

Health risk assessment of VOCs in air

1. Toxicity assessment of VOCs species

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Objective of toxicity assessment

Identify whether:

- Inhalation of VOCs
- at low concentration in ambient air for lifelong period
- cause any significant adverse health effect.

How to assess?

Does inhaled VOCs induce any adverse health effect?
(Qualitative assessment)



How severity of effects relates to concentration in air?
(Quantitative assessment)
- if enough data are available to conduct.

Information Sources

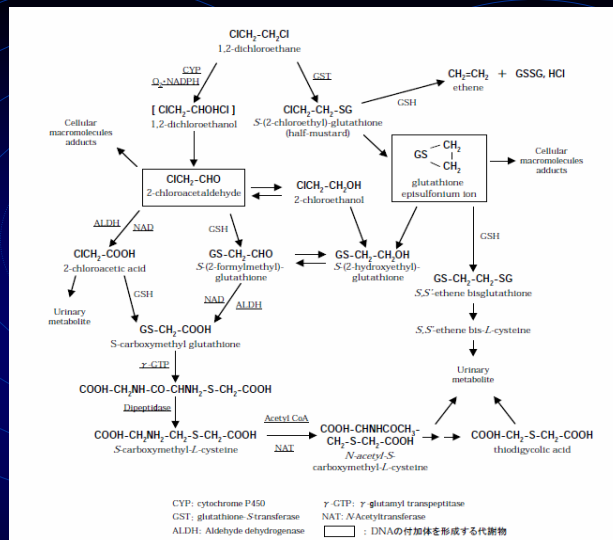
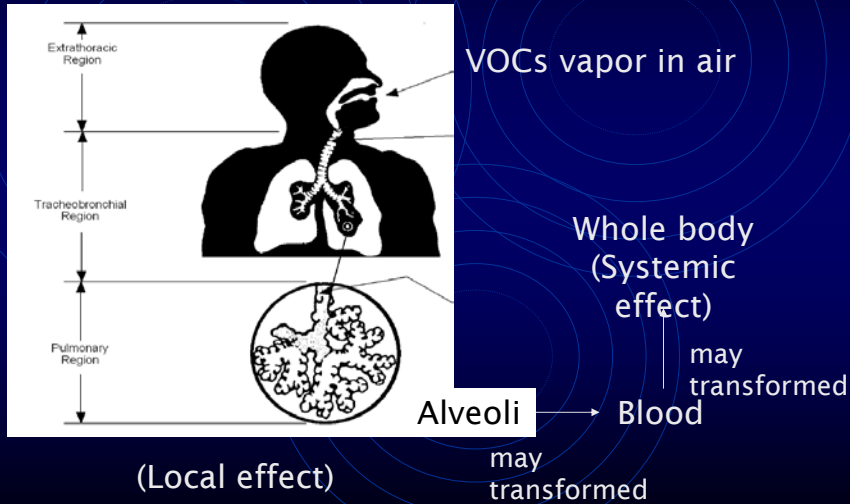
Primary: Study reports:

- Epidemiological study;
- Animal study (tests).

Secondary: Existing assessment reports:

- WHO, OECD, IARC(carcinogen), IPCS,...:
- U.S. EPA(IRIS, ATSDR,...):
- ACGIH(workplace),....

What happen on inhaled VOCs?



Metabolites of VOCs
 (shown for 1,2-dichloroethane)
 (IARC(1999) modified in JMoE(2006))

Qualitative assessment

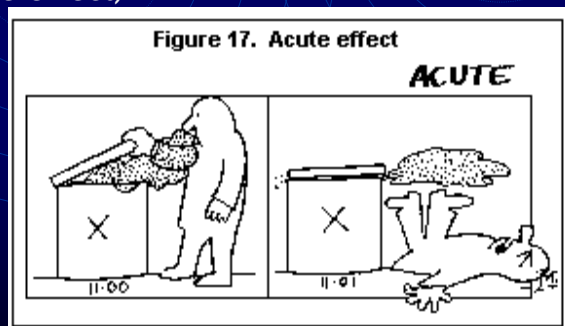
What may happen on one who inhaled VOCs?
(Adverse health effects)

- Detection of odors;
- nose and throat irritation;
- Wheeze, Asthma;
- Damage to respiratory tract (Local effects);
- Damage to other organs, nerve system,...(Systemic effects), up to Cancer, DNA damage, Death.

Quantitative assessment(1)

Concentration and Response(1)

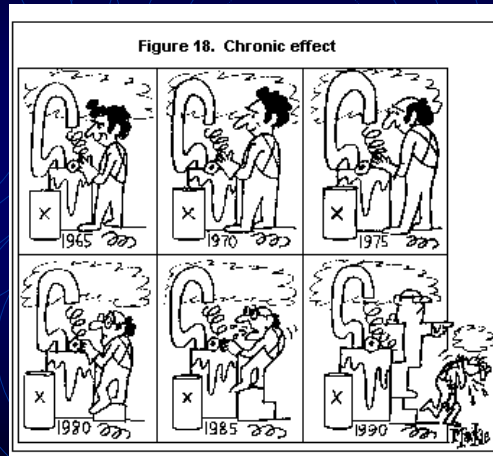
At high concentration, even with one-time or short-time exposure may cause significant effect (Acute effect).



Source: USERS' MANUAL FOR THE IPCS HEALTH AND SAFETY GUIDES

Quantitative assessment(2) Concentration and Response(2)

Even at low concentration, exposure occurring over an extended period of time may also cause significant effect (Chronic effect).



Source: USERS' MANUAL FOR THE IPCS
HEALTH AND SAFETY GUIDES

Quantitative assessment(3) How to do?

“Dose-response assessment” to the data from
Animal tests and epidemiological studies

Extrapolation to exposure
of general population of human,
at low concentration,
with 24h, lifelong.

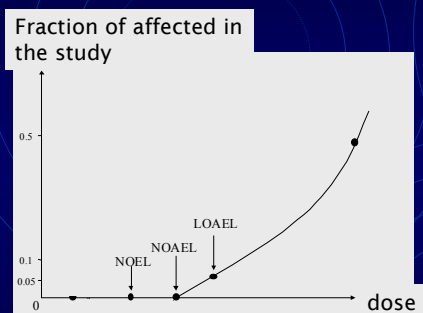
Are there any concentration level below which a
significant adverse effect is not expected?

Quantitative assessment(4) Dose*-response assessment

*Cumulative inhaled amount, or simply concentration at exposure with fixed manner (“scenario”).”

Assess Dose-response relation
specific to study, endpoint,
and scenario.

Quantitative assessment(5) Dose-response relation with threshold*



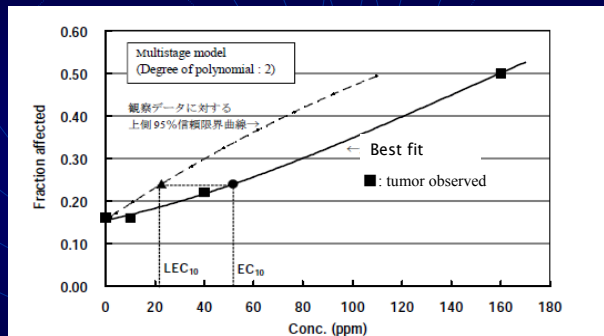
NOEL: No Observable
Effect Level

NOAEL: No Observed
Adverse Effect Level

LOAEL: Lowest Observed
Adverse Effect Level

*Threshold: the dose (concentration) below
which a significant adverse effect is not
expected.

Quantitative assessment(6) Dose-response relation without threshold



Carcinogen which cause DNA damage (adducts and breakage) is presumed to promote cancer at any low dose.

Quantitative assessment(7) Dose-response relation

| Adverse health effects | Type of relation |
|---|-------------------|
| -Non-cancer, -Carcinogenic but not cause DNA damage. | With threshold |
| -Carcinogenic and cause DNA damage. | Without threshold |

Quantitative assessment(8) Extrapolation to human dose- response relation

- Evaluation of data reliability.
- Extrapolation from;
 - results of animal study at high dose and/or;
 - results of epidemiological study, often of worker at high dose, to;human dose-response relation for general population at low dose.

Quantitative assessment(9) Extrapolation methods

- Simple to state-of-the-art.

Example of simple method:
use of uncertainty factor

| | |
|--|---------|
| Animal data to human | 1 to 10 |
| Variation with in species (Heterogeneity of population) | 1 to 10 |
| Use LO(A)EL, not NO(A)EL | 10 |
| Mutigenerational effects | 1 to 10 |
| Quality of the data (also called modification factor) | 1 to 10 |

Quantitative assessment(10)

Results of the assessment

| Effect | damage DNA? | Type of dose-response relation | Result |
|--------------|-------------|--------------------------------|------------------------|
| Non-cancer | NA | With threshold | Extrapolated threshold |
| Carcinogenic | - | | |
| | + | Without threshold | "Unit risk factor**" |

*In this case, the extrapolated excess lifetime cancer risk is expressed in terms of the lifetime average concentration (in $\mu\text{g}/\text{m}^3$) as:

$$(\text{cancer risk}) = (\text{concentration}) \times (\text{unit risk factor})$$

Relation to standard setting

- From the point of view to protect public health, the environmental standard shall be set
 - below extrapolated threshold, and;
 - (if the VOC is carcinogen and damage DNA) so as to excess cancer risk calculated for the standard is acceptable.*

*Many governments set acceptable risk level as 10^{-5} (one person per 100,000 population may suffer cancer during her or his lifetime) thus this is as the same as to say that the standard multiplied by unit risk factor is smaller than 10^{-5} .