part 2 and work part 3 studies.

<table>
<thead>
<tr>
<th>Direct contact</th>
<th>Surface contact</th>
<th>Deposition and impaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical state (liquid, solid)</td>
<td>Amount on surface</td>
<td>Source terms (concentration in air; energy term, duration)</td>
</tr>
<tr>
<td>Viscosity (stickiness) (liquid)</td>
<td>Intentional application:</td>
<td>evaporation and condensation; temperature</td>
</tr>
<tr>
<td>Particle size (solid)</td>
<td>amount applied</td>
<td>spraying and backbouncing; spray pressure</td>
</tr>
<tr>
<td>Moistness (solid)</td>
<td>transfer efficiency</td>
<td>resuspension: wind speed</td>
</tr>
<tr>
<td>Area of skin immersed</td>
<td>time after application</td>
<td>transport/movement of substance: height</td>
</tr>
<tr>
<td>Number of events</td>
<td>Accidental contamination:</td>
<td>mechanical processes: contact pressure or (electrical) power</td>
</tr>
<tr>
<td>Chances of spillage</td>
<td>air concentration</td>
<td>Air to skin</td>
</tr>
<tr>
<td>Position of worker relative to source</td>
<td>chance of spillage</td>
<td>velocity of aerosol</td>
</tr>
<tr>
<td>Amount on surface</td>
<td>cleaning (efficiency, etc.)</td>
<td>particle size (dustiness)</td>
</tr>
<tr>
<td>Skin coverage</td>
<td>Process, task, situation</td>
<td>concentration</td>
</tr>
<tr>
<td></td>
<td>contact area</td>
<td>skin area exposed</td>
</tr>
<tr>
<td></td>
<td>contact likelihood/frequency</td>
<td>duration</td>
</tr>
<tr>
<td></td>
<td>contact duration</td>
<td>wind speed; turbulence</td>
</tr>
<tr>
<td></td>
<td>pressure during contact</td>
<td>position of worker</td>
</tr>
<tr>
<td></td>
<td>skin moistness</td>
<td>skin coverage</td>
</tr>
<tr>
<td></td>
<td>Substance/product</td>
<td>distance to source</td>
</tr>
<tr>
<td></td>
<td>physical state</td>
<td></td>
</tr>
<tr>
<td></td>
<td>viscosity (liquid; adherence)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>particle size and moistness</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(solid)</td>
<td></td>
</tr>
<tr>
<td>Skin coverage</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4. Essentials of the toolkit concept

The toolkit is transparent and easy-to-handle and should be able to:

- Raise awareness
- Estimate exposure
- Identify control actions
- Recognize damaging and/or penetrating potential
- Evaluate risks

*STOP in hierarchical order: substitution; technical measures; organizational measures; personal protective measures.
The final outcome is a toolkit on paper, as described elsewhere in this issue (Oppl et al., 2003), but also in an electronic format that can be distributed on, for example, a CD-ROM or via a website (still to be developed). The user, who is supposed to be an educated non-expert, must answer relatively simple questions and will be guided by that to obtain qualitative scales for dermal exposure, the resulting risk and suggestions for possible control measures to deal with the risk. There will be many text blocks with relevant information on the various issues related to dermal exposure, dermal penetration and risk of locally acting and systemically acting compounds.

CONCLUSION

A series of studies relevant to the development of a dermal exposure risk assessment and management toolkit is published in this issue. The toolkit will be further developed based on the results of the quantitative dermal exposure studies, still to be published in a later issue of *Annals of Occupational Hygiene*, and a survey of practicality and plausibility to be done by occupational hygienists from Europe and the USA. It is intended to form an appropriate instrument for assessing risk of dermal exposure in workplaces and indicate ways to manage these risks and to reduce the incidence of health impairment from dermal exposure to hazardous substances.

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Partners 1–3 and 11–14 participated in the development of the toolkit.

REFERENCES


