

Environmental Exposure and Health Effects: TCE and PCE

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Objectives

After this presentation, the participant should be able to discuss:

- 1) taking an exposure history
- 2) human health effects related to trichloroethylene (TCE) and tetrachloroethylene (PCE) exposure
- 3) the evaluation of patients with possible exposure to TCE and PCE.

Exposure pathway: Air, soil, water

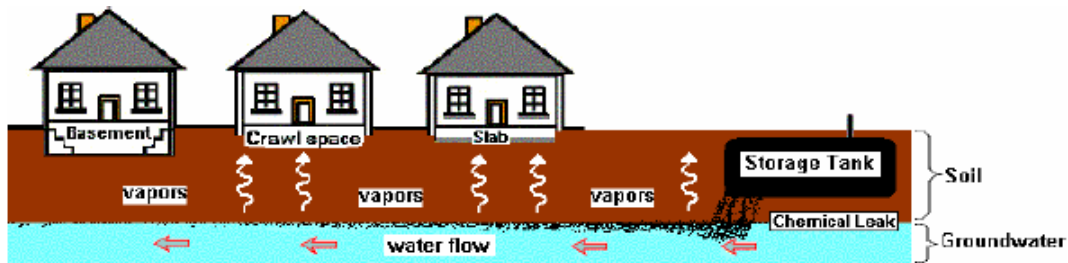
Routes of Exposure: Inhalation, ingestion, dermal contact

Time Frame: past, present, future

Vapor Intrusion

Migration of volatile compounds from contaminated groundwater through the soil into buildings

Health implications: Acute and chronic health effects, cancer risk, fire and explosion hazards



Association of Chemical Exposure with Health Impacts

Health effect has biologically plausible association with known toxicity of chemical

Level of exposure is consistent with dose known to cause health effects

- Complete exposure pathway
- Frequency and duration of exposure
- Concentration

Medical Exam: Exposure History

1. Do you live next to or near an industrial plant, commercial business, dump site, or nonresidential property?

2. Which of the following do you have in your home?

Please circle those that apply.

Air conditioner	Air purifier	Central heating	Gas stove
		(gas or oil?)	
Electric stove	Fireplace	Wood	Humidifier

3. Have you recently acquired new furniture or carpet, refinished furniture, or remodeled your home?

4. Have you weatherized your home recently?

5. Are pesticides or herbicides (bug or weed killers; flea and tick sprays, collars, powders, or shampoos) used in your home or garden, or on pets?

6. Do you (or any household member) have a hobby or craft?

7. Do you work on your car?

8. Have you ever changed your residence because of a health problem?

9. Does your drinking water come from a private well, city water supply, or grocery store?

10. Approximately what year was your home built? _____

“The findings and conclusions in this presentation have not been formally disseminated by the Agency for Toxic Substances and Disease Registry and should not be construed to represent any agency determination or policy.”

1. Are you currently exposed to any of the following?
 - metals
 - dust or fibers
 - chemicals
 - fumes
 - radiation
 - loud noise, vibration, extreme heat or cold
 - biologic agents
2. Have you been exposed to any of the above in the past?
3. Do any household members have contact with metals, dust, fibers, chemicals, fumes, radiation, or biologic agents?
4. Do you know the names of the metals, dusts, fibers, chemicals, fumes, or radiation that you are/were exposed to? [If yes, list them below.]
5. Do you get the material on your skin or clothing?
6. Are your work clothes laundered at home?
7. Do you shower at work?
8. Can you smell the chemical or material you are working with?
9. Do you use protective equipment such as gloves, masks, respirator, hearing protectors? [If yes, list the protective equipment used.]
10. Have you been advised to use protective equipment?
11. Have you been instructed in the use of protective equipment?
12. Do you wash your hands with solvents?
13. Do you smoke at the workplace?
 - at home?
14. Are you exposed to secondhand tobacco smoke at the workplace?
 - at home?
15. Do you eat at the workplace?
16. Do you know of any coworkers experiencing similar or unusual symptoms?
17. Are family members experiencing similar or un-usual symptoms?
18. Has there been a change in the health or behavior of family pets?
19. Do your symptoms seem to be aggravated by a specific activity?
20. Do your symptoms get either worse or better at work?
 - at home?
 - on weekends?
 - on vacation?
21. Has anything about your job changed in recent months (such as duties, procedures, overtime)?
22. Do you use any traditional or alternative medicines?
23. Have you or your child ever eaten on-food items, such as paint, plaster, dirt, clay?

(From: ATSDR's Case Studies in Environmental Medicine: Taking an Exposure History;
<http://www.atsdr.cdc.gov/csem/csem.html>)

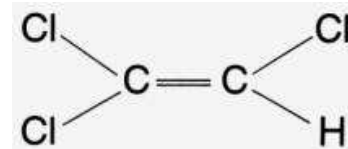
Trichloroethylene (TCE)

Volatile chlorinated hydrocarbon

Industrial degreaser/solvent

Consumer products: adhesives, spot removers, cleaning fluids for rugs, paint removers/strippers, typewriter correction fluids

Historical uses: extractant, medical



Pharmacokinetics

Absorption—readily absorbed across membranes

Ingestion: 90-95%

Inhalation: ≈ 75%

Skin absorption: negligible from vapors; high from liquids

Distribution—lipophilic

Richly perfused organs (liver, kidneys, lung)

Adipose tissue (1/2 life 3.5-5 hours), brain

Metabolism—rapid

Oxidation by Cytochrome P450 – major pathway, primarily liver

Conjugation with GSH

Elimination: Urine and Exhaled breath

Acute human health effects (inhalation)

Neurologic

81-110 ppm threshold for mild CNS depression

>500 ppm: excitation, light-headedness, headache, nausea, incoordination, impaired ability to concentrate

>2000 ppm: anesthesia

Cardiovascular: High concentrations: cardiac arrhythmia

Hepatic

Liver toxicity at high concentrations; Increased ALT, AST

Alcohol consumption increases risk

Chronic human health effects (inhalation)

Neurologic

Damage to cranial nerves

Impaired trigeminal nerve function (blink and masseter reflexes)

Memory loss, impaired cognitive function

Renal: High repetitive exposures—renal proximal tubule damage

Reproductive and developmental

Crosses the placenta

Congenital cardiac anomalies (ingestion exposure)

Respiratory: Minimal irritant; RADS or irritant induced asthma at very high concentrations

Dermal

Contact dermatitis, rashes, burns

Degreaser's flush (alcohol plus inhaled TCE)

Immunological

Exacerbate underlying autoimmune disease or trigger the onset of a syndrome

Genetic susceptibility: TCE metabolism

Association with systemic scleroderma

Cancer

International Agency for Research on Cancer – Group 2A (probably carcinogenic to humans)

Kidney: RR = 1.7 (1.1-2.7), Liver: RR = 1.9 (1.0-3.4)

Other cancer associations (Wartenberg et al. 2000. *EHP* 108(Suppl 2):161-176.)

■ Non-Hodgkin's lymphoma: RR = 1.5 (0.9-2.3)

■ Hodgkin's lymphoma, Cervical cancer

Confounded by exposure to other solvents, quantifying exposures, risk factors

Tetrachloroethylene (PCE)

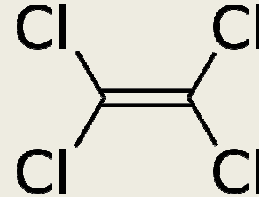
Volatile chlorinated hydrocarbon
 Industrial degreaser/solvent; chemical intermediate, dry cleaners
 Consumer products: spot removers, fabric water repellants,
 paint removers/strippers, typewriter correction fluids

Pharmacokinetics

Absorption—readily absorbed across membranes
 Highly lipophilic
 Readily absorbed by inhalation
 Proportional to ventilation rate

Distribution—lipophilic
 Richly perfused (12-16 hrs)
 Poorly perfused (30-40 hrs)
 Adipose (55 hours)
 Crosses the placenta

Metabolism—rapid, primarily in the liver
 Oxidation by Cytochrome P450 – major pathway; Conjugation with GSH
 Elimination: Urine (1-3%) and Exhaled breath (97-99%)



Human health effects (inhalation)

No clinical effects at exposures below 50,000 ppb
 Major Target Organs: brain, liver, kidney
 International Agency for Research on Cancer – Group 2A (probably carcinogenic to humans)
 Liver and kidney tumors in animals

TCE and PCE: Medical Testing

Occupational settings:

	TCE	PCE
Blood	trichloroethylene, free trichloroethanol	tetrachloroethylene
Urine	trichloroacetic acid, trichloroethanol	trichloroacetic acid
End-exhaled air	trichloroethylene	tetrachloroethylene

TCE and PCE: Medical Management (Inhalational vapor intrusion exposure)

Exposure history

- Proximity of home to known waste sites
 - Environmental sampling results, if available
- Past and present occupational duties

Special laboratory tests not indicated

Usual preventive screening, medical management

Avoidance of exposure

No antidote for TCE or PCE

For More Information:

ATSDR (www.atsdr.cdc.gov)

Case Studies in Environmental Medicine

- Taking an Exposure History, Pediatric Environmental Health, Trichloroethylene, Tetrachloroethylene

Toxicological Profiles

Medical Management Guidelines

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