Walk through of ConsExpo practical case: consumer exposure to insecticide

1a) Developing the exposure scenario

exposed population

Most likely exposure to the described products will arise at two different occasions: during use of the spray and after use due to contacting the product that has deposited on the floor and walls.

We presume sensible handling of the product so that children are not present during the spraying of the products and in this application phase the exposed population is of adult users of the product.

In the post-application phase however, exposure to children will possibly occur and since small children are more likely to contact floor surfaces more intensely and children are in general considered to be more sensitive to chemical exposures, this group is taken as the relevant exposed population in the post-application phase.

Nothing at this point is known about the toxicological profile of the substance X, so that there is no immediate reason to include other sensitive subgroups.

products

For all the specified products exposure will probably arise in both application and post-application phases. Although the use-description of anti-flea spray 1 explicitly mentions that the spray is not to be used in areas children in age 0-4 can not reach, we do not assume that all users will read and adhere to this prescription and we include the post-application exposure of children in our assessment.

description of exposure process

Application: the sprays are used in a room, during use the product will become airborne in the form of droplets (the vapour pressure of X is only 0.0001 Pa, so it is assumed that evaporation of the compound is negligible).

We assume the exposure will mainly arise by inhalation of airborne droplets.

The amount of product that becomes airborne depends on the type of spray used. The anti-fly spray is used as an airspace (keeping at least 50 cm from objects according to use prescription) and hence all, or nearly all product will become airborne. On the other hand, the anti-flea sprays are directed towards surfaces/cracks&crevices. Much of these products will deposit on the floor and walls immediately, and only a smaller fraction will become airborne.

When the spray droplets have become airborne, they are being removed from air by ventilation and deposition on the ground. The user of the spray will be present during use of the product, and it is assumed that he/she may not leave the room immediately but may stay in the room for some time after the treatment.

Post-application: the product is deposited on the floor on which a child may crawl, thereby being exposed dermally to the hands. Exposure will depend on the amount of product sprayed/deposited per unit surface area of the floor/wall, the total area on which the product has deposited, the area of the contaminated surface on which the child crawls, and the efficiency of the transfer of the chemical X from the surface to the hands of the crawling child.

data needed

Application: distinction needs to be made between scenario assumptions and exposure factor data. In order to calculate exposure in a certain scenario assumptions for this scenario have to be made. These include assumptions on how long a person stays in a room after using a product, the size of the room in which the product is being used, the ventilation of the room (open windows?) etc.

Application: data is needed on the mass generated by the spray, the size of the droplets being produced by the spray, the composition of the product, the size of the room in which the product is being used, the ventilation of this room, breathing rate of the exposed person, body weight of the exposed person.
It is important to note that some of these parameters are 'real' and measurable data (such as product composition, droplet sizes of the spray) but others are scenario assumptions that we have to make ourselves (such as: the person is using the spray in a small room with low ventilation and remains there after spraying for a certain time).

Post-application: amount of substance X on floor surface, transfer coefficient, floor area on which the child crawls, bodyweight of the child.

1b) rough estimate

In the absence of exposure factor data we make conservative assumptions for the unknown parameters.
Assuming that the product is being used in a moderately sized living room we might estimate its size as 50 m^3 (4x5x2.5). As a first estimate we take it that the room is not ventilated. A typical spray can holds 200ml-400ml of product. Assuming that such a spray can be used say 10 times, the amount of product being sprayed per time would be 40 ml ≈ 40 g (density about 1 g/cm^3) at maximum.
For the anti-flea spray an airborne fraction would have to be estimated. This is very arbitrary. A conservative estimate could be 100%, but in view of the mode of application (directed towards the ground) a value of 20% seems to be quite conservative.

So that we get now for the 3 inhalation exposures:

$$C_{air} = F_{airborne} \times A \times w_f / V_{room}$$

Where $F_{airborne}$ = 1 for spray 1, and equals 0.2 for the other two sprays.
This leads to the following air concentrations:

spray1: $C_{air} = 1 \times 40[g] \times 0.015 / 50[m^3] = 0.012 g/m^3$
spray2: $C_{air} = 0.2 \times 40[g] \times 0.001 / 50[m^3] = 0.00016 g/m^3$
spray3: $C_{air} = 0.2 \times 40[g] \times 0.004 / 50[m^3] = 0.00064 g/m^3$

with a breathing rate of 1 m^3/hr (TGD default for adult/light exercise), a body weight of 70 kg (TGD default), the assumption that the user of the product stays in

the room for 4 hours and the assumption that all of the inhaled substance is take up in the lung we find for the internal dose:

$$D = C_{air} \times Q_{breath} \times T \ / W_{body}$$

spray1: $D = 0.012[g/m3] \times 1[m3/hr] \times 4[hr] / 70[kg] = 6.9 \times 10^{-4}[g/kg]$
spray2: $D = 0.00016[g/m3] \times 1[m3/hr] \times 4[hr] / 70[kg] = 9.1 \times 10^{-6}[g/kg]$
spray3: $D = 0.00064[g/m3] \times 1[m3/hr] \times 4[hr] / 70[kg] = 3.7 \times 10^{-5}[g/kg]$

This preliminary estimation suggests that anti-flea spray 2 will not contribute significantly to the total inhalation exposure. Since it seems not very likely that a person will use 2 different anti-flea sprays simultaneously it seems justified to exclude anti-flea spray 2 at this point from the inhalation calculations.

Post-application:
Dermal exposure to all of the substance X on the floor.
For all sprays:

$$D = A_{sprayed} \times w_f \ / W_{body}$$

with the bodyweight of 9 kg (≈weight 1 year old child).
yielding:

spray1: $D = 40[g] \times 0.015 / 9 = 0.067 g/kg$
spray2: $D = 40[g] \times 0.001 / 9 = 0.0044 g/kg$
spray3: $D = 40[g] \times 0.004 / 9[kg] = 0.018 g/kg$

3) Detailed analyses

As an example we treat spray 1, inhalation route only. Other routes/products could be done in a similar fashion.

a) **Fly spray (spray 1)**:

i) **ConsExpo spray model parameters**:

body weight

From background document: adult mixed population (male/female), 25th percentile: 65 kg

use frequency

Unknown. Scenario assumption: 1 time a day during summer (3 months).

spray duration

Unknown. We assume a moderately small sized living room (60 m^3) as the location of use. According to the use description the product should be used 1 second per 10 m^3, however we assume the user does not necessarily adhere exactly to the prescriptions, so take 2 sec x 6 = 12

seconds of spraying, but we estimate that this may vary from 1 to 4 secs per 10 m^3.

exposure duration

Unknown. Scenario assumption: user stays in the room for 4 hours.

room volume

Scenario assumption: small living room of 60 m^3 (25^{th} percentile of size distribution Dutch homes, obtained from background document).

room height

Estimate: 2.5 meters.

ventilation rate

Scenario assumption: low ventilation (windows closed during entire exposure, contrary to prescriptions. From background document): 0.5 h^{-1}.

spray mode

Airspace, not directed towards person.

solvent evaporation

We do not know this. Calculations should be performed with both options. Spread in outcomes gives boundaries between which the exposure may vary.

mass generation rate

From the experimental data on spray products (background document) we see that the mass sprayed per second for spray cans ranges from 0.7 g/sec to 1.3 g/sec. In the measured set there is one fly spray with 1 g/sec. So, a mass generation of 1.3 g/sec seems a reasonable generation rate.

airborn fraction

Airspace application, assume that all of the product becomes airborne.

weight fraction propellant

Specified in background document: 60%

weight fraction non-volatile

Non-volatile fraction is defined as all of the product except propellant (gas) and solvent (evaporating relatively quick). From specification in background document: Propellant + solvent: 60% + 38.5%, rest : 1.5 %

weight fraction compound

From specification in background document: 1.5 %

weight fraction solvent

From specification in background document: 38.5 %

density solvent

Unknown. Commonly used solvents are ethane and water with densities of 0.8 g/cm^3 and 1 g/cm^3 respectively. We assume density of this solvent is in the range 0.8-1.2 g/cm^3

density non-volatile

Unknown. Densities of organic materials are usually of the order of 1.3-1.5 g/cm^3. We assume here that this range is from 1g/cm^3 to 2 g/cm^3.

initial distribution

From background document: distributions for measured spray cans range from medians of 10 micrometer to 50 micrometer. The measured fly spray has a median of about 30 micrometer (ignoring the droplets > 80 micometer) We anticipate that a smaller droplet size leads to a

higher exposure (longer resident times in air, deeper penetration into the lung), but at the same time, the deodorant spray (smallest droplets), will not be representative for a fly spray. Thus we assume here a droplet size distribution with median of 20 micrometer and a s.d. of 10 micrometer, distributed lognormally. (Coefficient of variation = s.d./mean≈0.5).

inhalation cut-off

Unknown, lies in the order of 10 micrometer, take 15 micrometer, to be conservative.

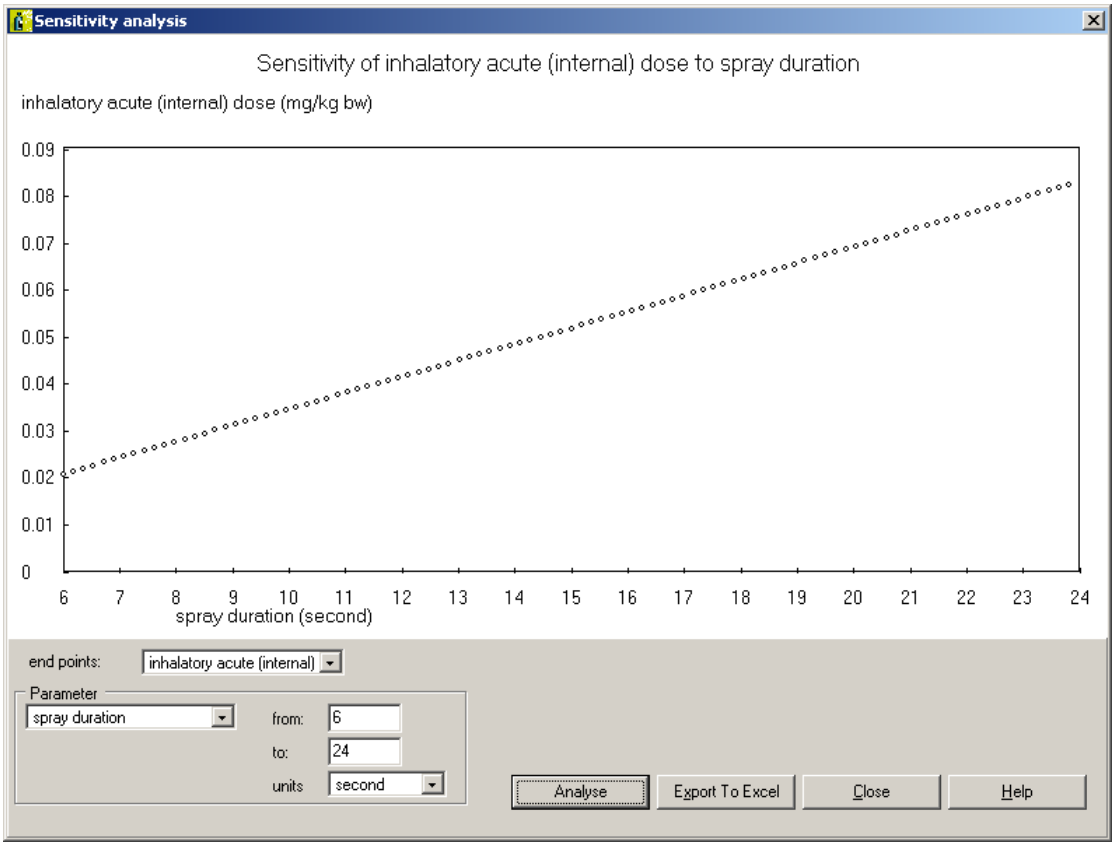
ii) **Data uncertainty**

Most uncertain parameters: use frequency, exposure duration, spray duration, solvent evaporation, density solvent, density non-volatile, inhalation cut-off. In addition it might be important to study the effect of initial droplet size distribution. A reasonable estimate of the distribution can be made, but it is not very clear beforehand how small changes in this parameter may influence the outcome of the results.

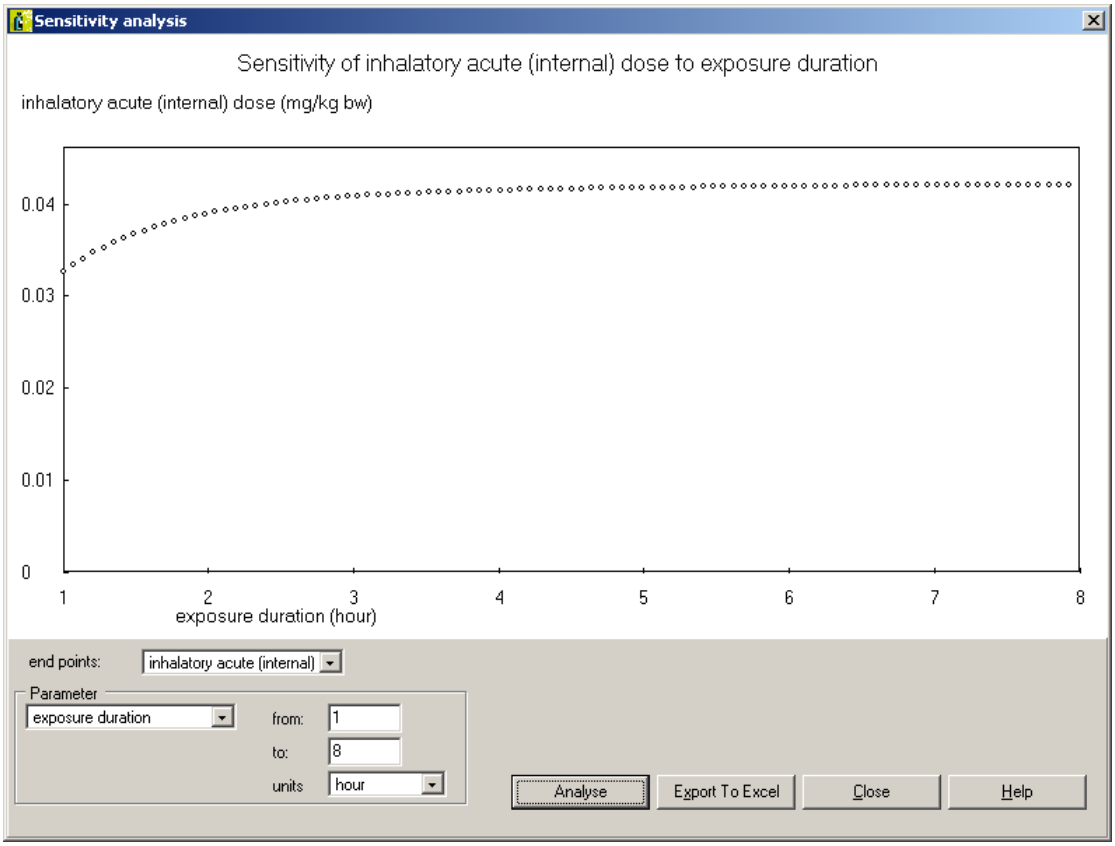
Sensitivity analysis

Three examples:

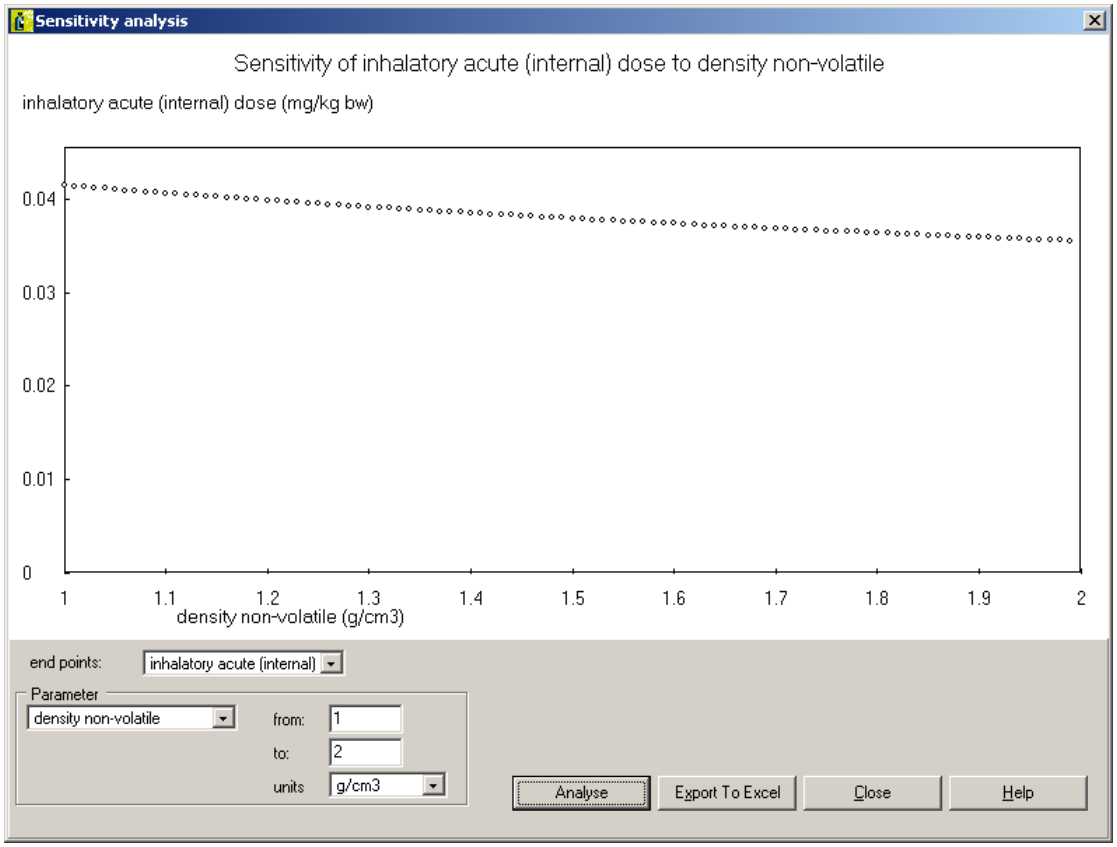
spray duration: vary from 1 to 4 sec/10 m^3



exposure duration : vary from 1 to 8 hours



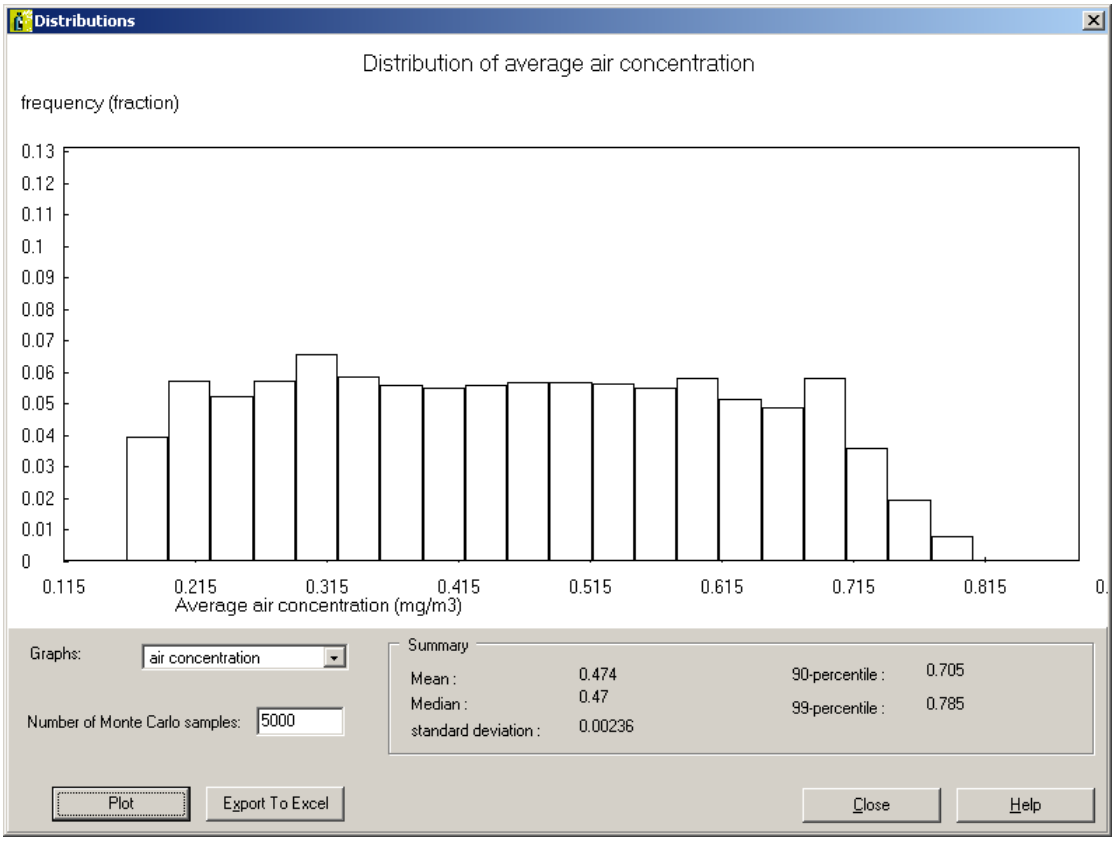
density non-volatile: vary from 1 to 2 g/cm^3



Conclusion: of the studied parameters the outcome of the assessment is only sensitive to changes in spray duration for the specified ranges. Consequently uncertainty in the exposure outcome is driven by the uncertainty in this parameter. If higher accuracy of results is needed, this parameter should be specified more accurately (if possible).

Note: we did 1 parameter sensitivity analysis in this case, keeping all parameters fixed and varying only 1 parameter at a time. To see results of varying all parameters simultaneously, we could perform a distributional calculation, specifying uniform distributions with boundaries that correspond to the range within which we expect the parameters to lie (the same as used in the sensitivity analysis).

The result is a distribution of exposures that reflects our uncertainty in the outcome. Following this procedure for the situation above:



So that the bounds of our estimates are from 0.2 to 0.8 mg/kg with a slight tendency (higher certainty) towards intermediate values.

b) The assessment of the dermal route is similar to the procedure followed above. For sake of brevity it is left to the reader to repeat the steps above.